International Experience in Green Growth

Mainstreaming the Values of Natural Capital into Policy and Finance Worldwide

Edited by Gretchen C. Daily, Lisa Mandle and James Salzman

natural capital PROJECT

保尔森基金会
PAULSON INSTITUTE

This publication was produced as part of a collaborative effort among the National Development and Reform Commission of the People's Republic of China (NDRC), Chinese Academy of Sciences (CAS), the Natural Capital Project, and the Paulson Institute. The aim of the collaboration is to create and improve diversified mechanisms for protecting, enhancing and investing in the value of natural capital and the ecosystem services generated by it. The international case studies within showcase experience from around the world and support China's efforts in creating policy and finance mechanisms for natural capital that are informed by international standards and best practices. The Paulson Institute supported the case writing, as well as the development and presentation of a training in green growth by the Natural Capital Project that engaged leaders of the NDRC and representatives from other key central government agencies and pilot provinces.

Front cover image: Tea plantation and surrounding landscape, near Yangshuo, China.
Photo by Stacie Wolny.

International Experience in Green Growth

Mainstreaming the Values of Natural Capital into Policy and Finance Worldwide

Edited by Gretchen C. Daily, Lisa Mandle and James Salzman

Graphics edited by Charlotte Weil

2017

Table of Contents

Contributing Authors

Katie Arkema, Natural Capital Project, Stanford University and University of Washington, United States of America
Ian Bateman, Land, Environment, Economics and Policy Institute (LEEP), Business School, University of Exeter, United Kingdom
Silvia Benitez, The Nature Conservancy, Latin America Region
Rebecca Benner, The Nature Conservancy, New York State, United States of America
Rick Bennett, Northeast Region, US Fish and Wildlife Service, United States of America
Amy Binner, Land, Environment, Economics and Policy Institute (LEEP), Business School, University of Exeter, United Kingdom
Kate A Brauman, Institute on the Environment, University of Minnesota, United States of America
Leah Bremer, University of Hawai'i Economics Research Organization and Water Resources Research Center, United States of America
Rebecca Chaplin-Kramer, Natural Capital Project, Stanford University, United States of America
Gretchen C. Daily, Natural Capital Project, Department of Biology, and Stanford Woods Institute, Stanford University, United States of America
Alyssa Dausman, The Water Institute of the Gulf, United States of America
Brett Day, Land, Environment, Economics and Policy Institute (LEEP), Business School, University of Exeter, United Kingdom
Carlo Fezzi, Land, Environment, Economics and Policy Institute (LEEP), Business School, University of Exeter, United Kingdom
Lisa Mandle, Natural Capital Project, Stanford University, United States of America
Len Materman, San Francisquito Creek Join Powers Authority, United States of America
Alex Rusby, Harrow School, United Kingdom
James Salzman, Bren School of Environmental Science & Management, University of California, Santa Barbara, and University of California Los Angeles Law School, United States of America
Greg Smith, Land, Environment, Economics and Policy Institute (LEEP), Business School, University of Exeter, United Kingdom
Rick Thomas, Bren School of Environmental Science & Management, University of California, Santa Barbara, United States of America
Alvaro Umaña Quesada, first Minister of Environment and Energy, Costa Rica, currently Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), Costa Rica
Kari Vigerstøl, The Nature Conservancy, Global Water
Nicola Virgill-Rolle, Economic Development and Planning Unit, Office of the Prime Minister, The Bahamas
Charlotte Weil, Natural Capital Project, Stanford University, United States of America
Ruth Welters, School of Environmental Sciences, University of East Anglia, United Kingdom

1. INTRODUCTION

James Salzman, Lisa Mandle and Gretchen C. Daily

In recent times, growth in human numbers and economic activity has dramatically transformed the planet. While driving great improvements in human well-being, this period and form of growth also deeply eroded natural capital, embodied in Earth's lands, waters, and biodiversity. We can see this clearly across the world. In China, rapid economic development since the late 1970s lifted hundreds of millions of people out of poverty and created the world's second largest economy and the largest manufacturer and exporter – a tremendous achievement. Yet the costs of this success are reflected in high losses of natural capital. These are visible in massive loss of primary forests; degradation and desertification of arid regions; destruction of wetlands and other ecosystems; and endangerment of the Giant Panda and many other iconic species. These losses of natural capital have contributed to massive flooding; sand and dust storms; extreme climate events; and loss of livelihoods.

Globally, the loss of natural capital – and the resulting costs – are commanding increasing attention from both scientists and policy makers seeking a new business model for people and nature. Securing natural capital is at the heart of China's Dream, to become the ecological civilization of the 21st Century. Food and fiber production, provision of clean water, maintenance of a livable climate, security from floods, the basis for many pharmaceuticals, and appreciation of the wonders and beauty of the natural world are a few of the many dimensions of human well-being that hinge on living natural capital.

The urgent challenge now is to move from ideas to action on a broad scale. Doing so requires a more rigorous understanding of the values of natural capital – today, and under alternative policy scenarios for the future – to inform investment in conservation and restoration. This understanding has been advanced rapidly over the past decade, and demonstrated in countries worldwide.

Moving from ideas to action on the scale required also requires creating innovative and effective policy and finance mechanisms that encourage conservation of natural capital and provision of services. These approaches will typically have dual goals of securing the well-being of both people

and nature simultaneously – green growth. In government policy, recognition of the value of natural capital is not new: one can find examples from societies throughout history of wise conservation practices. Yet, one need not look far today for activities that not only fail to consider the impacts on natural capital but that actively degrade it. Indeed, most laws in most countries do not explicitly consider, much less conserve, natural capital. Because services from natural capital are generally public goods and not reflected in market prices, their loss is unrecognized until the consequences are too large to ignore.

Over the past two decades, there has been tremendous innovation in policy and finance mechanisms designed to drive systemic change toward green growth pathways. A key focus is on the incentive structure for landholders – the stewards of natural capital stocks of forest, grassland, shrub lands, wetlands, coastal mangroves and coral reefs, farming and grazing lands, and the full suite of ecosystems providing benefits to society. How can economic and other incentives be channeled to make conservation and restoration attractive and mainstream?

As we shall see, there is a wide range of examples to learn from. Leaders in government, business and community groups around the world are increasingly recognizing the critical role that natural capital plays in human well-being.

This report provides best-practice examples that seek to channel economic resource flows to the conservation and restoration of natural capital. In the case studies that follow, we present programs from different regions using very different approaches. The innovation and creativity present in these cases is impressive. Despite the great variety of approaches, they fall into five broad categories.

Government Subsidy

Public bodies pay landholders either to ensure the provision of ecosystems services or to enhance provision. This is the largest in terms of value of transactions and the most common strategy.

Philanthropic Payments

Wildlife and other private groups pay landholders or purchase land themselves in order to ensure provision of services. Traditionally, this has most often been used to ensure the conservation of biodiversity.

Compliance Payments

Parties facing voluntary or regulatory obligations either compensate other parties for activities that maintain or enhance comparable ecosystem services or goods in exchange for a standardized credit or offset; or they undertake green infrastructure investments themselves to comply.

Market-Based Transactions

Companies see market opportunities in paying to provide ecosystem services or in gaining certification that their products are produced or provided in a sustainable manner.

Development Planning

Regional and local governments closely assess the impact of potential development on the provision of natural capital, providing economic incentives or zoning restrictions to conserve valuable natural capital.

Some of the case studies in this report provide clear examples of an approach listed above while others blend various aspects of these approaches. Costa Rica's national program, for example, features aspects of government subsidy and market-based transactions.

The case studies have been structured to follow a common format which is described below.

Description of the Problem explains the problem that the policy seeks to address. It may be contamination of drinking water sources, loss of biodiversity, or rural poverty. This initial framing is important because choosing the most appropriate policy instrument hinges on the nature of the specific problem.

Biophysical explanation of the relevant ecosystem service(s) sets out how the service will be provided. Not all natural capital is equally effective in service provision. Focusing on upstream forest conservation may be more effective to ensure flood protection and water quality, for example, than downstream grasslands.

Identification of the beneficiaries sets out which parties will either benefit from service provision or are threatened by the potential loss of service. Payment schemes are driven by demand: by the perceived scarcity of ecosystem services. The scarcity may concern water quality, flood protection, climate stability, or loss of biodiversity. If a service is not scarce (or is scarce but taken for granted), there is no evident need to pay for it. Because many services are public goods, demand can be amplified through regulation. This prevents free-riding and overcomes the collective action costs of organizing diffuse beneficiaries.

Identification of the suppliers sets out who provides the service. In most cases, this is landowners. To change their behavior, the incentives must be competitive with the opportunity costs. Put another way, PES on its own will make trees worth more standing than cut down only if the service payments to economically-motivated landowners are as attractive as, for example, the extractive values of timber or palm oil plantations.

Quid pro quo refers to the terms of the exchange. If payments are involved, what are the respective obligations of the parties? For example, is the landowner paid for input (changing the land management) or the output (actual provision of the desired service)?

Mechanism for transfer of value describes the operation of the exchange. For subsidy programs, how is eligibility determined and how are payments distributed? Institutions are particularly important in this context in order efficiently to bring together services suppliers and beneficiaries.

Monitoring and verification concern how those providing value or regulating service provision can ensure that the appropriate land management practices are, in fact, undertaken. This is a critically important aspect of any policy mechanism. Inadequate monitoring increases the possibility of cheating and inefficient provision of services.

Effectiveness addresses whether the program actually makes a difference on the ground. Payment and subsidy schemes may operate smoothly but, for a variety of reasons, not change the actual flow of services or state of natural capital. One can measure effectiveness in terms of service provision (a biophysical measure), efficiency (an economic measure), or improvement of social welfare (such as poverty reduction, gender equity, or securing property rights). For the vast majority of natural capital programs, we simply do not know because most policies are never assessed for effectiveness.

China is a world leader in some of the mechanisms presented, and has considerable experience with many of them. The challenge is to design, test, implement, and enforce a coherent system of policies to support green growth. Time is short – and the highest levels of ambition, commitment, and innovation are required. The future of China and the world depend on success.

2. PUBLIC PAYMENTS FOR ECOSYSTEM SERVICES – GOVERNMENT PAYMENTS

Lisa Mandle and Rick Thomas

Introduction

Government payment programs for ecosystem services, particularly for hydrological and for climate stabilization services, represent one of the longest-standing mechanisms for financing conservation of natural capital. Government institutions are often well-positioned to aggregate funds on behalf of many beneficiaries, for example through taxes or utility rate fees, and to compensate service providers.

In this chapter, we describe six examples of how government payments have been used to secure and enhance environmental benefits. The first two examples come from the United States: the cases of New York City's water supply and of the federal government's Conservation Reserve Program. The third example, the case of Working for Water, comes from South Africa. While Working for Water explicitly combines the dual goals of securing water resources and providing job opportunities to the rural poor, the two U.S. examples also have a goal of improving rural livelihoods. In the case of New York City's water supply, the service providers are compensated by the New York City beneficiaries. The Conservation Reserve Program Working for Water both operate primarily through government subsidies, in which ecosystem service providers are paid by the general tax base, rather than by specific beneficiaries of the service (Figure 2.1).

We focus on payments for climate regulation through the UNFCCC's REDD+ program in the last three examples in this chapter. Under REDD+, developed countries provide funds to developing countries for reductions in greenhouse emissions from deforestation and forest degradation, as well as for the enhancement of forest carbon stocks and forest cover. The first two REDD+ cases in Indonesia and Costa Rica are examples of multilateral funding, in which

funding has been pooled from multiple governments. The third and final case focuses on the Amazon Fund, a bilateral funding mechanism between Brazil and Norway.

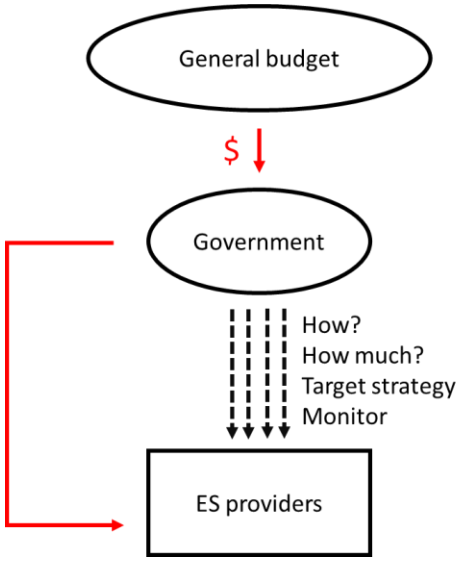

Figure 2.1 Under the government subsidy model, the government compensates ecosystem service providers with funds from its general budget. The government determines where and how to pay for securing or enhancing ecosystem services and is responsible for monitoring

Case 1: New York City's Water Supply

The problem

New York City's water system provides 4.5 million cubic meters of water per day to over 9 million people in and around the city. All of the water comes from surface sources: three watersheds located 80-200 km outside the city – the Croton, Catskill and Delaware watersheds (Figure 2.2). Giant pipes transport the water to reservoirs outside the city, where it is chlorinated and then distributed to city water mains. The result is urban drinking water quality that has long been recognized as among of the very best in the United States.

In response to an outbreak of water-borne disease (Cryptosporidium) in Milwaukee, Wisconsin, that killed over 60 people, the United States Environmental Protection Agency (EPA) implemented the Surface Water Treatment Rule in 1989. The new rule required large public water systems that rely on surface sources to filter their water regardless of quality. Based on this, the city built a treatment plant to filter water from the nearest watershed – the Croton, which was most impacted by suburban development and supplies 10% of New York's water. Constructing this filtration plant came at an eventual cost of over USD 3 billion, from an original estimate of USD 600 million.

The EPA rule also had a waiver provision, however, that allowed the city to avoid building a treatment plant if it could demonstrate that it had taken other steps necessary to maintain safe

drinking water. This left New York City with two options for the Catskill/Delaware watersheds, which supply the other 90% of its drinking water: build an additional filtration system at an estimated cost of up to USD 6 billion (plus annual operating expenses of USD 250 million), or petition for an exemption by showing that it could maintain safe, high quality drinking water through effective management of its unfiltered source watersheds. Based on a comparison of costs between filtration and watershed protection, the city chose to work with and invest in upstream communities in order to deliver safe, clean drinking water without filtration. This agreement was formalized in 1997 with the New York City Watershed Memorandum of Agreement and remains in place today.

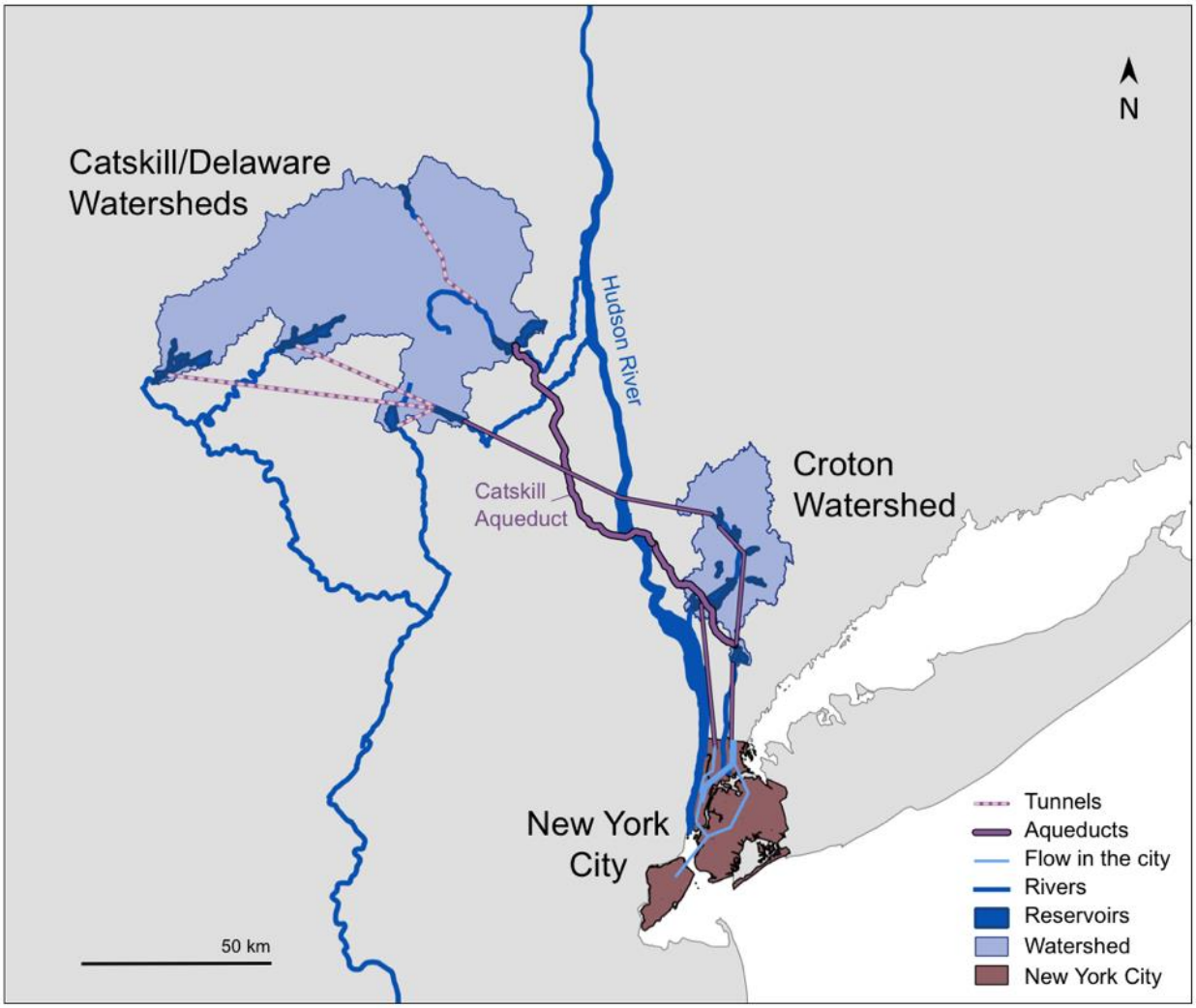

Figure 2.2 New York City's drinking water supply originates in the Croton, Catskill and Delaware watersheds, located between 80 and 200 km outside the city. Since 1997, the city has worked with and invested in communities in the Catskill and Delaware watersheds to protect water quality regulation services and deliver safe, clean drinking water without filtration.

The ecosystem service

Watershed protection contributes to regulation of water quality in two ways. First, maintaining natural vegetation and following best management practices reduce the amount of pollutants entering the system. This includes pollutants from discrete point sources, such as wastewater treatment plants and sewage systems, and from diffuse non-point sources, such as agricultural lands. Second, vegetation acts as a natural filtration system, capturing water and directing it to shallow subsurface flow, where soil and vegetation can sequester pollutants and keep them from reaching water bodies. This filtration capacity is especially critical in riparian areas around streams and reservoirs.

In the case of the New York City water supply, if water quality regulation services were not maintained through watershed management, a water filtration system provided an alternate option. Constructing such a system to treat water from the Catskill/Delaware watersheds would cost an estimated USD 4-6 billion with a projected 10-year life span, and with an additional USD 250 million annually in operating costs.

Ecosystem service beneficiaries

The beneficiaries of maintaining clean water are the water consumers ("rate payers") in New York City, who otherwise would face increased water and sewer rates if an expensive filtration plant needed to be built. According to estimates from the New York City Independent Budget Office in 2000, the average household would face fees that were 13% higher with the construction of a filtration plant.

Ecosystem service suppliers

With 70% of the Catskill/Delaware watersheds under private ownership, farmers and other rural lands owners are the main suppliers of water quality regulation services. Typical livelihoods are in producing apples, managing dairy cows, and growing trees for timber production. Famers who enroll in the voluntary Whole Farm Program and follow best management practices defined by the Program, to minimize impacts on water quality, receive direct compensation for these activities. In addition, communities in the source watersheds receive funding for general economic development.

Terms of the exchange/*Quid pro quo*

New York City initially provided USD 350 million in funding in 1997 for a variety of activities aimed at maintaining water quality of the upstream watersheds. To date, the city has spent approximately USD 1.5 billion in total.

Some of this funding contributes directly to improving water quality and is not spent on ecosystem service provision, for example by upgrading waste water treatment plants to reduce point-source pollution and by reducing the use of salt on icy roads during winter. Funding also

supports economic development and job opportunities in the upstream watersheds via the Catskills Development Council. This funding comes in exchange for restrictions on development and land use agreed upon under the Watershed Rules and Regulations. Many of these restrictions protect water quality regulation services. For example, they prohibit new impervious surfaces near waterways, wetlands and reservoirs in order to protect the water filtration capacity of vegetation in these areas.

In addition, farmers are paid directly through the Whole Farm Program to improve management practices and enhance ecosystem service provision on their land. This includes implementation of best management practices such as installation of vegetated filter strips, which trap sediments and nutrients in agricultural runoff, and fencing to keep livestock out of wetlands and streams.

Finally, some funding is used to buy land outright or purchase easements at a fair market value from willing landowners. This allows New York City to acquire and protect land around reservoirs and their tributaries, buffer areas that are key sources of water filtration services. Altogether, approximately 30,000 hectares are under improved management and 50,000 hectares of land or easements have been purchased.

Mechanism for transfer of value

The transfer of funding from New York City to service providers in upstream watersheds occurs under the New York City Watershed Memorandum of Agreement (MOA). Funding for the MOA comes from a combination of rate payer fees and from bond funds ultimately supported by tax payers. The MOA – which includes New York City, New York State, the United States Environmental Protection Agency, a coalition of 30 watershed towns, and environmental groups – was formalized in 1997. Somewhat unusually, state law gives New York City the power to regulate land use and development activities in its source watersheds in order to maintain the quality of its drinking water. The power to regulate land use over 150 km outside the city limits is very rare in United States law. It was the threat of unilateral regulation that brought upstream communities to the table to work out a bilateral agreement with the city.

The MOA established the Catskill Watershed Corporation to administer many of the community-level programs for protecting water quality and promoting economic development. The Watershed Agricultural Council implements the Whole Farm Program, described above in *Terms of the exchange*. Participation in the Whole Farm Program is voluntary for individual farmers. However, upstream communities needed to get the participation of 85% of landowners within 5 years; otherwise, they would face unilateral land use regulation by New York City. In the end, the farmer participation rate exceeded 90%.

Monitoring and verification

The quality of water from the Catskill/Delaware watersheds is monitored extensively and remains high. New York City's Department of Environmental Protection monitors compliance with the Watershed Rules and Regulations.

Effectiveness

From a biophysical perspective, watershed management has been successful at maintaining water quality that meets federal and state safety and quality standards. New York City's water supply permit and filtration exemption from Environmental Protection Agency was renewed in 2002, 2007 and 2017. The city's water supply remains the largest unfiltered source of drinking water in the United States. The MOA was renewed for another 15 years in 2012 with the support of watershed communities. This suggests that the social dimensions of the program are deemed successful to communities, as well.

Key lessons learned

As the balance of costs between watershed management and a water filtration plant demonstrates, natural infrastructure can be more cost-effective than built infrastructure at delivering services, even without including the co-benefits from conserving natural infrastructure, such as recreational opportunities and aesthetic values. This example also illustrates how a variety of mechanisms – from direct support to landowners, to general support of economic development of the supplying region, to outright land acquisition – can be combined to achieve the desired provision of water quality services.

It is important to note that the regulatory environment, and specifically the 1989 rule change that required either filtration or active watershed management, set the stage for New York City's investment in upstream watersheds. Without the regulatory mandate, it is not clear at all that New York City would have seriously investigated the payment scheme to watershed landowners and communities, much less raised the funds to pay for service provision. The city's ability under state law to regulate land use in upstream watersheds was another critical factor that pushed rural land owners to work cooperatively with government officials and generate a voluntary agreement.

Even keeping these specific conditions in mind, the Catskills program represents the best known and arguably one of the most successful payment for ecosystem service schemes. Faced with a regulatory mandate to ensure safe drinking water for its residents, New York City determined that investing in "green, natural capital" such as improved land use was a better financial decision than investing in "grey capital" such as a water treatment plant.

Case 2: The United States Conservation Reserve Program

The problem

In the 1970s in the United States, agricultural policy and domestic demand led to steep increases in the price of agricultural commodities. In order to increase supply, American farmers were

encouraged to plant "fencerow to fencerow." As a result, perennial vegetation, including forests, shrublands and grasslands, and extensive marginal, low-productivity lands were converted to crop production. This had detrimental environmental effects, including increases in soil erosion, decreases in water quality from runoff of agricultural pollutants, and loss of habitat for wildlife. The increases in production, combined with international geopolitical factors, also depressed crop prices for farmers. The Conservation Reserve Program (CRP) was established in 1985 to reduce the environmental impacts of agricultural production, while also supporting farmers during a period of low crop prices. CRP provides subsidies to farmers to convert environmentally sensitive croplands to perennial vegetation in order to improve environmental conditions.

The ecosystem services

CRP has three main environmental objectives: to improve water quality, reduce soil erosion and improve wildlife habitat. Fertilizers and pesticides applied to crops can run off into waterways, diminishing water quality. Tilling leaves topsoil exposed to wind and rain, exacerbating erosion and reducing soil fertility, air quality and water quality. Conversion of natural vegetation to farmland reduces habitat available for wildlife species. CRP's objectives are linked to a variety of ecosystem services, with economic and health benefits, including improved drinking water quality, improved marine and freshwater fisheries resulting from improved water quality, recreational opportunities from improved water quality and increased wildlife viewing and hunting opportunities, and improved air quality from reduced wind-borne dust.

Ecosystem service beneficiaries

Many people stand to benefit from the ecosystem services provided by CRP. The specific beneficiaries depend on the location of CRP activities relative to where and how people rely on clean water, clean air and benefits from wildlife (meaning the same as biodiversity). Unlike the case of New York City's water supply, the beneficiaries do not pay directly for the ecosystem service benefits, which are instead supported by the federal tax base (see *Mechanism for transfer of payment* below).

Ecosystem service suppliers

Farmers whose land-use decisions and management practices affect water quality, soil loss and wildlife habitat are the ecosystem service suppliers. Eligible farmers who choose to enroll in CRP are compensated. Public lands are not included.

Terms of the exchange/*Quid pro quo*

Under CRP, farmers who enroll eligible land agree to remove that land from crop production and plant perennial vegetation to improve environmental quality in exchange for an annual rental fee over the 10- to 15-year duration of the contract. To be eligible, land must have been in production for 4 out of 6 of the previous years, or be marginal cropland or pastureland near a water source.

CRP also provides up to 50% cost share (paying for up to 50% of the total costs) and up to 20% of the annual rental fee for additional conservation activities like windbreaks, filter strips and riparian buffers.

CRP provides approximately USD 1.9 billion per year in funding. At its peak in 2007, 15 million hectares were enrolled. As of 2016, enrollment had declined to 10 million hectares – the lowest level since 1988 – reflecting the acreage cap the government set in 2014 aimed at reducing the CRP budget (Figure 2.3).

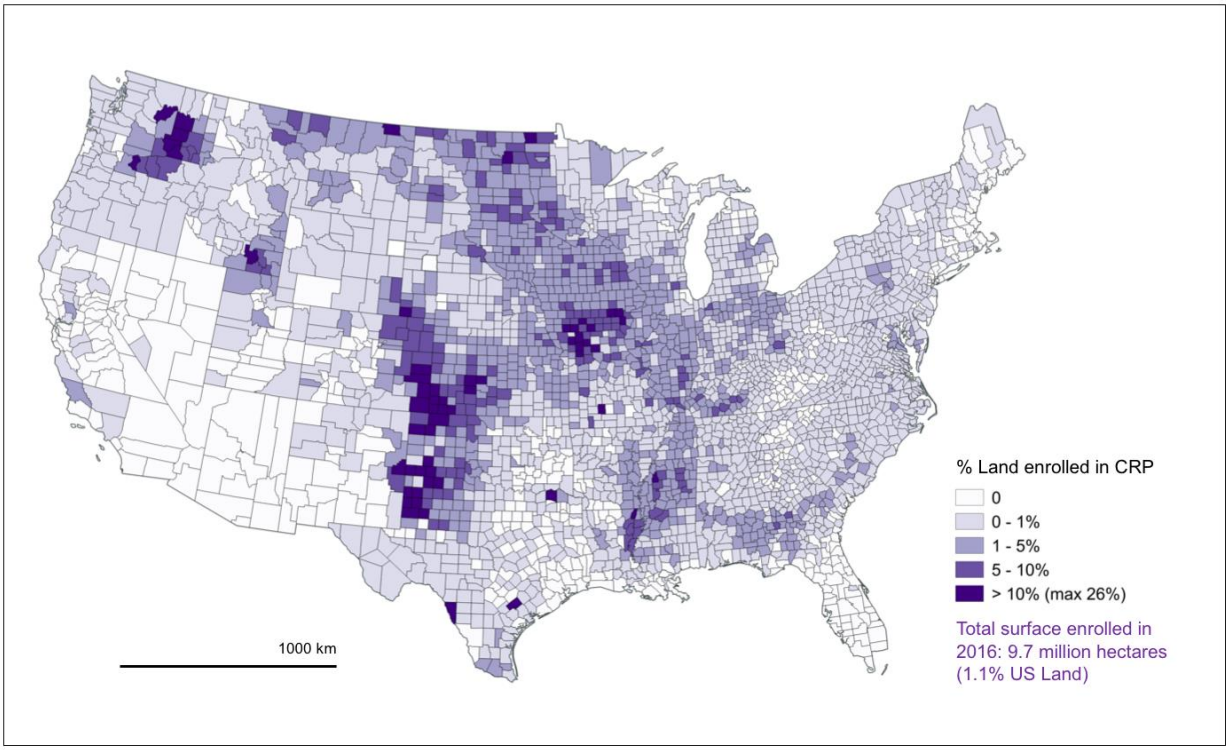

Figure 2.3 Distribution of land enrolled in CRP across the United States in 2016

Mechanism for transfer of value

CRP is funded under the US Farm Bill. It is administered by the Farm Service Agency (FSA) within the US Department of Agriculture. Farmers enter into contracts with the Commodity Credit Corporation, also under the US Department of Agriculture (USD A). Contracts are awarded based on a reverse auction, which works as follows: Landowners submit bids for a requested rental rate for a specific conservation activity (e.g., planting grasses, trees or riparian buffers) on a specific parcel. Bids are accepted during an approximately annual enrollment window. Bids submitted during this time are then ranked against each other based on an Environmental Benefits Index (EBI). EBI scores are calculated based on the parcel and its associated conservation activity's value for water quality, erosion control, wildlife, as well as the parcel's rental rate. Bids are accepted in order of their EBI score, up to a maximum target acreage. In addition, CRP acreage cannot exceed 25% of the cropland per county.

Because of the acreage limits and the limited enrollment time window, farmers are competing against each other to win a contract and enroll in CRP. Farmers can increase the likelihood of their bid being accepted into CRP by increasing their EBI score in two ways: by lowering their requested rental rate, and/or by offering to implement an activity on the parcel with greater conservation value. The FSA sets the maximum rental rates for the contracts. The rates vary by parcel, based on soil productivity and crop value, and these rates are provided to landowners to be used in preparing their bids.

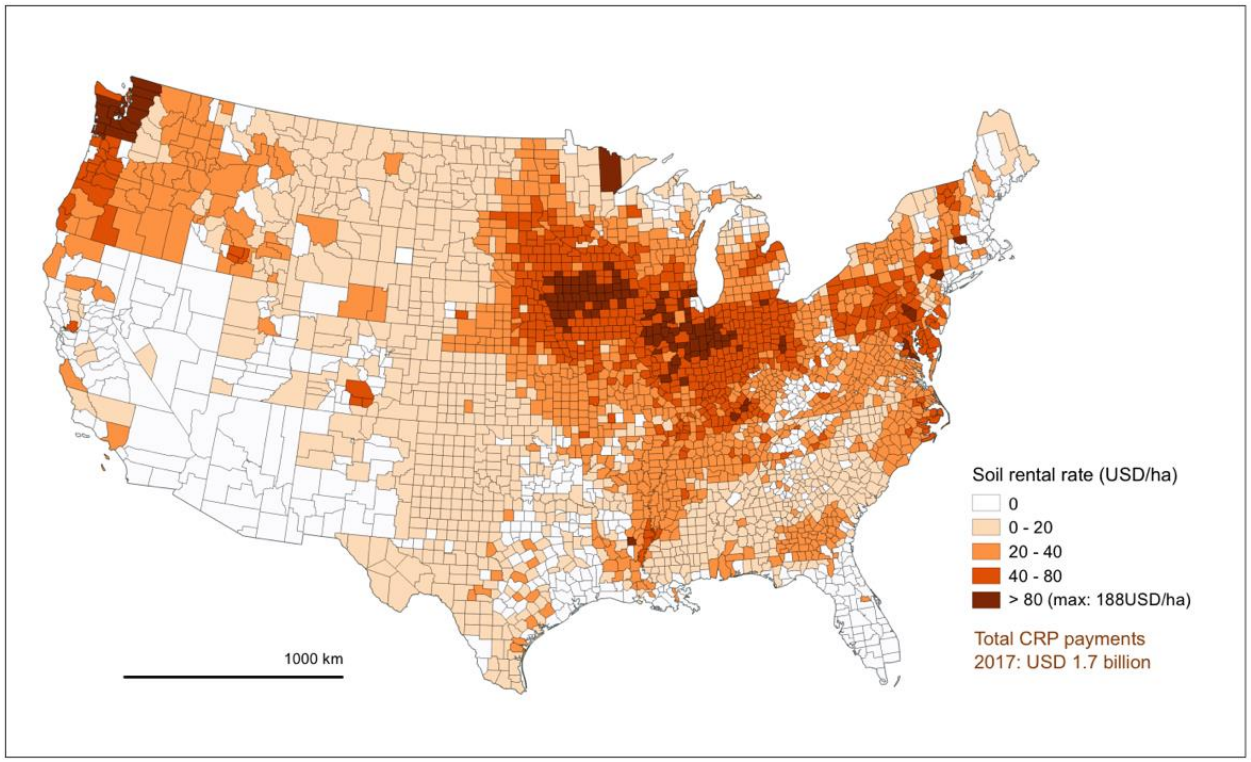

Figure 2.4 Average soil rental rates (USD/ha) for CRP land across the United States in the 2016 fiscal year

Monitoring and verification

The FSA is supposed to monitor CRP contracts to ensure they comply with their required conservation practices and acreage enrolled. However, according to the most recent assessment by the United States Office of Management and Budget in 2005, monitoring has been problematic. There is often not an effective response when land is not being managed according to the contract.

Effectiveness

CRP is estimated to have prevented over 8 billion metric tons of soil from eroding, as well as reduced nitrogen runoff by 95% and phosphorous runoff by 85%, relative to annually tilled cropland. As a result of CRP, 1 million hectares of wetlands have been restored and 275,000 kilometers of streams have been protected with riparian buffers. In addition, CRP has promoted

the sequestration of an average of 44 million metric tons of greenhouse gases annually. The benefits of CRP to wildlife have also been substantial, especially for grassland birds and waterfowl.

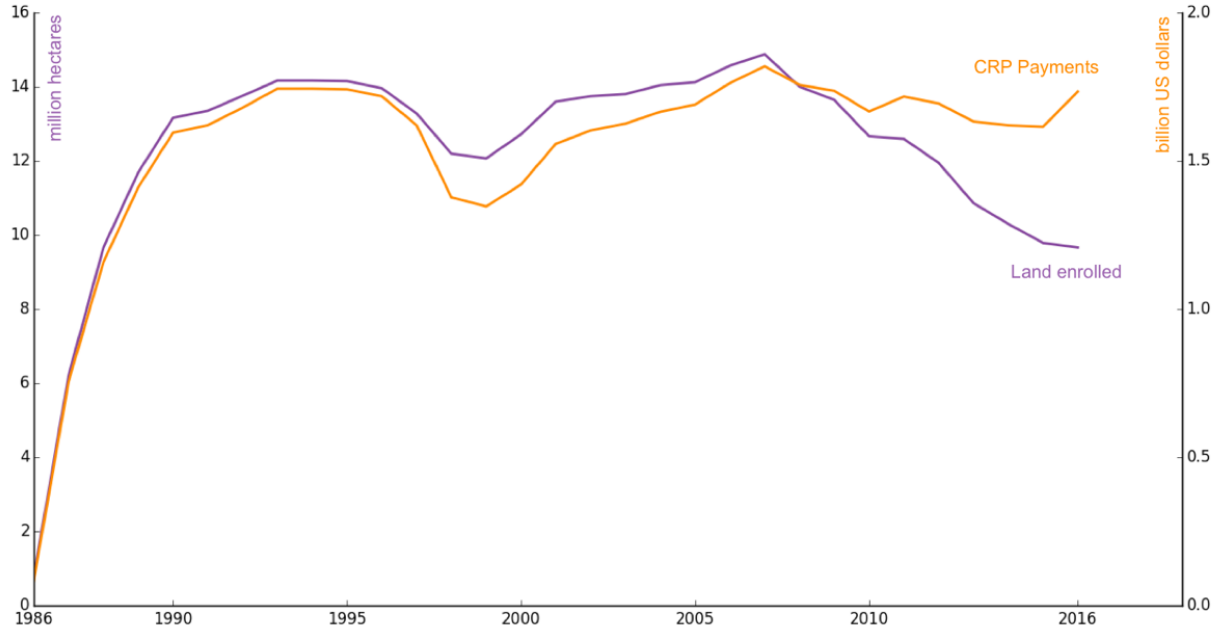

Figure 2.5 Area of land enrolled in CRP and CRP payments from 1986 to 2016

What these biophysical changes mean in terms of economic values or other benefits to people is less clear. A 1999 study estimated the economic benefits of sediment retention at ~USD 300 million per year. A 2007 USD A study estimated that the program provided USD 1.3 billion in annual benefits nationally, which represents 75-80% of the program's costs. However, the study valued only a subset of the program's total benefits, so this represents a very conservative estimate. Earlier assessments concluded that CRP benefits outweigh program costs.

CRP could more effectively target the places where reduced erosion and improved water quality matter most to people and increase the program's economic benefit by adjusting the method used to prioritize land for enrollment based on its environmental benefits. Scores from the CRP's Environmental Benefits Index (EBI) are based largely on the biophysical aspects of ecosystem services, or the *potential* for a particular parcel to improve air quality and water quality regulation services. EBI provides some weighting for land that occurs in high priority water quality and air quality zones. However, a 2008 CRP program assessment suggests that this is not enough, and providing additional weight to land in priority areas could improve the program's contribution to solving water quality and air quality problems at national and regional scales.

Adjustments to the design of CRP's reverse auction enrollment mechanism could also increase the program's effectiveness. Over time, the bids accepted into CRP have converged towards the maximum rental rate for parcels. Because there are recurring enrollment periods approximately annually, and because most bids are accepted, farmers whose bids are not

accepted one year can apply again the next year using the information they gain to adjust their bids accordingly. Farmers can therefore be aggressive in their bidding and capture more rent for providing the same benefit than they might otherwise. Increasing competition among farmers and inducing bids closer to the real opportunity cost through changes to EBI or the auction mechanism could make CRP more cost effective.

Finally, environmental groups have raised concerns about the durability of CRP benefits. At the end of a 10 to 15 year CRP contract, landowners can choose whether or not to re-enroll their land. When crop prices are high relative to the maximum rental rates, land is often not re-enrolled, and is instead converted back to agricultural production. For example, between 2007 and 2014, a period of rising crop prices, 6.5 million hectares of CRP lands were not re-enrolled when their contracts expired. A number of groups have suggested that acquiring long-term or permanent easements would secure environmental benefits more cost effectively, despite the higher cost per acre.

Key lessons learned

CRP has successfully enrolled millions of hectares, leading to important reductions in sediment and pollutants in waterways, improvements to air quality and enhancement of wildlife habitat. The subsidy support it provides to farmers, especially in times of low crop prices, has been key to attracting political support and funding. The CRP's reverse auction system for enrolling land is the program's main policy innovation. While there may be opportunities for further increasing its effectiveness, the reverse auction mechanism has secured environmental benefits more efficiently than offering a simple per-acre price.

Sustaining the benefits of CRP is a challenge, especially in the face of increasing crop prices. Because CRP contracts come up for renewal every 10 to 15 years, if crop prices are high, famers may choose not to re-enroll and instead put lands back into agricultural production, making the environmental gains transient. In addition, funding for the program under the Farm Bill must be renewed approximately every 5 years, and securing adequate funding in a changing political climate can be difficult.

Case 3: Working for Water in South Africa

The problem

Water scarcity is a major challenge for the country of South Africa. With a semi-arid climate, water availability is limited and fluctuates dramatically both throughout the year and between years. In addition, water resources are distributed unevenly across the country, with 50% of the water flowing in rivers and streams coming from just 13% of the land. Water requirements exceed availability for much of the country. Without increases in water use efficiency, demand for water is projected to exceed supply in the country as a whole by 2025. Historically, water demands were met through engineered solutions, with construction of 800 large dams to store water and 28 inter-basin transfer schemes, including import of water from neighboring countries.

However, opportunities for increased water supplies through additional dams and transfers are limited and expensive.

Starting in the 1970s, there was a growing realization in the scientific community that the spread of water-thirsty, invasive alien plants threatened not only the country's native plant biodiversity but also its water resources. Without funding to control the spread, stream flows in the western part of the country were likely to decline between 20 and 50%, and water supplies to the city of Cape Town could potentially be reduced by 30%. The Working for Water (WfW) program was launched in 1995 as a public works program to support clearing of invasive alien plants in order to create jobs and secure South Africa's water resources (Figure 2.6).

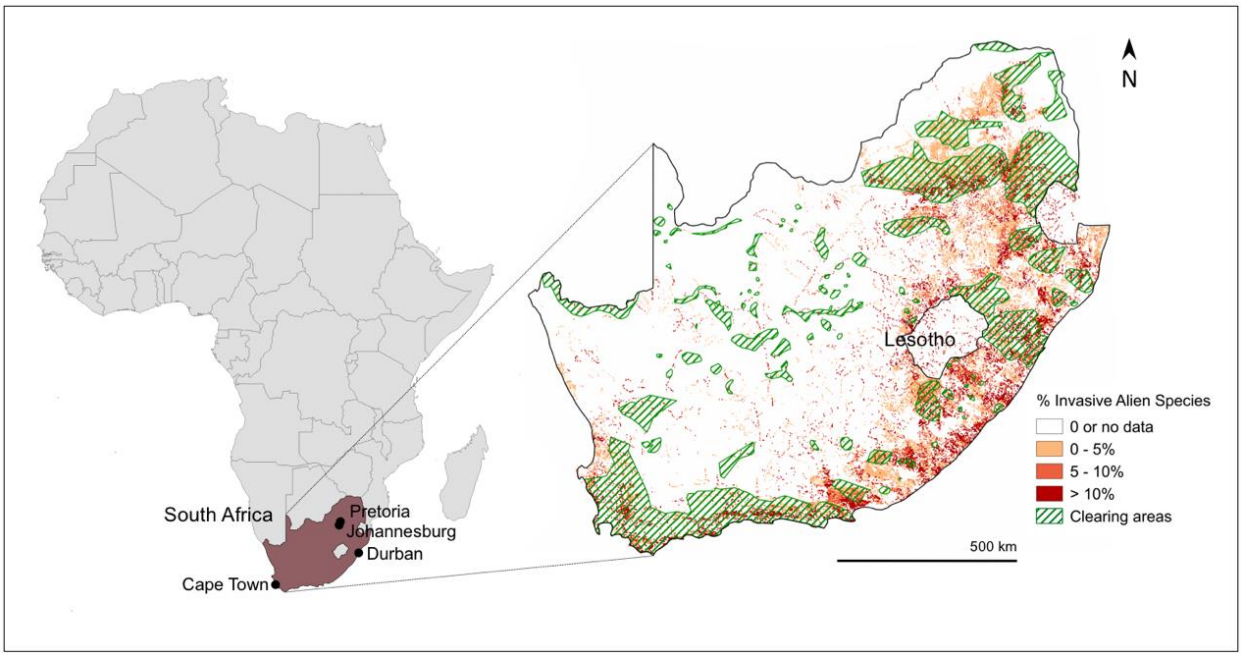

Figure 2.6 Extent of invasive alien species in South Africa (shown in orange and red), along with areas cleared by Working for Water (shown in hatched green). Note that these areas show where at least some clearing has occured, but not all land within these areas

The ecosystem service

Invasive alien plants in South Africa, including trees such as pines, eucalyptus and wattles, as well as riparian woody species, use more water than the native vegetation they replace. Through their roots, they transfer water from underground (where it feeds into streams) to the atmosphere (where it is lost to local people). Catchment-scale studies have shown that removal of these alien species leads to increased stream flows, especially dry-season flows.

Clearing of invasive alien species can be a cost-effective option for increasing water supplies, as several studies undertaken in the early 1990s demonstrated. An analysis of the water supply for the Cape Town metropolitan area showed that controlling invasive species in the existing source catchment would provide water at 13.6% of the cost as compared to building a new dam to capture water from an additional catchment. Clearing vegetation was shown also to

be more economically favorable for increasing water supply than desalination or reuse of sewage.

Ecosystem service beneficiaries

Water users – including cities, industry and agriculture – benefit from the increased water availability that comes from clearing invasive alien species. For the most part, beneficiaries do not pay directly, but there are some exceptions (see below in *Mechanism for transfer of value*).

Ecosystem service suppliers

The suppliers of the ecosystem service of water provision are the government and the people who clear invasive alien plants from the land. Compensation is provided to the people who clear the plants, rather than the landowners, as is the case in the other case studies in this chapter. Much of the land cleared under WfW is public land.

Terms of the exchange/*Quid pro quo*

WfW began in October 1995 with ~USD 2.5 million and 10 projects in 6 out of 9 provinces. As of 2016, this had expanded to 300 projects across all 9 provinces, with a budget over USD 75 million. Since its start, 2.5 million hectares have been cleared at least once, with follow-up clearing 2.7 times on average (Figure 2.6). As of 2015, 40,000 people have been employed through WfW. It has spurred the development of a portfolio of similar programs with other environmental objectives, such as Working for Wetlands, aimed at wetland rehabilitation, and Working on Fire, aimed at fire management.

Mechanism for transfer of value

Implementation of WfW is based on a contractor system. WfW appoints implementing agents that are responsible for managing projects on the ground. Institutions or organizations such as municipalities, government conservation agencies, irrigation boards or forestry companies serve as implementing agents. Implementing agents then recruit and manage contractors, who are individuals that have set up their own small businesses and contract with WfW. Contracts are awarded through a non-competitive bidding system, though there is pressure to change this to a competitive system. Contractors are assigned specific areas to clear and paid at a rate based on the particular species present and their density. Contractors employ the teams of workers who carry out clearing and management of invasive alien plants.

At its start, WfW was funded by the South African government's Reconstruction and Development Programme, which focused on reconstruction and socio-economic development in the post-Apartheid era. WfW is currently funded primarily by the Expanded Public Works Programme in the Department of Public Works. The program is administered by the Department of Environmental Affairs. According the most recent budget estimates available, around 80% of WfW's budget comes from the central government's Poverty Relief Fund, generated from general

tax revenues. Approximately 10% of the budget comes from water resource management fees charged to water users in certain Water Management Areas; this funding is earmarked for removal of aquatic weeds. Some municipalities, state-owned utilities and private companies have paid the WfW program for clearing specifically within their catchments. Foreign donors and other government departments (e.g., Tourism, Agriculture) have also contributed funding. WfW has also experimented with attracting co-funding from land owners to clear invasive alien plants from private lands, though this is still a minor component of the WfW program.

Monitoring and verification

Monitoring and verification addresses both biophysical and social dimensions of the program. Control efforts are monitored in terms of the area of invasive alien plants treated, the number of sites where biological control agents are established, and the number of emerging invasive alien species controlled. On the social side, the focus is the number of full-time equivalent jobs created, with sub-targets for women, young people, and people with disabilities. Because the program is funded by the Expanded Public Works Programme, which is aimed at providing work opportunities for the unemployed, success is evaluated primarily in terms of costs per person per day, with the goal of minimizing costs and maximizing employment opportunities. The ecosystem service outcomes, in terms of changes in water resources, are not monitored.

Effectiveness

In the 20 years since the establishment of WfW, the program has created over 500,000 work opportunities and more than 190,000 full-time-equivalent job-years. The program has succeeded in providing temporary employment opportunities to many people, but whether it has improved long-term employment is not clear.

WfW has funded the clearing invasive plants from large areas. Although the effectiveness of the program at securing water resources or other ecosystem services is not directly monitored (see *Monitoring and verification* above), the government estimated that between 50 and 130 million cubic meters per year were made available by clearing through 2003, equivalent to between 0.1 and 0.3% of mean annual runoff in the country.

However, the spread of invasive alien species is still outpacing control efforts in many areas. Because of the program's job-creation goals, clearing efforts are not necessarily directed at the highest priority areas from a water resources perspective. Scientists have mapped priority areas for invasive alien plant removal; however, projects continue in low-priority areas because of political demands to create jobs there. WfW has received criticism from the scientific community that job creation has been prioritized too heavily over the objective of improving water resources. In addition, the areas that are cleared are often not cleared effectively, due to the technical difficulty and physical demands of invasive species control, for which WfW teams are often insufficiently trained and lack adequate performance incentives.

Key lessons learned

WfW's dual goals of invasive species control and poverty alleviation are both the key to its success and a challenge in its implementation. The level of funding and effort that WfW has garnered for invasive species control could have not been mobilized without its job creation component. However, when it comes to deciding which areas to prioritize for WfW projects, there is often a tension between allocating funding to those places that are a priority for job creation and those that are a priority for improving water resources. Because WfW is fundamentally a public works program, the job creation priorities take precedence in practice. In addition to the critical component of poverty alleviation, credible science underpinning the policy has been crucial, demonstrating that there is significant alignment of priority places for job creation and for improving water resources, even though there will always be tension over tradeoffs where alignment is not perfect. Finally, having champions in government at an opportune time also enabled the success of WfW.

REDD+ payments for forest carbon

One area of public payments for ecosystem services that has received a lot of attention is compensation for forest carbon. These payments are seen as a major policy tool to address deforestation, the second leading cause of greenhouse gases globally. The biggest international instance of direct payments for forest carbon to date is the UNFCCC's REDD+ program. Under REDD+, developed countries provide funds to developing countries for reductions in greenhouse emissions from deforestation and forest degradation, as well as for the enhancement of forest carbon stocks and forest cover. Given historic difficulties of ensuring that public payments are utilized for their intended purpose, REDD+ payments are typically disbursed only upon verification of a decrease in greenhouse gas emissions stemming from deforestation within a developing country's borders. While this type of results-based approach has become increasingly common, REDD+ also includes mechanisms for capacity building to help developing countries successfully implement deforestation prevention strategies.

REDD+ payments take one of two forms: multilateral agreements, where developing countries apply for funds from an organization that multiple parties contribute to, and bilateral agreements, where developing countries negotiate direct payments from a single developed country. This section covers both of these funding options available through REDD+. The first two examples are case studies of multilateral funding through the Forest Carbon Partnership Facility's Readiness and Carbon Fund in Indonesia and Costa Rica. The third example focuses on the Amazon Fund, a bilateral funding mechanism between Brazil and Norway.

Case 4: Multilateral Agreements: Forest Carbon Partnership Facility Readiness Fund in Indonesia

The problem

Indonesia is home to the third largest tropical forest (after the Brazilian Amazon and Democratic Republic of Congo forest), and its peatlands have the largest carbon stocks in the tropics. The country contains high floral and faunal biodiversity, including 10% of the world's plants, 12% of the world's mammals, 16% of the world's reptiles and amphibians, as well as 17% of the world's bird species. Unfortunately, anthropogenic fires within these forests and peatlands, as well as the conversion of forests for other uses such as palm oil plantations threaten many of these species with extinction and have made the country one of the global leaders in land-based emissions. Over a 12-year period from 2000-2012, the country lost over 6 million hectares (ha) of its forest land, with deforestation rates increasing by 47,600 ha per year on average over that same time period. In total, this degradation and deforestation accounts for about 85% of the country's carbon emissions.

While this habitat destruction is a global concern due to the carbon emitted, it causes disproportionate harm for the citizens of Indonesia. Indonesia has many communities who rely on forests for their livelihoods; it is estimated that more than 74% of the country's poor depend on ecosystem services for their livelihoods, services that are compromised as the land becomes degraded or deforested. Smoke from the slow burning peatlands has also been linked to respiratory diseases and decreased productivity in the workforce. These fires, most of which are often started deliberately and illegally to clear forests, were estimated by the Indonesian government to cost the country over USD 30 billion in 2015. Additionally, in any given year, it is estimated that illegal logging costs the country USD 3 million in lost revenue.

The ecosystem service

Forests provide numerous ecosystem services. From a global perspective, forests' ability to store huge amounts of carbon helps mitigate the dangerous effects of climate change. On a more local level, forests help prevent soil erosion and nutrient loss and can increase water availability by slowing storm water runoff, thereby filtering the water and recharging aquifers. It is well-documented that investing in this natural capital has the potential to save countries money over time.

Specifically, in Indonesia a REDD+ study in the province of Central Sulawesi found that one hectare of forest prevents soil erosion equivalent to 6,538 kg/ha/year, which translates to an avoided cost of approximately USD 30 ha/year when considered alongside avoided soil nutrient loss due to surface run-off. Expanded to five key provinces throughout the country, the study found that the economic value of soil erosion prevention in the provinces ranges from USD 2-81 million per year. Considering other ecosystem services, the economic value of carbon sequestration and storage ranges within these provinces range from USD 17-97 million and USD

1.2-19 billion per year, respectively. The economic value of water augmentation ranges from USD 435 million-2.4 billion per year.

Ecosystem service beneficiaries

Beneficiaries are those whose livelihoods or quality of life would be compromised with continued deforestation. In Indonesia, because continued degradation of forests depletes the key regulating services mentioned above, one of the main groups that stand to benefit from ecosystem service protection are small-scale subsistence farmers. Farming is a key component for many of the country's provinces; 80% of the inhabitants of East Nusa Tenggara, for example, are involved in the agricultural sector and would benefit from more sustainable forestry management. Currently, many Indonesian farmers rely on slash and burn agriculture, a technique which compromises both the long-term productivity of the land and their community's resilience to future climate change impacts.

Additionally, because carbon is a global pollutant, the global community is a beneficiary of these ecosystem services, as it stands to be worse off should climate change effects amplify. In particular, communities vulnerable to harmful climatic events will benefit the most, such as inhabitants of coastal communities and low-lying islands.

Ecosystem service providers

Under the negotiations stipulated in the Readiness Fund, Indonesia's government is the ecosystem services provider and the entity that is being compensated for their actions. While this is a national approach, under REDD+ sub-national entities—such as provinces—can be considered suppliers of the ecosystem service, and therefore receive compensation.

Terms of the exchange/*Quid pro quo*

The Readiness Fund is meant to preserve and protect forest ecosystem services by helping developing countries prepare for participation in future, large-scale REDD+ initiatives. The Fund does this by assisting parties adopt national REDD+ strategies, develop reference emission levels (RELs), design measurement, reporting, and verification (MRV) systems, and set up REDD+ national management arrangements, including proper environmental and social safeguards. A reference level is the amount of greenhouse gas emissions from deforestation and forest degradation that a country's new emissions will be evaluated against and is typically the historical average of the area being monitored over a given timeframe. If a country's emissions post-REDD+ are lower than the reference level, it has achieved emissions reductions. Safeguards are strategies that ensure emissions reductions do not compromise other environmental or social goods, such as biodiversity or the well-being of indigenous communities.

Countries interested in receiving money from the Readiness Fund first submit a Readiness Plan Idea Note (R-PIN). The R-PIN is meant to serve as a template outlining the minimum requirements which a country must meet to begin its REDD+ implementation. For example, in

Indonesia where illegal logging is a main driver of deforestation, the R-PIN recommends significantly improving law enforcement and compliance to implement meaningful REDD+ strategies. Once the R-PIN is approved, the next step is for countries to prepare their Readiness Plan, which is a framework that sets a clear approach, budget and schedule to undertake REDD+ activities. Once this is approved, countries are eligible for Readiness Funds to finance the capacity building set forth in the plan.

Mechanism for transfer of value

A country's progress towards the Readiness Fund is overseen by The Forest Carbon Partnership Facility (FCPF). The FCPF is a global partnership of businesses, individuals, and governments created in 2007 following the Bali Accords. Although the Readiness Fund is multilateral, meaning money can come from both private and public sources, to date only public payments from national governments have been received. The entities that have contributed to the Readiness Fund include: the European Commission, Australia, Canada, Denmark, Finland, France, Germany, Italy, Japan, Netherlands, Norway, Spain, Switzerland, the United Kingdom, and the United States. With the World Bank as the Trustee overseeing these donations, the Readiness Fund has received USD 365 million in commitments since its inception.

As of June 2016, Indonesia has received over USD 3 million in start-up finance from the Readiness Fund. Disbursement of funds has occurred in the form of grants over the course of five years, starting in 2011.

Monitoring and verification

Before distributing funds, the FCPF reviews and assesses each country's Readiness Plan. In particular, the FCPF evaluates whether or not each plan will help the country meaningfully implement REDD+ strategies in the future. The FCPF determines this by verifying that the country has designed a rigorous national REDD+ strategy, identified accurate and appropriate reference emission levels and created a system to monitor and verify the impact of future programs.

Additionally, the FCPF verifies that each plan has a high degree of consultation with civil society and indigenous communities. This stipulation can be satisfied if the country has developed participatory mechanisms to ensure that indigenous communities are meaningfully consulted during the formulation and implementation of their country's Readiness Plan and REDD+ Strategy and benefit from the country's capacity building.

Effectiveness

The Readiness Fund has successfully helped Indonesia and 36 other countries design and implement rigorous infrastructure for REDD+ programs. As of June 2016, Indonesia's REDD+ Strategy has been finalized, meaning that the country has successfully determined its reference emission level, National Forest Monitoring System (NFMS), mechanism for measurement, reporting, and verification, and Safeguards Information System for REDD+ (SIS REDD+).

The Readiness Fund process has helped Indonesia identify areas of weakness in terms of forest management that the country would likely not have had the capacity to address on its own. Specifically, according to feedback from the FCPF, the country needed to invest more in capacity building and awareness of REDD+ for local communities and develop a clearer system of incentives and performance based mechanisms to ensure meaningful progress towards emissions reductions.

While this process has helped Indonesia address these deficiencies, because the country has yet to submit results from its REDD+ strategies, the Readiness Fund's effectiveness in reducing deforestation and forest degradation is still unknown.

Lessons learned

The case study of REDD+ financing in Indonesia highlights the importance and necessity of start-up funds for capacity building. Despite the widespread damage being done to Indonesia's forests, it is unlikely that meaningful progress towards forest management strategies would have occurred without this type of start-up assistance. This is predominantly due to corruption, the economic value that private actors can capture from deforestation, and the diffuse nature of the primary ecosystem service benefit (while services like soil erosion prevention can be internalized by the country, carbon storage, currently, cannot). An investigation into Indonesia's forest policy gives credence to this idea: the country established a moratorium on new permits to clear primary forests in 2011 only *after* Norway agreed to fund up to USD 1 billion in deforestation projects. It is interesting to note however, that out of this amount, Norway has only distributed USD 60 million due to fear of corruption and a lack of results.

Because the majority of money available for forest carbon is results-based, having rigorous systems in place like those that the Readiness Fund helps develop is a necessary prerequisite to meaningfully obtaining and quantifying emissions reductions.

Case 5: Multilateral Agreements: Forest Carbon Partnership Facility Carbon Fund in Costa Rica

The problem

During the 1940s, over 75% of Costa Rica was covered in tropical rainforest. Unfortunately, the country experienced some of the highest deforestation rates worldwide during the 1970s—up to 50,000 hectares per year—resulting in a reduction to only 26% forest coverage by 1983. Analysis conducted by the World Bank suggests that up to 80% of the country's deforested areas were converted to pasture and agriculture in response to cheap credit for cattle, laws for assigning title to land that incentivized clear-cutting, and extensive expansion of the country's highways and roads.

While Costa Rica's deforestation rate has sharply declined due to government intervention and market mechanisms, forest cover today is still well below historical levels at

52%. Furthermore, the government of Costa Rica anticipates the effects of markets will level off at 55% coverage, making it financially difficult to continue widespread reforestation initiatives. The overall decline in natural forest land poses a significant threat to the world's biodiversity, as Costa Rica is estimated to support 6% of the entire planet's species, many of which are at risk from environmental degradation.

The ecosystem service

As part of its efforts to reverse the alarming rates of deforestation, in 1996 the government of Costa Rica passed a forest law recognizing the important ecosystem services forests provide. While forests provide numerous ecosystem services as mentioned in Case 1, the law cites four specifically: mitigation of greenhouse emissions, protection of water for urban, rural or hydroelectric use, biodiversity conservation for conservation, sustainable use, scientific investigation or genetic enhancement and protection of ecosystems or scenic natural beauty for tourism or science.

Ecosystem service beneficiaries

Reductions in deforestation provide benefits both locally and globally, as described in the "ecosystem service beneficiaries" section for the previous Indonesia example. As in Indonesia, Costa Rica has many local communities that could greatly benefit from forest protection. For example, indigenous communities within the Limon province of Costa Rica rely predominantly on subsistence agroforestry, a practice that is dependent on the ecosystem services forests provide. Remote communities stand to benefit as well due to the ecotourism that well-maintained forests can generate; a 2014 study by the National Academy of Science found that Costa Rica's protected forests reduce poverty by 16%, primarily by bringing in ecotourism.

Ecosystem service providers

Under the Carbon Fund, Costa Rica's government is the ecosystem services provider and the party that is compensated for actions taken.

Terms of the exchange/*Quid pro quo*

The Carbon Fund is a results-based payment mechanism that builds upon strategies designed as part of the Readiness Fund. The Carbon Fund is open only to countries that have prepared a Readiness Preparation Proposal and have had their Readiness Package (R-Package) assessed by a committee.[1]

[1] The R-Package is composed of the five core elements outlined in the Readiness Fund: a REDD+ strategy, Implementation Framework, Reference Level, MRV system, and safeguards.

Because the Carbon Fund requires results before payments are disbursed, the process to securing funding is substantially more involved than that of the Readiness Fund. Once a country's R-Package has been assessed, it must then submit an Emissions-Reduction Project Idea Note (ER-PIN) that serves as an early proposal for a specific REDD+ project. If approved, the World Bank and country sign a Letter of Intent expressing a commitment to pursue an Emissions Reduction Payment Agreement (ERPA) which serves as a contract between the two parties.

The country then designs an Emission Reduction Program that complies with criteria and indicators set forth in the Carbon Fund Methodological Framework. The criteria and indicators were designed for the Carbon Fund but strive for consistency with emerging policy under UNFCCC. As stipulated in the Framework guidelines, countries must define an Accounting Area, the geographic location that will be assessed for emission reductions. These areas do not need to cover the entire nation, and in practice tend to be more localized, such as an eco-region or province.

Next, a country must determine their emissions Reference Level based on annual deforestation rates over the past ten years for this Accounting Area. This Reference Level must account for emissions from deforestation and include emissions from degradation if significant. Countries then measure, monitor, and report their emissions within their Accounting Area in accordance with their National Forest Monitoring system, comparing these emissions to their Reference Level. Because there is inherent uncertainty in assessing forest stocks, countries are required to identify, minimize, and buffer against major sources of uncertainty based on their estimates.

There are a number of concerns that arise from a results-based approach like this that the Framework tries to address. Perhaps the greatest concern deals with the overall benefit of the activities and whether or not the emissions reductions observed within the study area actually represent a net decrease of emissions. Historically, there have been issues of leakage, where drivers of deforestation are simply relocated outside of the area being monitored, resulting in a verified decrease in emissions for that area, but no net reduction in emissions. Even if a net reduction of emissions does occur, an issue arises with how permanent the reductions are—what if a fire or poor management after funds have been disbursed reverts the forest back to a carbon source? To address both of these concerns, under the Carbon Fund Framework, countries have to identify and minimize both drivers of leakage and reversals within the Accounting Area. To ensure none of these strategies compromise other environmental characteristics or unfairly treat indigenous communities in the process, a country must make a plan to address environmental and social safeguards stipulated in the Framework.

Once the country's Emissions Reduction Program satisfies these requirements the country can move to implementation, verification, and payments. As mentioned above, the Carbon Fund will make payments only for verified emission reductions. If the verification reveals that all or part of the monitored and reported emission reductions has not taken place, then there is no payment to be made. The payment is per ton of carbon emissions reduced, the exact price of which is negotiated as part of the Emission Reduction Program.

Mechanism for transfer of value

The Carbon Fund is distributed by the Forest Carbon Partnership Facility (FCPF), the same governing body that oversees the Readiness Fund. Like the Readiness Fund, the Carbon Fund is multilateral, meaning money comes from both private and public sources. To date, the Carbon Fund has received public contributions from the European Commission, Australia, Canada, France, Germany, Norway, Switzerland, the UK, the USA, and private donations from BP Technology Ventures Inc. and The Nature Conservancy. Since its inception in 2011, the Carbon Fund has secured commitments totaling USD 692 million.

In 2013 Costa Rica became the first country to sign a Letter of Intent to negotiate an Emission Reduction Payment Agreement with the FCPF, worth up to USD 63 million. This means that Costa Rica will produce some volume of emission reductions as part of its REDD+ strategy, which the Carbon Fund will purchase USD 63 million worth. In exchange for these funds, Costa Rica must agree to transfer the rights to the emission reductions to the Carbon Fund to minimize the risk of multiple claims on the reductions. After subtracting the volume purchased by the Carbon Fund and the amounts that are used to buffer against uncertainty, reversal, and leakage, Costa Rica may sell the remaining emission reductions to other interested purchasers. Just because a country produces emissions reductions does not mean they are guaranteed to receive payment for them as part of REDD+—it is up to the country to secure its own agreements.

Monitoring and verification

To ensure meaningful results, the World Bank has supervised and monitored Costa Rica's entire design and implementation process, ensuring the country's strategies and programs are thorough. Costa Rica must submit reports on emission reduction and how safeguards have been addressed, which will be verified by the World Bank prior to the distribution of payments through the Carbon Fund. Safeguards must comply with both UNFCC guidelines and the World Bank's own criteria.

Effectiveness

In total, the Carbon Fund intends to fund REDD+ pilot projects in 18 countries through the year 2020. In addition to protecting key forest ecosystem services, these pilot projects are also meant to help inform ongoing results-based financing and negotiations for payments for forest carbon.

Due to the high level of rigor of its requirements, the timeline between getting accepted into the Carbon Fund and receiving payments can be lengthy. In April 2017, four years after it was accepted into the Carbon Fund, Costa Rica submitted its third and final version of its Emission Reduction Program. This version addressed deficiencies in earlier submissions and has been deemed satisfactory by the Carbon Fund's Technical Advisor Panel. Although Costa Rica's program has been approved, the country has yet to submit results from its strategies. Therefore, the Carbon Fund's effectiveness in reducing deforestation and forest degradation is still unknown.

Lessons learned

The Carbon Fund's Methodological Framework highlights two key insights about payment of forest carbon as an ecosystem service: the difficulty to monitor and verify meaningful reductions and the need for long-term storage to harness actual benefits. Difficulties in verifying the production of ecosystem services arise from the need to not only show emission reductions for an Assessment Area, but also to show the emissions are not leaked somewhere that is not being monitored. This highlights the tradeoff of a more expansive Assessment Area, an approach which would capture greater certainty of a country's emissions but be more expensive and logistically difficult to manage.

Storage of forest carbon is different from many other ecosystem services in that its benefit can be retroactively compromised if there are reversals and the carbon is released. This requires more careful and long-term planning to ensure the benefit is maintained.

Case 6: Bilateral Agreements: Amazon Fund *(Norway-Brazil)*

The problem

The Amazon in South America is the largest rainforest on the planet and is estimated to contain over 390 billion trees. Covering 550 million hectares, the massive forest extends through eight countries, a fact that often makes designing consistent forest management difficult. Varying geographic areas and government policies amongst these countries have resulted in a very uneven distribution of deforestation in the Amazon—nearly 80% of all deforestation of the forest has occurred in Brazil. From 1988 to 2006, deforestation rates in the Brazilian Amazonia averaged 18,100 km^2/year, recently reaching 27,400 km^2/year in 2004. By 2001, about 837,000 km^2 of Amazonian forests had been cleared, much of it illegally. The main drivers of the clear-cutting have been to grow soybeans and raise cattle, two important sources of income for the country.

The ecosystem service

The sheer size of the Amazon results in large scale ecosystem services globally. A 2007 study found that the Amazon's trees store some 86 billion tons of carbon, more than a third of all carbon stored by tropical forests worldwide; it is estimated that in a single year, the forest is capable of absorbing 1.5 gigatons of carbon dioxide from the atmosphere. In addition to greenhouse gases, the forest extraction of soil water by tree roots recycles 25-50% of rainfall in the Amazon Basin, a phenomenon that impacts global atmospheric circulation.

Ecosystem service beneficiaries

Tens of millions of people live within the Amazon, including over 400 different indigenous communities, many of which rely on the regulating services of the forest to sustain their way of life. This is in additional to the global beneficiaries of reduced deforestation, as described in the "ecosystem service beneficiaries" section for the Indonesia example.

Ecosystem service providers

Under the Amazon Fund, the Brazilian government is the Party responsible for providing the ecosystem service.

Terms of the exchange/*Quid pro quo*

In order for Brazil to receive payments through the Amazon Fund, the country has to develop a number of initiatives to ensure meaningful reduction in greenhouse gas emissions. These initiatives include a national strategy plan that addresses drivers of deforestation and forest degradation, land tenure issues, forest governance issues, gender considerations and safeguards. Similar to requirements under the Carbon Fund, Brazil must also implement a national forest reference emission level, a robust and transparent national forest monitoring system for REDD+ activities, and a system for providing information on how REDD+ safeguards are being addressed. Finally, Brazil must also submit biennial reports on emissions and a Most Recent Summary that details how the safeguards are being addressed under REDD+.

Mechanism for transfer of value

Unlike the Readiness and Carbon Fund discussed in the previous case studies, the Amazon Fund is a bilateral payment mechanism, meaning that Brazil negotiates a contract with a single donor, in this case Norway.[2] Following negotiations, funds are transferred to the Brazilian Development Bank, the entity managing the Amazon Fund, and become available after the verification of pre-determined results. To date, Norway has donated over USD 1.1 billion into the Amazon Fund. Although the funds are meant for forest protection measures, Norway and Brazil's contract does not require Brazil to verify how it is using payments from the Amazon Fund.

Monitoring and verification

Similar to other results-based payment schemes, Brazil's emissions reductions are evaluated against a reference level based on a historical average. However, as negotiated between Brazil and Norway, every five years a new reference level is set at the last five year's average level, requiring Brazil to consistently improve its strategies to address deforestation over time. While

[2] Other bilateral negotiations that are part of the Amazon Fund include arrangements with Germany and the Brazilian petroleum company, Petrobras.

the emission reductions themselves are independently verified, under the contract, Brazil's plans to address safeguards are not monitored or evaluated in any way.

Following the country's emission reductions verification, all pertinent documents and results are posted to the Lima Information Hub, an online database organized by the UNFCC to aid in transparency.

Effectiveness

According to the Lima Hub, from 2006-2010, Brazil has successfully produced emission reductions totaling over 511 million tons of carbon equivalent per year and over 277 million tons per year from 2010-2015, altogether 6.125 gigatons of carbon equivalent. As of right now, Brazil is the only country to submit verified results to the Lima Hub. Once other countries have verified reductions, their results will be posted here as well.

Lessons Learned

Much of Brazil's emission reductions came prior to REDD+ implementation as a result of rigorous government programs, although many of the country's strategies became more robust as a result of international assistance. This highlights the importance of having designed the international protocol to work with parties' national policies to address deforestation, rather than undermine them.

Brazil's success in reducing its emissions from deforestation have helped generate other key lessons that will help with future REDD+ programs. For example, Brazil found that its REDD+ initiatives were most successful when integrated into cross-sectoral policies such as agriculture, forestry, infrastructure, and environmental policies. By integrating REDD+ initiatives, as opposed to keeping them isolated, each sector is forced to consider their contribution to greenhouse gases from deforestation, and the potential role they can play in mitigation. Another key insight is just how critical it is to provide assistance for capacity building to successfully implement REDD+ initiatives. Capacity building should not be limited to simply helping put infrastructure in place, but include educational outreach to help inform local communities of the issues and how they can contribute, something Brazil addressed through workshops and communication campaigns.

Brazil's success emphasizes how the most successful REDD+ initiatives are the ones that focus on community-oriented forest management. By including locals and indigenous communities that know the forests in the design of management plans, they are more likely to adhere to the plans, ultimately making the strategies more robust. These findings have been used to help inform REDD+ projects in several African countries, including Cameroon, Gabon, the Central African Republic, Democratic Republic of Congo, and Republic of Congo.

Although Brazil's efforts are generally considered a success, as discussed under the Carbon Fund Methodological Framework in the second case study, there is a serious risk of a reversal of these benefits should forest trends alter course. There is concern that this is already occurring in Brazil, as deforestation rates rose by nearly 30% in 2015-2016. Ensuring the ecosystem services provided under REDD+ endure will require continued and careful monitoring.

Recommended key references

Case 1

Appleton, A. F. 2002. How New York City Used an Ecosystem Services Strategy Carried out Through an Urban-Rural Partnership to Preserve the Pristine Quality of Its Drinking Water and Save Billions of Dollars. *Forest Trends*. doi:10.1017/CBO9781107415324.004.

National Research Council. 2000. Watershed Management for Potable Water Supply: Assessing the New York City Strategy. Washington, D.C.: National Academy Press.

Case 2

Hellerstein, D. M. 2017. The US Conservation Reserve Program: The Evolution of an Enrollment Mechanism. *Land Use Policy.* 63: 601–10. doi:10.1016/j.landusepol.2015.07.017.

Soil and Water Conservation Society, and Environmental Defense Fund. 2008. "Conservation Reserve Program (CRP) Program Assessment." Ankeny, IA and New York, NY. http://www.swcs.org/documents/filelibrary/CRPassessmentreport_3BEFE868DA166.pdf

Case 3

McConnachie, M. M., R. M. Cowling, C. M. Shackleton, and A. T. Knight. 2013. The Challenges of Alleviating Poverty through Ecological Restoration: Insights from South Africa's 'Working for Water' program. *Restoration Ecology.* 21 (5): 544–50. doi:10.1111/rec.12038.

Turpie, J. K., C. Marais, and J. N. Blignaut. 2008. The Working for Water Programme: Evolution of a Payments for Ecosystem Services Mechanism That Addresses Both Poverty and Ecosystem Service Delivery in South Africa. *Ecological Economics.* 65 (4): 788–98. doi:10.1016/j.ecolecon.2007.12.024.

van Wilgen, B. W., G. G. Forsyth, D. C. Le Maitre, A. Wannenburgh, J. D. F. Kotzé, E. van den Berg, and L. Henderson. 2012. An Assessment of the Effectiveness of a Large, National-Scale Invasive Alien Plant Control Strategy in South Africa. *Biological Conservation.* 148 (1): 28–38. doi:10.1016/j.biocon.2011.12.035.

Case 4

Margono, B. A., et al. 2014. Primary forest cover loss in Indonesia over 2000-2012. *Nature Climate Change* 4 (8): 730-735.

The Forest Ecosystem Valuation Study (FEVS), undertaken by the United Nations Office for REDD+ Coordination in Indonesia (UNORCID)

Case 5

Forest Carbon Partnership Facility. 2016. *Carbon Fund Methodological Framework*.

Forest Carbon Partnership Facility. 2017. *Technical Assessment of the Final ER-PD of Costa Rica*. Available online: https://www.forestcarbonpartnership.org/sites/fcp/files/2017/July/TAP%20Report%20version%20post-CF14-%20apr%2025%202017.pdf

Case 6

Saatchi, S. S., et al. 2007. Distribution of aboveground live biomass in the Amazon basin. *Global Change Biology.* 13(4): 816-837.

Viana, V. M., A. R. Aquino, T. M. Pinto, L. M. T. Lima, and A. Martinet. 2012. REDD+ and community forestry: lessons learned from an exchange between Brazil and Africa. Washington, DC: World Bank. Available online: http://documents.worldbank.org/curated/en/350641468223470027/REDD-and-community-forestry-lessons-learned-from-an-exchange-between-Brazil-and-Africa

Voigt, C. and F. Ferreira. 2015. The Warsaw Framework for REDD+: implications for national implementation and access to results-based finance. *Carbon & Climate Law Review*. 113-129.

3. WATER FUNDS: COORDINATING RESOURCES & ACTION FOR WATERSHED IMPROVEMENT

Kate A Brauman, Rebecca Benner, Silvia Benitez, Leah Bremer, Kari Vigerstøl

Demand for clean, abundant water is increasing, yet supply of clean water is increasingly at risk. As of 2010, about forty percent of watersheds upstream of large urban areas had high to moderate levels of land and vegetation degradation caused by deforestation, poor agricultural practices, and development. This can reduce the amount of available clean water or increase water treatment costs downstream.

While built infrastructure to move and treat water will always be necessary, nature-based solutions can improve water quantity and quality, reducing costs and increasing reliability. Managing upstream land cover and land use can regulate water flow and reduce pollutants in water, improving human wellbeing downstream while protecting terrestrial and aquatic ecosystems.

Despite these advantages, people often fail to capture the benefits of nature-based source water protection. There are a variety of reasons for this, including, for example, (1) spatial displacement between those in water source areas and those who use water, (2) insufficient knowledge about the specific water security benefits of watershed management, (3) lack of funds by those who could implement watershed management strategies, and (4) few mechanisms for funding to flow because of both the policy environment and specific financial structures.

Despite these challenges, nature-based investments to secure clean water are becoming increasingly common. A survey of the State of Watershed Investment found that, in 2015, payments to conserve or restore watersheds totaled about $US24.6 billion worldwide. This encompassed 419 programs in 62 countries affecting at least 487 million hectares (an area larger than India). Most of the payments that arose through these schemes went to private landholders, in total about $US9.8 billion in 2015.

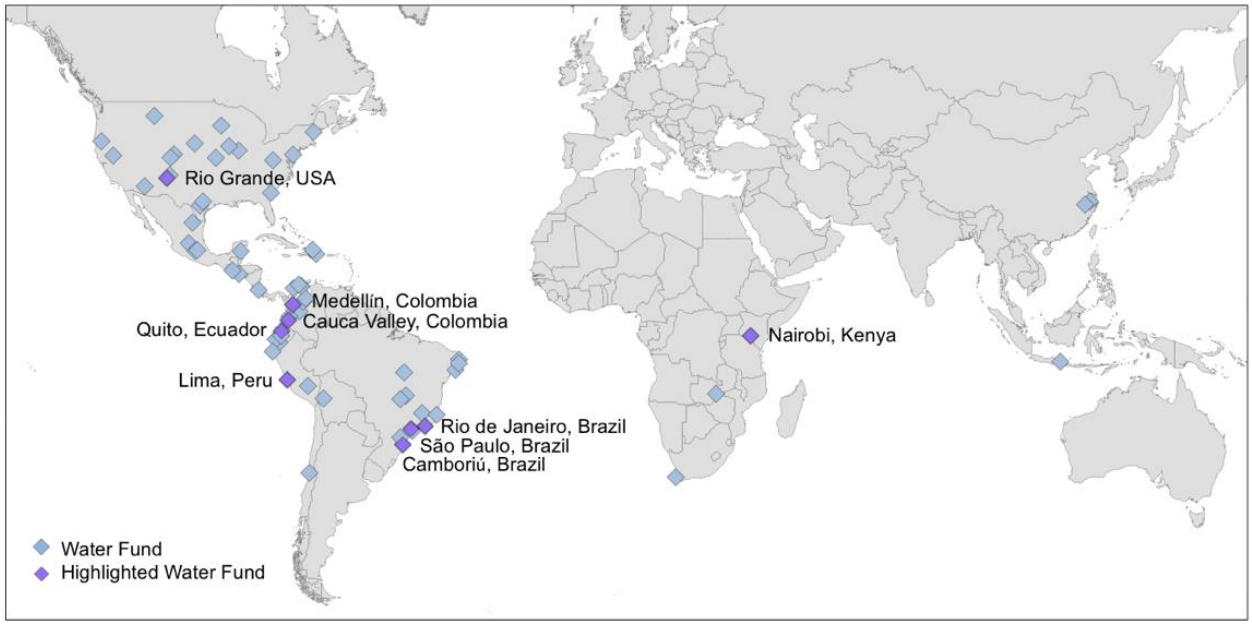

Figure 3.1 Water Funds locations. These include both operational and pre-operational Water Funds tracked by The Nature Conservancy. The ones labeled in purple correspond to the examples highlighted in this chapter.

What is a Water Fund?

Water Funds are one type of investment in watershed services. The label "Water Fund" refers to a replicable financial and governance model developed by cities, development banks (such as the InterAmerican Development Bank), and conservation practitioners (such as The Nature Conservancy (TNC)). This funding and governance mechanism links downstream water users to upstream residents, paying them to manage watersheds sustainably. Water Funds can create a virtuous cycle so that fund investments, when well-designed and equitable, create opportunities and support for upstream residents who then manage their land in ways that improve water resources in their own communities as well as for downstream water users. Recognizing the benefits of watershed services, downstream users provide continued political and economic support, benefiting everyone in the landscape.

Water Funds both mobilize funding and coordinate watershed management activities. Water Funds have been referred to as "collective-action funds" because they are characterized by pooled resources and coordinated action across a landscape. The success of a Water Fund depends on both the pooled financial resources from downstream supporters and on the coordinated support and engagement of upstream residents, who participate because they benefit from Water Fund activities in a meaningful way.

Water Funds have three primary organizational components:

- **a funding mechanism** to collect and provide resources for watershed management in the long term;
- **a governance mechanism** for joint planning and decision-making; and
- **a watershed management mechanism** to carry out funded conservation and management activities.

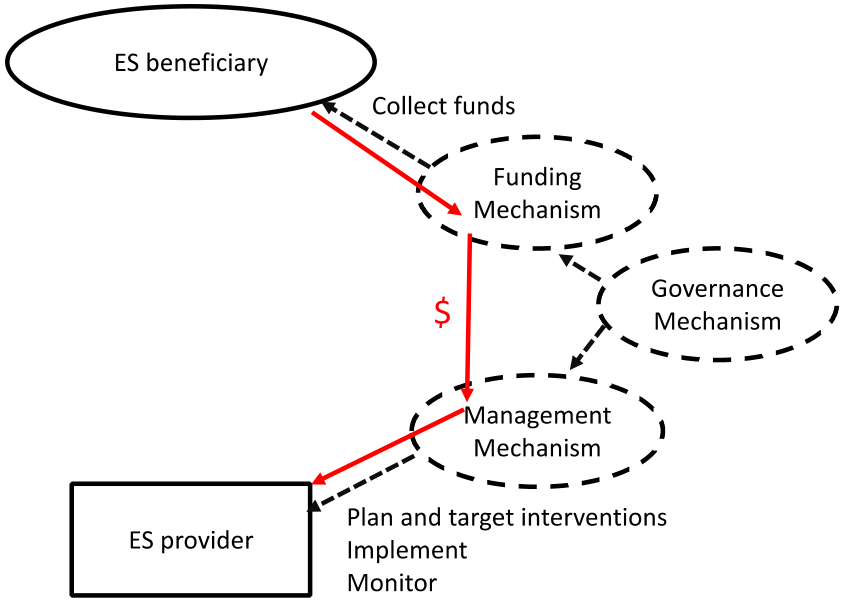

Figure 3.2 Water Fund: subset of voluntary beneficiary pays

The funding mechanism allows multiple stakeholders — including water users (public and private), government agencies, development banks, and non-governmental organizations (NGOs) — to coordinate and to provide long-term resources for source water protection.

The governance mechanism is a board or a project management unit composed of a diverse set of stakeholders, potentially including representatives of investors, the public sector, water companies, and local communities both upstream and downstream. The multi-stakeholder structure of this group, as well as transparency in how members are chosen and how decisions are made, builds trust and engagement among watershed stakeholders for project planning and decision-making.

The watershed management mechanism is a group that plans, targets, implements, and monitors activities on the ground. Each Water Fund has unique objectives and goals but, in general, they work to (1) improve or maintain water quality and water quantity for downstream users; (2) maintain regular flows of water throughout the year; (3) maintain or enhance biodiversity, both freshwater and terrestrial; and (4) improve or maintain human well-being for upstream human communities. Management mechanisms often seek to adopt a science-based approach to improve the impact and cost effectiveness of watershed interventions.

History of Water Funds

There are many approaches to source water protection. For example, some cities in the U.S. have purchased land in their source watersheds to ensure that polluting activities are not undertaken there. Chapter 2 discusses New York City, which invested in watershed protection to avoid building a costly water filtration plant. Other payment models exist as well. For example, in 2003 Fundación Natura initiated the "*Watershared*" model in Bolivia when downstream irrigators

negotiated to provide alternative development tools like beehives or fruit trees in exchange for upstream landowners conserving forests by fencing out cattle.

The term Water Fund refers to a particular set of watershed conservation approaches that include governance, financial, and conservation mechanisms. The Water Fund idea was conceived in the late 1990s in Quito, Ecuador – a growing city with substantial water demands. There was concern that land use in Quito's watershed could compromise the water supply. However, many farmers and ranchers depended on the watershed for their livelihoods, making management difficult. The possibility arose of water users making voluntary financial contributions to compensate farmers and ranchers for watershed management. In 1997, TNC and its partners began negotiations with the municipality of Quito and Quito's water utility (now Empresa Metropolitana - EPMAPS). The fund launched in 2000 with voluntary donations from EPMAPS and TNC going into a trust fund that formed the financial basis of the Water Fund. Several other water users and institutions subsequently joined the Water Fund.

Following the creation of the Water Fund in Quito, the model has spread rapidly through Latin America and the world. In 2011, The Nature Conservancy joined the Inter-American Development Bank, FEMSA Foundation, and the Global Environmental Facility to support existing Water Funds and promote the creation of new Water Funds in Latin America and the Caribbean. The Latin American Water Fund Partnership initiative has been key for the growth and support of Water Funds in the region, with 20 funds in operation and approximately 20 more in design. TNC and its partners have moved the idea of Water Funds to multiple countries and continents around the global. As of 2017, TNC has a portfolio of 29 funds in operation and approximately 30 in design. TNC's goal is to improve the Water Fund model to reduce the risks associated with source water protection investments.

Variation among Water Funds

Within the structure of a water fund, each takes its own form and function because Water Funds must be tailored to the socio-cultural, ecological, and economic context of their location. As a result, Water Funds display a diversity of funding, governance, and management strategies, though they all organize and mobilize resources and implement watershed management. The table below specifies key elements of Water Funds and includes details about how those differ among funds.

City of Water Fund	Objectives	Funding source(s) * primary	Participants (who carries out protection activities)	Role of government	Source of water issues	Program activities	Measures of success (currently monitored)
Cauca Valley, Colombia	Water quantity, biodiversity conservation, sediment reduction, livelihood improvements	Private companys, Government environmental agencies, private group of landholders	indigenous communities; rural landholders	State governments provide funding	potentially agriculture and cattle management in upper watershed	Forest protection; assisted revegetation; unassisted revegetation; livestock management; environmental education; agroforestry; silvopasture; strengthening of local organizations	dry season flow; sediment concentrations; local livelihoods and perceptions
Medellin, Colombia	Water quality - nutrients and sediment reduction	water companies, government environmental agencies, numerous private companies, municipality, NGOs	Private and communal landowners with support from the water fund implementation team. Partnerships with universities for research and monitoring. Contractors are hired for specific work (e.g. planting trees, studies)	Public companies and public sector (municipal and regional goverments) provide funding and decision making. Work is aligned with public policies and coordination is done with other public institutions (e.g. Ministry of the Environment)	Cattle and agriculture in upper watershed, working on creating sewage	Targeted land protection (wetlands, riparian areas, forests), restoration of natural ecosystems, improved agricultural practices, environmental education, basic sanitation in rural areas	nutrients and sediment
Quito, Ecuador	Water quality and Water quantity	Water company, electric company, NGO, private companies, multi-laterals, bi-laterals, municipality	Private and communal landowners supported by water fund implementation team. Contractors are hired for specific work (e.g. planting trees)	Public water company and electric company are contributing members and decision makers, Quito municipality is invited to participate on the board. Coordination with several government institutions as National Water Agency and Ministry of the Environment	Agriculture and cattle and sheep degrading fragile ecosystems, fire	Targeted land protection (paramos, wetlands, riparian vegetation), paramo restoration, wetlands restoration, improved agricultural practices, land acquisition and management, environmental education, water management	Water quantity (flows), water quality (several physical and chemical indicators and biological indicators), freshwater ecosystem integrity, terrestrial ecosystems integrity, wetlands monitoring
Lima, Peru	Sustainable water management	private company, civil society, university, private companies, NGOs, other agencies	Private and communal landowners supported by water fund implementation team. Contractors are hired for specific work (e.g. planting trees)	No major role currently; Federal water regulator now requires all water companies (including Lima's public agency, SEDEPAL) to invest in natural infrastructure - this may result in funding opportunities.	Agriculture and cattle degrading fragile ecosystems fire	Targeted land protection and restoration, water treatment and re-use, environmental education, improved agricultural practices, strengthen watershed governance; traditional water technology restoration	dry season flow and socio-economic outcomes for community members
São Paulo, Brazil	Flow regulation; sediment reduction, increase environmental awareness; increase rural incomes	Municipalities, watershed committees, government water agency, state environemtntal agency, NGOs	Farmers in Extrema and other municipalities in PCJ and Alto Tiete watersheds	Primarily publically funded and run; Extrema municipality runs program and finances through municipal tax; watershed committee on Project Management Unit (for non-Extrema projects) and provides funding; State Environmental Agency provides funding.	land mismanagement	Assisted revegetation; forest protection, unassisted revegetation; soil conservation; dirt road management	dry season flow; sediment concentrations; socio-economic studies on livelihood outcomes in Extrema

Rio de Janeiro, Brazil	Sediment reduction; flow regulation; biodiversity; reduce contamination risk; increase rural incomes	Watershed committee; State Environmental Agency; NGO	Farmers in Rio Claro municipality and eventually other municipalities	Primarily publically funded and run; National Water Agency, watershed committee and municipality on Project Management Unit	land mismanagement	Assisted revegetation; forest protection, unassisted revegetation; soil conservation; dirt road management; rural wastewater services	dry season flow; sediment concentrations; bird diversity; socio-economic studies on livelihood outcomes
Cambirou, Brazil	Sediment reduction; water quantity during high tourist season	Municipality, water company, NGO	Farmers in Camboriú municipality	Primarily publically funded and run; National Water Agency, municipalities, water company on Program Management Unit; Municipal water company main funder	land mismanagement; roads	Forest protection; dirt road management; assisted revegetation; unassisted revegetation	dry season flow; sediment concentrations; baseline socio-economic studies
Nairobi, Kenya	Sediment reduction, stakeholder engagement, participatory land and water planning	Sewer and water company, electric company, government agency, private companies, NGOs	NGOs, Farmer associations, civil society organizations working with land stewards and small-scale farmers	Government involvement occurs at different levels, such as involvement in the planning and implementation of activities The Water Resources Management Authority provides engagement support and technical expertise.	Watershed degradation due primarily to increased farming on steep slopes; dirt roads	Improved agricultural practices (terracing on steep slopes, creating ditches to drain water properly, water basins to catch excess water runoff, drip irrigation, etc.), tree planting on steep stopes and in riparian areas	Turbidity, flows, economic benefits to communities, CO2 sequestered or loss avoided, ability of people to manage environmental or climate risks, projects lessons incorporated into government policies or programs, change in water abstraction, change in crop productivity, river kilometers protected
New Mexico, USA	Forest restoration; avoid severe water supply contamination from eroded soils and debris due to post-fire flooding.	federal, state and local government agencies, water utilities, and private companies and individuals	Federal government, local logging companies, NGO	Participates in different ways at different levels of government (through various agencies). Pays into the fund, participates in decision-making and planning, and receives some of the funds to carry out forest restoration work.	Degraded and / or overgrown forests that have a higher risk of higher severity forest fires. Flooding after devastating forest fires can cause huge volumes of eroded soils and debris to flow into the waterways, degrading them beyond use and shutting down water intakes.	Forest thinning, forest restoration, environmental education.	Hectares of forest restored, downstream river flows, fire frequency and intensity, number of jobs created, decreased water supply interruptions, funding leveraged, number of students educated.

Table 1 Water Funds information. For further details, links are provided in the references at the end of this chapter.

Three case studies

Three case studies presented here illustrate similarities and diversity among operational Water Funds.

The Fund for the Protection of Water (FONAG) in Quito, Ecuador was created in 2000 by Quito's water company and TNC in response to growing water demands and concern over watershed degradation. It is the oldest official Water Fund. FONAG has an endowment of more than $US11 million, a board of directors as the decision-making body, and a technical secretariat that implements watershed management activities.

The Upper Tana-Nairobi Water Fund, begun in 2012, works in the Tana River watershed in Kenya. This watershed supplies 95% of Nairobi's water, 50% of Kenya's electricity, and is home to over a million farming families. The fund was set up with multiple objectives, including improving agricultural livelihoods upstream and securing Nairobi's water supplies by reducing erosion and maintaining dry season flow.

The Camboriú Water Producer Project serves the municipality of Balneário-Camboriú, Brazil, an important tourist destination. The program aims to reduce the concentration of total suspended solids at the municipal drinking water intake in order to reduce water losses and treatment costs. The project pays landowners to conserve and restore forest along rivers and in steeply sloped areas, priority areas under the Brazilian Forest Code.

Case 1: FONAG

In response to growing water demands and concern over watershed degradation in Quito, Ecuador, in 2000, the municipality of Quito, Quito's water company, TNC, and others created The Fund for the Protection of Water (FONAG). FONAG is a private fiduciary fund that manages both public and private watershed areas and had an endowment of more than $US12 million in July 2017. It has a board of directors as the governance body made up of the Quito Water Company, the Quito Electric Company, TNC, a privately-owned brewery, a bottler, and a local NGO. This multi-stakeholder board provides a mechanism for joint investment in watershed protection. The management mechanism is a technical secretariat.

As the oldest official Water Fund, FONAG has successfully protected and restored over 25,000 hectares of *páramo*, wetlands, and Andean forests. In addition to direct source watershed protection activities, FONAG has worked with over 400 local families to strengthen watershed governance, environmental education, and communication. FONAG's vision is to mobilize all actors in the watershed to exercise their civic responsibility on behalf of nature, particularly water resources.

Biophysical explanation of ecosystem services

The watersheds that provide water for Quito are located high in the Andes. Much of this area is *páramo*, a high altitude shrub and grassland ecosystem; the watershed also includes high-

elevation wetland and high-elevation forest. Because of their deep organic soils, *páramos* are crucial for water regulation. Activities such as grazing (e.g. cattle, sheep), agriculture (e.g. potatoes), fire used in agricultural management, and afforestation can compact soils, alter water use regimes, and degrade water quality (e.g. sediments, turbidity, nutrients, bacteria). FONAG has prioritized the location of its work based on development threats and on the importance of individual sub-watersheds in municipal water supply.

In addition to their importance for water, the ecosystems FONAG manages are important for biodiversity and carbon storage. *Páramo* is characterized by a high percentage of endemic species. Threatened species including the Andean Bear, the Andean Tapir and the Andean Condor are found there. Andean wetlands have been found to store very high values of carbon, and the *Polylepis* forest is a species endemic to the Andes.

Identification of the beneficiaries

In the late 1990s, TNC and partners recognized that all of Quito's citizens would benefit from watershed conservation through the provision of plentiful and clean water. Based on TNC and partners' work, the mayor and the municipality of Quito came to support the Water Fund. FONAG initially had two main members: TNC and the Quito Water Company (the key water user). Other water users have since joined: the Quito Electric Company in 2001; private organizations including a beer company in 2003; the Swiss Agency for Development and Cooperation in 2005 (which ceded its space on the board to a local NGO); and a water bottling company in 2005. The main incentive for the water utility and the other major water users is avoided or reduced future costs for water treatment and supply. For TNC, the incentive is long-term financing for conserving nature.

FONAG has an average annual budget of US$ 2 million. The sources of the annual budget are: interest from the endowment, annual contributions from board members (30% of the annual contribution goes to the annual budget of the fund, the other 70% is invested on the endowment), and additional donations or contributions from board members and other organizations interested in supporting FONAG.

In 2000, FONAG had $21,000 - $20,000 from the Quito water company and $1,000 from TNC - in its endowment. By 2008, the trust had grown more than 250 fold to about $5.4 million and is now (2017) more than $12 million. This endowment yields about $400,000 in interest each year (but this number varies year to year) to spend on conservation projects

FONAG's public board members provide the largest source of funding: the Quito water company provides more than 80% of annual contributions and the Quito Electric Company provides the next largest contribution. Decision-making power on the board is linked to these monetary contributions. In 2006, FONAG, with the support of its board members, helped to pass a municipal bylaw requiring the Quito Water Company to provide 2% of its revenue to the Water Fund. This was an increase from the initial 1% voluntary commitment. This has been essential for ensuring FONAG's long-term financial security.

FONAG has also received funding from development bank sources (e.g. the InterAmerican Development Bank) and bi-lateral cooperation. USAID was an important donor that supported and strengthened FONAG during its early years. Grants and donations from other organizations

interested in supporting the objectives of the Water Fund have included Quito Municipality, bi-lateral and multi-lateral organizations, other private donors such as foundations, and NGOs. Finally, FONAG has been attractive to corporate donors such as Coca Cola and its local bottler. Through a collaboration program with TNC, Coca Cola has been providing funding to FONAG under its water replenishment program.

Identification of the suppliers

Quito's water supply comes from watersheds upstream of several extraction points. The Guayllabamba watershed, where Quito is located, is a major source, as are watersheds that drain to the Amazon; that water is piped into Quito (an inter-basin transfer).

There are a wide variety of suppliers in these watersheds. Some of the source watersheds are National Protected Areas managed by the Ministry of the Environment. In addition, both the Quito water company and FONAG itself own land in the watershed. The remaining suppliers are a mix of small-scale subsistence ranchers and farmers, communal land-owners that own and manage land under communal rules (these are often indigenous communities), and large private land owners.

Terms of the exchange/*Quid pro quo*

FONAG works on lands owned by the water company, by the fund, by private land-owners, and by well-organized communities. FONAG runs a variety of programs to conserve and restore watersheds areas:

Management of land owned by the fund and its partners

FONAG is in charge of managing more than 16,000 hectares of land owned by the Quito Water Company and by FONAG. To ensure protection of *páramos* and wetlands, the fund invests in fencing to exclude cattle and in hiring local people as "*páramo* guards" to help control threats such as cattle and fire. It has been common for decades to raise cattle and sheep in the *páramo*, in riparian areas, and in wetlands, so restoration is necessary in some areas. Restoration may be passive (e.g. fencing to exclude cattle and allow the *páramo* restore itself) or active (e.g. replanting native species). Recently, FONAG has begun to restore wetlands.

When FONAG was created in 2000, the National Protected Areas located in Quito's source watershed were underfunded. FONAG provided important support for the management of those areas by implementing key activities such as park guards. As the Ministry of Environment gained capacity to manage and fund all their Protected Areas, FONAG began targeting its work outside those boundaries, though it still maintains high level of coordination and collaboration with the Ministry of the Environment

Work with communal and private landowners

Since the beginning, FONAG has been working with local communities and farmers to protect and restore key areas on their lands. In most cases, landowners set aside key areas and

implement conservation activities; FONAG supports the landowner with an incentive or in-kind payment. Incentives include:

- supplies for fencing
- seeds for re-vegetation
- supporting alternative income sources like guinea pig farms
- providing alternative food sources like organic vegetable gardens
- supporting establishment of organic gardens
- support for a community to switch from raising cattle to raising Alpacas (*Andean Camelid*, which have valuable wool)
- technical and in-kind help to plant live fences
- technical assistance to improve farm activities
- fire control training

In addition to direct management to protect and restore natural ecosystems, FONAG has programs to *promote good watershed governance and sustainable watershed management*. These include:

- Environmental education program: More than 45,000 people have been involved in an environmental education program teaching sustainable watershed management in the water sources areas and in Quito municipality.
- Water management program: FONAG has worked to improve the quality and accessibility of watershed data for decisionmaking. This has included close collaboration with Ecuador's National Water Agency to help them improve and update their information on water concessions.
- Communication program: FONAG reaches out to the general public to promote the importance of sustainable watershed management and communicates the work and results of the Water Fund.

Mechanism for transfer of value

FONAG signs conservation agreements with landowners that set the conditions for the collaborative work. FONAG supports the landowner with an incentive or in-kind payment. FONAG itself has a staff of about 40 people. These employees ensure that communities receive the in-kind payments or incentives. Other employees of the management unit include, a director (technical secretariat), technical director, community park guards, hydrologists in charge of monitoring, a technical team for restoration activities, communication staff, administrative staff, and a team that leads the education work at local schools.

The conservation agreements that FONAG signs state the type of contribution that FONAG will provide. The incentive is negotiated with individual landowners and reflects local needs and interests. The type of incentives varies and can include training, support for productive activities, and fencing. The technical team of FONAG negotiates this work and FONAG provides the incentive. All this work is paid from the annual budget of FONAG.

Monitoring and verification

FONAG has recently undertaken a number of monitoring and evaluation projects to measure the impacts of its work. FONAG is monitoring water flows and water quality in several key watersheds for water provision in Quito. The information from this hydrologic monitoring program is used to improve the effectiveness of investments, particularly in respect to the water company objectives, and for communication to potential investors. In addition, FONAG is measuring terrestrial and freshwater ecosystem integrity. There is evidence of systematic positive impacts on water quality and ecosystem integrity in the watersheds where FONAG is monitoring.

In terms of biodiversity, a study done by TNC showed positive results from Water Fund investments. Conservation areas supported by Water Fund investments were compared to areas with no such investments and a "pristine" reference site. The species composition of Water Fund-supported conservation areas was found to be similar to the reference site and to differ considerably from areas without investment. There have also been reductions in grazing impacts and fire damage in areas where the Water Fund supports protection. Finally, the TNC analysis demonstrated that the conservation activities of the Water Fund helped maintain the ecology of the sites in an economically efficient manner.

In addition to investing financial resources in monitoring and evaluation, FONAG has established partnerships with universities for research and monitoring. This includes a recent program to monitor the impact of restoration activities in high-mountain wetlands.

Effectiveness

FONAG has successfully protected and restored over 25,000 hectares of *páramo*, wetland, and Andean forest. Currently, with support of the Latin America Water Fund Partnership, FONAG is implementing a Return-on-Investment Study to evaluate the economic benefits to the Quito Water Company from investing in watershed conservation. Scientists and managers from FONAG, the Quito Water Company, and TNC are collaborating on this research.

The final report will be completed by the end of 2017. Initial analysis suggests a positive return on investment for FONAG´s interventions over the next 20 years. This results from financial savings for water treatment for the Quito Water Company because of a reduction in nutrients, bacteria, turbidity, and sediments in source water, as well as an increase in water flows.

Case 2: Upper Tana – Nairobi Water Fund

The Upper-Tana Nairobi Water Fund was created to help provide clean, reliable water to the city of Nairobi. Over 90% of Nairobi's water comes from the Upper Tana River. The Nairobi City Water and Sewerage Company was facing declining water quality, especially during storm events, because of sediment in the water supply. In addition, the country's largest hydropower company, KenGen, was affected by sediment in its hydropower reservoirs on the Upper Tana River. KenGen's hydropower provides half of Kenya's electricity.

Exploration of a Water Fund for the basin began in 2012 with six founding partners, although analysis and discussion of source water protection as a viable solution had occurred previously. After several years of technical analyses, partnership building, development of a governance structure, prioritization of activities to meet desired outcomes, and implementation of pilot projects in the basin, the fund officially launched in March 2015.

The Nairobi Water Fund is an independent charitable trust with a governance board consisting of the county government, the agricultural minister, the council of governors, the Nairobi water company, a beverage company, and a hydropower company.

Biophysical explanation of ecosystem services

The Tana River runs 1,000 kilometers from the Aberdare Mountain Range to the Indian Ocean, creating essential habitats and nurturing important ecosystems along its entire length. The headwaters lie in the Aberdare National Park, home to rare and endemic wildlife, including the endangered Mountain Bongo antelope and the Columbus monkeys. From this headwater area, the river passes through forests, small-scale agricultural communities, and small towns before reaching the intake for the City of Nairobi's drinking water. There are five hydropower dams on the main stem of the Tana River with an installed capacity of 543 MW. The river supplies drinking water for 4 million residents of Nairobi and an additional 5 million people in the watershed.

Since the 1970s, the watershed has undergone a huge expansion of farming, mostly tea, coffee, bananas and other crops farmed by small farmers. Land scarcity and declining soil productivity due to erosion have driven farmers to expand cultivation onto steep slopes and into riparian areas. This has led to a loss of ground cover, leaving bare slopes vulnerable to erosion. During the rainy season, massive amounts of sediment are washed into the river.

The heavy sediment load increases water treatment costs by more than 33% as sediment spikes during the wet season. Reservoirs lose active storage capacity as they fill with sediment, limiting the ability of hydropower producers to balance production across seasons. New agricultural lands have increased demand for irrigation water, competing with the water needs of a city that already has a 30% deficit. Loss of natural wetlands that once stored runoff water and recharged aquifers has reduced dry-season flow.

The Water Fund aims to strengthen the delivery of reliable, clean water and reduce the impacts of sediment on short-term and long-term hydropower generation. To do so, the Water Fund invests in various activities to restore degraded and agricultural lands to reduce erosion. These include:

- Planting native tree species in high altitude areas of the watershed that have been cleared for agriculture but are not currently productive farmland
- Planting buffer zones of trees and plants along rivers and streams to slow the conveyance of runoff
- Stabilizing soil by terracing crop fields
- Applying mulch to secure soil from wash out and to restore soil fertility
- Growing buffer zones to retain soil and ease water conveyance, such as planting riparian habitat and bamboo to stabilize banks

- ❖ Creating water trapping pits at the top of the catchment to store and capture excess rain water
- ❖ Reducing water withdrawals from the river by installing rain tanks and drip irrigation to reduce irrigation pressure during dry periods

Through these activities, the Water Fund helps hold soil on the landscape. This improves farm productivity and reduces the impacts of agriculture on downstream water quantity and quality.

Identification of the beneficiaries

The primary beneficiaries of the Upper Tana-Nairobi Water Fund are the residents of Nairobi, Nairobi City Water and Sewerage Company, and the hydropower generating company KenGen. Nairobi's population has doubled in the last 25 years and will continue to rise. This growing population will require increasing supplies of food, water, and electricity from the Upper Tana River basin.

Similar to FONAG, the Upper Tana-Nairobi Water Fund is a private-public partnership that is supported by a combination of voluntary contributions and multilateral funders. In the first four years, the Water Fund was able to mobilize $US4 million through voluntary contributions. Board members are not required to provide an annual contribution, though many do contribute to the fund. For example, The Nairobi City Water and Sewerage Company imposed a 0.5% tariff on water fees to support the Water Fund and is an important contributor. There are also important multi-lateral funders, including the Global Environment Facility (GEF), which has committed $1 million in seed funding. The project aims for a $US15 million endowment that will provide funding over the long-term. An Upper Tana-Nairobi business case aims to mobilize additional downstream support by detailing the fund's hydrologic objectives and projected economic returns.

Table 2 Expected benefits of the Upper Tana-Nairobi Water Fund Anticipated benefits of source water protection in the Upper Tana River Basin and recipient stakeholder groups. Adapted from TNC 2015.

Stakeholder	Benefit
Nairobi City Water and Sewerage Company (NCWSC) + Municipal water users	- Reduction in wet sludge disposal and treatment costs - Increased dry season flows - Greater supply of water
Kenya Electricity Generation Company (KenGen)	- Reduction in reservoir sedimentation - Avoided turbine intake maintenance costs
Upstream farmers	- Increased soil and water conservation and fodder for livestock - Additional income and employment opportunities
Urban private sector processors	- Improved water supply
Local communities	- Cleaner drinking water
General: Ecosystem services	- More habitat for pollinators - Increased carbon storage in new trees planted

Table 3 Expected monetary benefits to major beneficiaries of the Upper Tana-Nairobi Water Fund. Predicted benefits are over a 30-year time frame. Adapted from Vogl, et al., 2016.

Stakeholder	Benefit or (Cost)	Present Value (USD)
Water Fund	Cost: Investment cost (voluntary contributions from Board and multilateral investors)	(7,110,000)
Agricultural producers in watershed	Cost: Maintenance of erosion control structures, etc.	(8,520,000)
	Benefit: Increased agricultural productivity	12,000,000
Nairobi City Water and Sewerage Company (NCWSC)	Benefit: Avoided water treatment cost (flocculants and electricity), revenue from saved process water, future savings assuming increased future demand	3,390,000
Kenya Electricity Generation Company (KenGen)	Benefit: Avoided interruptions, increased generation from increased water yield	6,150,000
	Present value of benefits	**21,500,000**
	Present value of costs	**(15,600,000)**
	Net present value	**5,900,000**

There are many additional beneficiaries of this Water Fund, including farmers who are engaged in the Fund via increased agricultural productivity, cities along the Tana River who also draw their water from the river, the people of Kenya who depend on hydropower for their electricity, and everyone who benefits from ecosystems that are protected or restored across the basin. On example of this is increased carbon storage in restored areas.

Identification of the suppliers

There are 300,000 small farms on the steep slopes in the Upper Tana watershed. About 98% of the people who live in the watershed are farmers who grow tea, coffee, bananas, and other

crops. It is estimated that about 50,000 of these farmers are located in the steepest and most critical areas.

Terms of the exchange/*Quid pro quo*

Similar to FONAG, the Upper Tana-Nairobi Water Fund uses in-kind compensation mechanisms to encourage farmers to adopt agricultural best management practices, install riparian buffers, and reforest. These in-kind compensation packages include provision of water pans, seeds, equipment, and livestock. Compensation also includes capacity building and training around agricultural production. As farmers adopt incentivized practices, sedimentation is reduced. Farmers enrolled in the Water Fund also act as conservation advocates throughout the community, spreading the word about conservation through community meetings and local social groups.

Mechanism for transfer of value

The Water Fund works with farmers using the social capital built by organizations that have worked in the upper watershed over many years. The Water Fund works through several nonprofit and for-profit agricultural and tree-planting organizations and agencies to implement activities in the basin. These include The Green Belt Movement, SACDEP, Water Resource Users Association, Kenya National Farmers Federation, and civil society organizations.

Monitoring and verification

The Nairobi – Upper Tana Water Fund has developed a robust monitoring and evaluation plan, much of which has been implemented. The Fund aims to measure both the scale of action and the delivery of a wide range of desired outcomes structured around the three Water Fund strategies.

The Water Fund will also collect data and conduct analysis on outcome indicators, including:

- Turbidity at multiple basins within the watershed
- Sediment load flowing into reservoirs
- Number of days per year with maximum turbidity at water intake low enough to avoid switching to more expensive water clarifiers.
- Decrease in river water abstracted by smallholder farming households after installing drip irrigation and/or a rainwater pan.
- Increase in crop productivity after installing drip irrigation and/or a rainwater pan.
- Increase in households with improved Multidimensional Poverty Assessment Tool score
- Increase in households saying permanent vegetation cover has increased and that soil erosion has decreased on their farm
- Project lessons reflected in government policies, strategies or programs

Table 4 Some of the indicators on which the monitoring and evaluation plan will collect (grouped according to each implementation strategy). # stands for number.

Monitor how the Water Fund is being institutionalized	Monitor the Water Fund's support for livelihoods, food security, and economic development	Monitor status of knowledge management and learning systems
- Status of the endowment fund - # of government policies that refer to the Water Fund - Amount of funding in the endowment - # of meetings held by the Project Steering Committee. - # of meetings held by the Board of Trustees. - # of advisory committee meetings.	- # receiving project services - # adopting incentivized technologies - # of hectares of land involved - # of acres reforested - # of installed rainwater pans # of installed drip irrigation systems	- # of Land Degradation Surveillance Framework surveys completed - # of water monitoring stations installed - # of information sharing platforms established - # of meetings to share Water Fund knowledge - # of schools participating in awareness program - # of government policies to protect soil and water

Effectiveness

The Water Fund has already engaged over 10,000 farmers, helped bring 120,000 acres of farmland under sustainable management, and has planted 175,000 trees annually. Farmer participation has been approximately doubling each year since engagement began in 2013.

A business case study was conducted on the Upper Tana-Nairobi Water Fund that modeled the projected cost savings and other benefits of implementing the Water Fund at scale. Some of the expected outcomes at full implementation are:

- Over 50% reduction in sediment concentration in rivers (varying by watershed and time of year);
- 18% decrease in annual sedimentation in a key reservoir;
- Up to 15% increase in annual water yield across the priority watersheds during the dry season;
- Up to US$3 million per year in increased agricultural yield for smallholder farmers;
- Over US$600,000 increased annual revenue for KenGen as a result of increased power generation and avoided shutdowns and spillages;
- Approximately US$250,000 in cost savings a year for NCWSC stemming from avoided filtration, lowered energy consumption, and reduced sludge disposal costs;
- Improved water quality, with a potential decrease in waterborne pathogens, for more than half a million people.

In total, a US$10 million investment in Water Fund interventions is expected to return US$21.5 million in economic benefits over a 30-year time period.

Case 3: Camboriú

The coastal municipality of Balneário-Camboriú is an important tourist destination in Brazil. During the summer tourism season, the permanent population of 170,000 people increases to more than 800,000 people. Balneário-Camboriú has year-round concerns about elevated sediment concentrations. There are additional concerns about water quantity during the tourist season, when demand more than quadruples.

To address these concerns, the Camboriú Water Fund was formed. It is an initiative of the Balneário Camboriú Water Company and partners including TNC, the National Water Agency, and the municipalities of Camboriú and Balneário Camboriú. The Water Company treats water for both the Balneário Camboriú municipality and the Camboriú municipality, inland of Balnéario Camboriú.

Funding for the Water Fund comes from a pool of money set aside by a municipal law which requires that 1% of the Water Company's budget goes to finance watershed management initiatives. This law predated the Water Fund. After visiting Brazil's first Water Producer project in Extrema, São Paulo, an innovative local Water Company employee took advantage the opportunity to finance a Water Producer Program using these legally-mandated funds.

The Camboriú Water Producer Project has inspired TNC to work with the State Water Regulator to allow the local Water Company and other Brazilian water companies to charge a water tariff for conservation. They are working to scale this approach with other water regulators and water companies throughout Brazil.

Biophysical explanation of ecosystem services

Source waters for Camboriú and Balnéario Camboriú lie in the Atlantic Forest Mountains. While forest cover remains high in the immediate regions surrounding Camboriú, the Atlantic Forest is the most threatened forest biome in Brazil and there is concern about future deforestation for agricultural and urban expansion.

The Water Company faces high levels of sediment in source water that increase treatment costs as well as frequent shortages of water during the tourist season. Based on the assumption that deforestation is a major cause of sediment, the Water Fund aims to improve water quality by incentivizing landowners to conserve and restore forest. Following Brazil's Forest Code, the Water Fund prioritizes reforestation in riparian buffers and on steeply sloped areas. There is also a focus on improving dirt roads, which are a major source of sediment. Objectives of the program are to reduce the concentration of total suspended solids at the municipal drinking water intake. The intended benefit is to reduce water losses and reduce treatment costs.

Another major challenge facing the region is increasing urbanization in lower elevation areas that are currently used for rice cultivation. The program is considering strategies to address this, but it is currently beyond program scope.

Identification of the beneficiaries

The primary beneficiary is the Balneàrio-Camboriú Water Company, which in turn provides water for tourists and residents of Balnéario Camboriú. The Water Company also provides water to the upland municipality of Camboriú. The Water Company, in collaboration with TNC, the two municipalities, and the National Water Agency started a Water Producer Project. The Water Company is the most important funder in the project, contributing from a pool of money set aside by a municipal law which requires that 1% of the Water Company's budget goes to finance watershed management initiatives.

The costs and benefits of the Camboriú Water Fund over a 30-year period (2015-2045) were modeled. The monetary benefits were not projected to be as large as the costs when only focusing on reducing sediment. Reductions in treatment costs and water losses could offset 80% of the Water Company's investment and 60% of the Water Fund's total cost. However, significant co-benefits, including reduced risk of flooding, were identified, increasing the Water Fund's overall benefits.

Identification of the suppliers

Land in the source watershed is owned primarily by farmers with large to medium-sized landholdings. Program managers have worked hard to build trust in a region where recruitment is challenging given a long history of distrust of government agencies. The program has also faced the challenge of building trust between the municipalities of Balneario Camboriu and Camboriú, which share the water system. Because of the beach and the benefits of tourism, Balneario Camboriu is one of the five wealthiest municipalities in Brazil. Camboriú, the inland neighboring municipality where the water suppliers live, is ranked much lower. The Balneario Camboriu Water Company provides water to the Camboriú water company, but there was still a need to invest significant resources to build trust to enable a Balneario Camboriu Water Company program to work in Camboriu watershed.

Anyone with de facto land tenure can enroll in the Water Fund. An important challenge thus far has been getting people to join; there is currently more money available than can be spent. The program has worked to build trust, and there are now over 15 landowners enrolled. Their contracts primarily focus on forest conservation.

Active restoration, including grass eradication and tree planting, can cost upwards of $10,000 USD per hectare. In Camboriú, there is high forest cover and thus a seedbank available, so the program is considering passive restoration in areas needing restoration.

Terms of the exchange/*Quid pro quo*

Unlike FONAG and the Upper-Tana Nairobi Water Fund, in Camboriú farmers receive direct compensation of $300 Reals per year (~$100 USD), paid twice per year, for restoration and conservation. Unlike other areas in Brazil where participants may receive more money for conservation than for restoration, in Camboriú all areas enrolled in the program are compensated equally.

Critical to the context in this region is that Brazil's Forest Code mandates conservation and restoration of streamside and hilltop priority zones. Thus, the program provides a benefit to participants by helping them comply with the law. However, the Camboriú area has had consistently poor enforcement of the Forest Code, so it is unclear if this provides motivation.

Mechanism for transfer of value

Farmers and landowners receive direct payments for forest conservation and restoration. The Water Company is the primary project manager, although other members of the Project Management Unit participate in monitoring, site verification, and outreach.

Monitoring and verification

Camboriú has partnered with the State meteorological organization to monitor sediment and flow. They use a Before-After-Control-Impact design. Verification of properties and activities is done once every 6 months with the Water Company and at least one other member of the Project Management Unit.

Effectiveness

Camboriú is a new program so it is difficult to quantify the ecosystem service outcomes of the program. 17 landowners are currently enrolled (2017) with approximately 20 ha in restoration and 300 ha in conservation.

Hydrologic and economic models of the project have been run to project likely effectiveness when the project is mature. Hydrologic models indicate substantial improvements in water quality and quantity from the program when it is fully enrolled. The monetary benefits are also substantial, though not projected to be as large as the costs. Significant non-monetized co-benefits have also been identified.

Recommended key references

Abell, R., et al (2017). Beyond the Source: The environmental, economic and community benefits of source water protection. Arlington, VA, USA, The Nature Conservancy.

Asquith NM, Vargas MT, Wunder S. 2008. Selling two environmental services: In-kind payments for bird habitat and watershed protection in Los Negros, Bolivia. Ecological Economics 65:675-684

Bennett, G. and N. Carroll (2014). Gaining depth: state of watershed investment 2014. Washington, DC, Forest Trends Ecosystem Marketplace.

Bennett, G. and F. Ruef (2016). Alliances for Green Infrastructure: State of Watershed Investment 2016. Washington, DC, Forest Trends Ecosystem Marketplace.

Boucher, T. 2011. A Terrestrial Ecological Impact Assessment of the Quito Waterfund. The Nature Conservancy, Arlington, USA

Brauman, K. A., et al (2007). "The Nature and Value of Ecosystem Services: An Overview Highlighting Hydrologic Services." Annual Review of Environment and Resources **32**: 67-98.

Brauman, K. A. (2015). "Hydrologic ecosystem services: linking ecohydrologic processes to human well-being in water research and watershed management." Wiley Interdisciplinary Reviews: Water **2**(4): 345-358.

Bremer, L., et al. (2016). Bridging Theory and Practice for Hydrological Monitoring in Water Funds, Latin America Water Funds Partnership.

Buytaert, W., V. Iniguez and B. D. Bievre (2007). "The effects of afforestation and cultivation on water yield in the Andean paramo." Forest Ecology and Management **251**(1,2): 22-30.

Kroeger, T., et al. (2017). Assessing the Return on Investment in Watershed Conservation: Best Practices Approach and Case Study for the Rio Camboriú PWS Program, Santa Catarina, Brazil. Arlington, VA, USA, The Nature Conservancy.

TNC (2015). Upper Tana-Nairobi Water Fund Business Case. Version 2. Nairobi, Kenya, The Nature Conservancy.

Vogl, A. L., et al (2016). "Valuing investments in sustainable land management in the Upper Tana River basin, Kenya." Journal of Environmental Management.

Water Funds Weblinks

Cauca Valley, Colombia: http://www.asocana.org/modules/; http://www.fondosdeagua.org/es/agua-por-la-vida-y-la-sostenibilidad-valle-del-cauca-colombia-2010-0/11981.aspx;

Medellin, Colombia: http://www.cuencaverde.org

Quito, Ecuador: http://www.fonag.org.ec

Lima, Peru: http://aquafondo.org.pe/

São Paulo, Brazil: http://fondosdeagua.org/esp/fondo-de-agua-pcj-y-alto-tete-sao-paulo/

Rio de Janeiro, Brazil: http://fondosdeagua.org/esp/productores-de-agua-de-floresta-guandu/

Camboriu, Brazil: http://fondosdeagua.org/esp/pago-por-servicios-ambientales-camboriu/

Nairobi, Kenya: https://www.nature.org/ourinitiatives/regions/africa/explore/nairobi-water-fund.xml

New Mexico, USA: mexico-rio-grande-water-fund.xml?intc=nature.fnav.about

4. REGULATORY-DRIVEN MITIGATION

Lisa Mandle and Rick Thomas

Introduction

Around the world, development activities are a major driver of the loss of natural capital and biodiversity, with forests cut down, grasslands paved over, and wetlands filled in to make way for cities, industry, agriculture, and infrastructure. Often, this process has traded the broad, public benefits provided by ecosystems for economic benefits to smaller groups of people, such as in companies. To ensure that development provides a net benefit to society, government regulations in the United States require that development projects -- both public- and private-sector -- minimize their environmental impacts and mitigate unavoidable impacts through restoration or enhancement of habitats, ecological function, or ecosystem services.

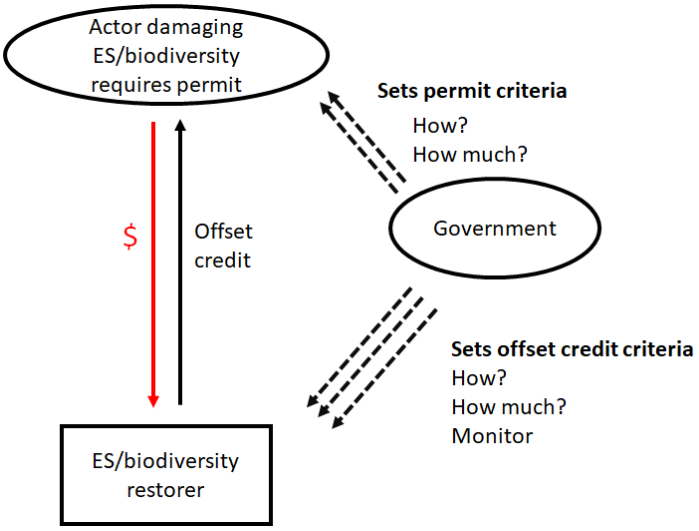

Figure 4.1 In the case of regulatory-driven mitigation, actors who damage ecosystem services or biodiversity pay other entities who restore ecosystem services or biodiversity, in exchange for mitigation or offset credits. The government sets the amount and type of offset credits required of permittees, as well as amount and type of activities that restorers must undertake to generate credits. The government is also involved in monitoring compliance, to ensure that credits adequately represent the environmental values intended, whether in terms of ecosystem services, ecological functions or biodiversity.

Initially, this compensatory mitigation occurred project-by-project, often on the same site as a development project or development activities. However, this approach proved to be both ineffective and expensive, as project developers lacked mitigation expertise and the resulting mitigation efforts were piecemeal. Over time, innovations such as mitigation banking and cap-and-trade have been adopted, with the goal of increasing the environmental and economic effectiveness of mitigation.

In this chapter, we present four cases studies from the United States covering a range of regulatory-driven mitigation mechanisms: green infrastructure for stormwater mitigation in Washington, DC; wetland mitigation banking across the United States; biodiversity conservation banking in California; and forests offsets as part of California's greenhouse gas cap-and-trade program. These examples share a common underlying mechanism (Figure 4.1), in which government regulation provides the impetus for developers to pay for preservation, restoration or enhancement of biodiversity and ecosystem services, and in the process creates business opportunities for conservation. The case studies also highlight the range of environmental values that can be addressed through such a mechanism, and the different roles for multiple levels of government, businesses and civil society organizations.

Case 1: Green Infrastructure Investment for Stormwater Management in Washington, DC

The problem

As the city of Washington, DC, has grown, natural areas, green spaces and empty lots have been replaced with buildings and pavement. Now, 43% of the city's area is occupied by paved and impervious surfaces. These impervious surfaces prevent rainfall from being absorbed into the soil. Instead, large amounts of stormwater flow through municipal storm sewers directly into local rivers, carrying oil, sediment and other pollutants. In this way, a single 3 cm storm creates 2 million m^3 of stormwater runoff in DC. In addition, the city's combined sewage/stormwater run-off system overflows regularly, sending an additional 10 million m^3 of runoff and sewage into the Potomac and Anacostia rivers each year. This has degraded the water quality of DC's local rivers, as well as the Chesapeake Bay, the largest estuary in North America, into which these rivers flow (Figure 4.2). This has exacerbated a number of problems in the bay, including reducing drinking water quality, and damaging habitat.

Reducing stormwater runoff in DC is necessary to bring the city into compliance with national Clean Water Act requirements and avoid large fines and other penalties. Towards this end, DC's Department of Energy and Environment (DOEE) issued new stormwater regulations in 2013. These new regulations created a mandate that all new developments and major redevelopments in the District must mitigate their impacts on stormwater flows. These new regulations also created the Stormwater Retention Credit (SRC) market, which allows projects to meet some of the regulatory requirements through the purchase of credits from others who have

implemented nature-based solutions such as green roofs, grass filter strips, wetland construction and tree planting.

The ecosystem service

In the absence of stormwater management infrastructure (either nature-based "green" infrastructure or engineered "grey" infrastructure), stormwater that lands on roofs and paved surfaces picks up sediment, oil and other pollutants and washes them into sewers, which then flow to DC's three rivers (the Potomac, Anacostia and Rock Creek) and into the Chesapeake Bay. When high volumes of water end up in streams after storms, this erodes stream channels, and the sediment is carried downstream, degrading aquatic habitat. Green infrastructure therefore contributes two main ecosystem services: water quality regulation through filtration of pollutants, and regulation of water flows by increasing infiltration and slowing storm flows. Green infrastructure for stormwater management also provides co-benefits that grey infrastructure does not, including aesthetic values, recreational opportunities and associated health benefits.

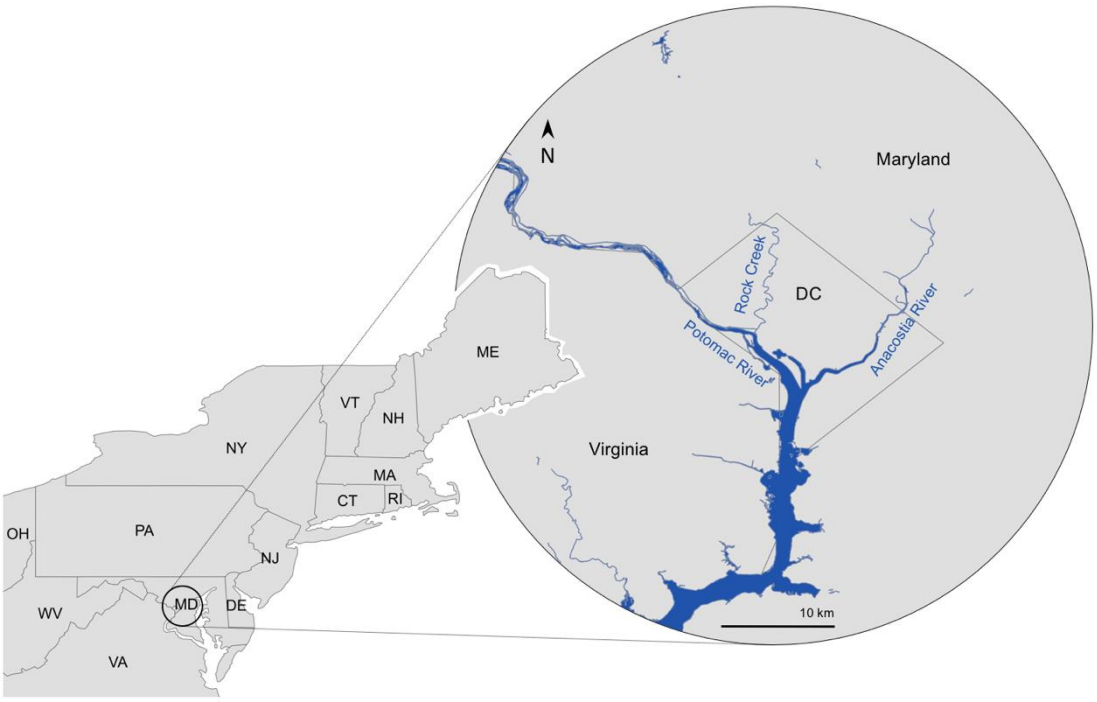

Figure 4.2 Stormwater from the city of Washington, DC -- along with debris and pollutants it picks up along the way -- runs into Rock Creek and the Anacostia and Potomac rivers, eventually flowing south into the Chesapeake Bay. The District is using green infrastructure, such as green roofs, grass filter strips and rain gardens, to reduce this runoff and the associated degradation of water quality.

Ecosystem service beneficiaries

The improved water quality in DC rivers provides benefits to many DC residents and visitors, and improved water quality in the Chesapeake benefits those involved in recreational and commercial fishing and water-based tourism in the area. The communities located near the mitigation sites are also expected to receive benefits associated with increased green space.

Ecosystem service suppliers

The property owners who replace impervious surface with permeable cover that contributes to stormwater retention are the ecosystem service suppliers.

Terms of the exchange/*Quid pro quo*

Under DC's stormwater regulations, regulated development projects are required to retain a certain amount of stormwater (Stormwater Retention Volume or SWRv). Up to 50% of the required SWRv can be met through off-site activities (Off-Site Retention Volume or Offv); the rest must be retained on site. Projects categorized as major land-disturbing activities (those that disturb > 140 m^3 of soil) must retain the volume of a 3 cm storm, equivalent to a 90^{th} percentile rainfall event in a 24-hour period in DC, or ~300,000 liters per hectare of impervious surface. Projects categorized as major substantial improvements (those with a project footprint <140 m^3 and renovation costs >50% of project value) must retain the equivalent of 2 cm of stormwater runoff.

A project can meet Offv requirements by: 1) generating its own SRCs offsite of the project site, 2) buying SRCs, 3) paying in-lieu fees, or through some combination of 1-3. Thirteen pre-approved Best Management Practices (BMPs) can be used to meet on-site and off-site SWRv requirements, or to generate SRCs. Many BMPs, such as green roofs, impervious surface disconnection with grass filter strips, biorentention, vegetated open channels, construction of stormwater ponds and wetlands, as well as tree planting and preservation, include green infrastructure elements.

One SRC is equivalent to retention of ~4 liters of water for 1 year. Projects that generate their own SRCs implement an appropriate amount of SRCs to meet their Offv requirements. Otherwise, projects purchase the SRCs they need from private groups that have implemented BMPs. Fees are paid to the city (known as in-lieu fees) and go towards developing retention projects managed by the government. The average price of one credit in 2017 was USD 2.11, as compared to an equivalent in-lieu fee of USD 3.58. The in-lieu fee is based on the city's estimate of its own costs for implementing BMPs, adjusting annually for inflation. This suggests that the private market is able to provide stormwater retention more cost-effectively than the government, and the city could use in-lieu fees it receives to purchase SRCs at a lower cost than if it implemented retention projects itself. However, the existence of the in-lieu fee option reduces uncertainty about compliance for project developers, should not enough credits be available on the market in the future.

The ability to purchase SRCs provides flexibility to regulated developers, as they can mitigate off-site if it is more cost effective and then make more money from additional space or amenities in their development (e.g., more parking spaces, a rooftop pool, etc.). The hope is that this SRC market will also increase both job opportunities and green space in the poorer areas of the city. The cost of land is lower in these areas, so off-site mitigation here is likely to be cost-effective relative to on-site mitigation in the city's center where most development is happening. Construction and maintenance of off-site mitigation in these poorer areas might provide employment opportunities.

Since the SRC market began in 2014, over 100,000 credits have been traded with a value of over USD 220,000. The market shows growing activity, as more than half of total credits were traded in 2017. A similar trading system has been developed in Chattanooga, Tennessee. Analysis by The Nature Conservancy identified 12 additional US cities with good potential for developing a SRC market, as pilots for a broader, national program.

Mechanism for transfer of value

Project developers that need SRCs can buy them directly from private SRC-generating projects. Anyone within the city of Washington, DC, can generate SRCs and sell them. Trading of SRCs is restricted to the administrative boundaries of the city of DC, even though DC's watersheds extend into neighboring states. Projects must acquire enough credits to cover their stormwater retention needs each year. Credits can be bought on an annual basis, or credits for several years can be purchased up front and banked for future use. SRC sellers are responsible for maintaining SRC-generating projects over time.

A land owner wishing to sell SRCs to a developer must first implement BMPs on their land and receive certification from the Washington, DC, Department of Energy and Environment (DOEE). DOEE certifies the number of credits based on the stormwater retention value of the BMPs (see "Monitoring and verification" below for more details). The land owner can then list these credits for sale. Project developers seeking SRCs can contact those selling credits, and the two parties negotiate a mutually agreeable contract, including price, for the sale of credits. They then apply to the DOEE to transfer ownership of credits from the seller to the project developer. Upon approval, the project developer takes ownership of the credits and pays the land owner.

As of August 2017, more than 200,000 credits were available for sale from 11 groups, ranging from faith-based organizations (e.g., churches) to private companies. NatureVest (the conservation investing unit of The Nature Conservancy NGO), and Encourage Capital (a private investment firm), along with an initial USD 1.7 million investment from Prudential Financial (a company in the financial services industry) established a company called District Stormwater, LLC. This company is designed to fund, develop and manage SRC-generating projects, while generating financial returns for investors.

Monitoring and verification

SRCs are verified and independently audited by the DOEE. SRC-generating projects must be designed and installed in accordance with an official Stormwater Management Plan and the DOEE's Stormwater Management Guidebook. Projects must pass a DOEE inspection after being constructed to ensure that BMPs are properly installed, and projects must ensure that BMPs will be maintained. If they meet these conditions, DOEE will award credits for the next 3 years (*ex ante* crediting), though the site can be re-inspected before then to confirm compliance. If the project is not adequately maintained, there is a fee for non-performance. Project owners must re-apply for credit certification every three years.

DOEE assigns each credit that it issues a unique serial number based on certification year, drainage number and Stormwater Management Plan. DOEE tracks the ownership of each SRC, along with its use towards mitigation. DOEE must approve transfers of SRC ownership between sellers and buys to make sure credits are valid. Mitigation projects and credits are listed on an online registry system.

Effectiveness

As of mid-2017, there does not yet seem to be any review or quantification of program performance, either in its biophysical or social objectives, which is not surprising given that the credit market only began in 2014. In what is perhaps an indication the market has gotten a slower start than hoped, DOEE announced an SRC Purchase Agreement Program in 2016, which provides USD 11.5 million for SRC purchases by the city over six years. This grant program aims to spur investment in green infrastructure projects by the private sector and other non-governmental groups by providing SRC-generating projects with a guaranteed minimum price for their credits from DOEE, and thereby reducing the risk to project developers. Projects would still have the option to sell their credits on the open market, should prices be higher there. Credits purchased by DOEE will be retired, so that this program will provide additional water quality benefits beyond what is required for compliance with stormwater management regulations. This program will also favor green infrastructure projects in the parts of DC that would provide the most water quality benefits.

Key lessons learned

This case study highlights the role of government in enabling market-based mechanisms for financing green infrastructure. Washington DC's need to comply with national Clean Water Act requirements to limit pollutants entering DC's local waterbodies and the Chesapeake Bay are what spurred the city to implement new stormwater regulation in 2013. Developers who needed permits to manage the stormwater resulting from their projects were forced to choose among engineering stormwater management on site, paying in-lieu fees or purchasing SRCs, instead. This, in turn, created the SRC market, creating business opportunities for local companies and organizations. The government plays a second critical role in administering the SRC Purchase

Agreement Program. Publicly administered purchase agreement programs like this are important for the functioning of new environmental markets, particularly while markets are small and lack a history of demand for credits, so private investment in credit-generating projects is limited. The challenge now for Washington, DC is whether a robust market – with an adequate supply of credits meeting the demand from development projects – can be sustained, and whether the program can successfully meet its multiple goals of improved stormwater management with reduced costs to the city and increased benefits to the city's poorer communities.

Case 2: Wetlands Mitigation Banking in the United States

The problem

More than 50% of the wetlands in the continental United States have been drained, filled and converted to development, agriculture and other uses that were traditionally considered more economically productive. In the 200 years between 1780 and 1980, wetlands were lost at an average rate of 25 hectares per hour, and the state of California lost more than 90% of its wetlands.

The conversion of wetlands has also meant the loss of wetland-associated ecological functions and ecosystem services. Since the late 1980s, US policy has called for "no net loss" of wetlands, meaning that any wetland loss due to development should be compensated for with wetland restoration, creation or enhancement. Development projects that impact wetlands are required to mitigate their impacts. Initially, each project mitigated its own impact, often on the project site, or at an off-site location created for that single development project. However, mitigation in this form proved to be ineffective: on-site mitigation resulted in small, isolated wetlands whose quality was impacted by the adjacent development, and the country experienced continued wetland losses. This led to the development of wetland mitigation banking as a way to more effectively and reliably mitigate losses of wetlands, along with their ecological functions and their services. In 2008, under the Clean Water Act, the US Army Corps of Engineers and the Environmental Protection Agency regulations established mitigation banking as the preferred mechanism for mitigating unavoidable impacts to wetlands in the United States, as compared to on-site mitigation or in-lieu fees.

The ecosystem service

Wetlands provide a diversity of ecosystem services. These include recreational opportunities such as wildlife viewing, boating and fishing; flood regulation by storing stormwater, water quality regulation by trapping sediment and other pollutants, and protection of coastal areas from inundation and erosion from storms. Mitigation banks create, enhance or restore wetland ecosystems and their functions as a means of maintaining the ecosystem services they provide.

Ecosystem service beneficiaries

Wetlands provide a diversity of ecosystem service benefits, including protection from coastal storms; attenuation of inland flooding, water filtration, groundwater recharge and recreational opportunities. Wetlands are also important for biodiversity conservation, including supporting migratory bird populations and providing nursery habitat for fish and other aquatic species. Under the principle of no net loss, mitigation banking aims to maintain the ecosystem service benefits that wetlands provide to the public.

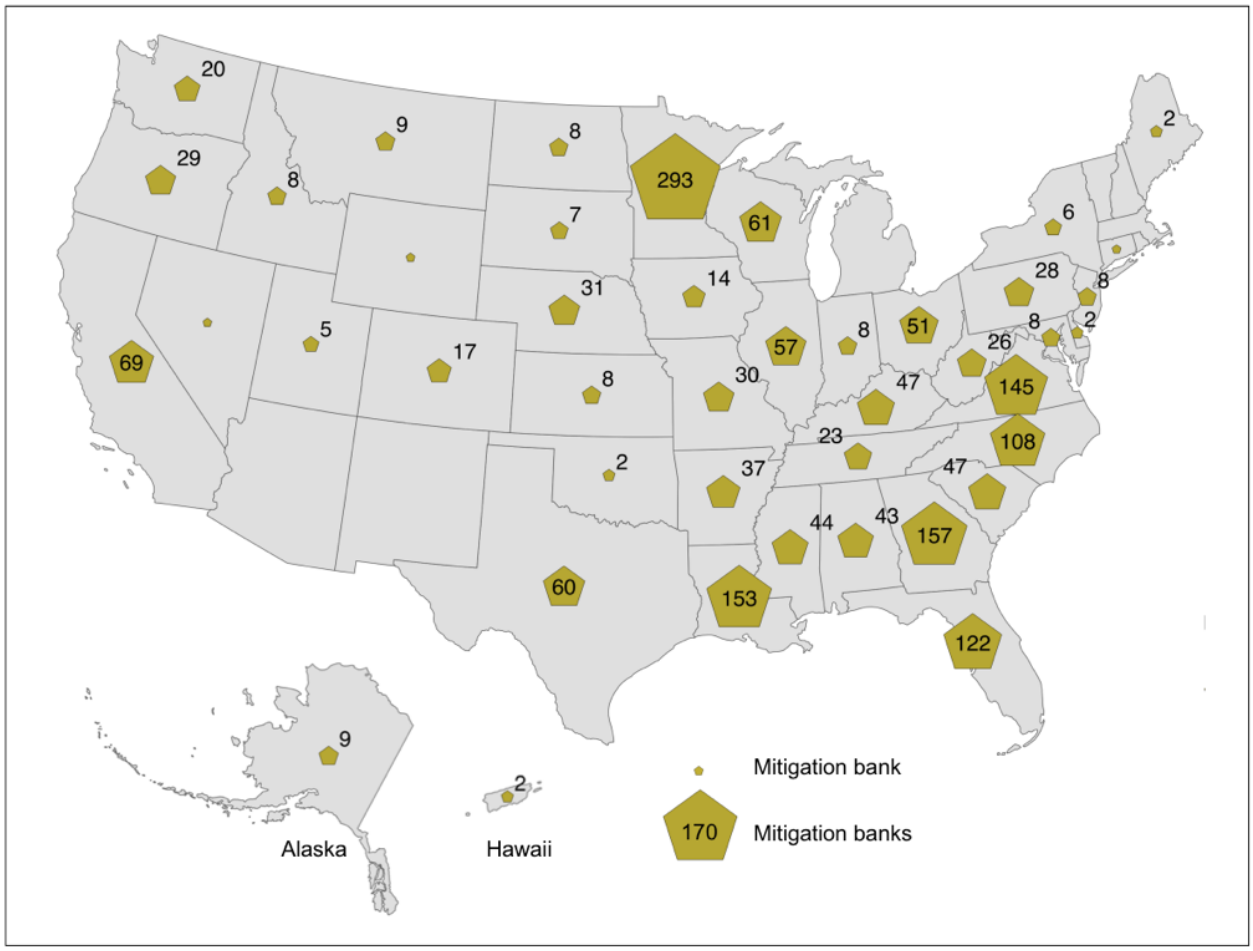

Figure 4.3 More than 1,300 wetland mitigation banks throughout the United States have been approved to sell credits, and over 200 of these banks have sold out of credits. The label indicates the number of approved mitigation banks per state in states with more than one bank.

Ecosystem service suppliers

The mitigation bank owners and managers who carry out wetland restoration, creation or enhancement are the ecosystem service suppliers. The mitigation banks are paid by project developers who impact wetlands through the purchase of credits.

Terms of the exchange/*Quid pro quo*

Mitigation banks restore, create or enhance wetland habitat and functions. Based on the size and nature of these activities, mitigation banks generate credits. Developers whose activities damage wetlands buy credits in order to offset their impacts, as required by government regulations in order to issue a development permit. The number of credits a developer must buy is again determined by the size and nature of their impacts on wetlands.

The wetland mitigation banking mechanism benefits developers whose projects impact wetlands. The developers pay to offset their impacts to wetlands by buying credits from mitigation banks. By turning over mitigation activities to mitigation banks run by third parties, developers are able to meet regulatory requirements for compensatory mitigation at a lower cost, and do not have to be responsible carrying out mitigation themselves when it is not their core business.

Mitigation banking began in the 1980s, primarily as a means of mitigating impacts by state governments, especially Departments of Transportation that were building roads and needed to mitigate large wetlands losses. Early banks were generally government sponsored. Mitigation banking expanded rapidly after federal guidance was issued in 1995. By 2001, there were over 200 mitigation banks. Nearly two-thirds of this were privately-owned enterprises. As of September 2017, more than 1,300 mitigation banks have been approved to sell credits for mitigation under the Clean Water Act, with an additional ~300 banks pending (Figure 4.3). Over 200 banks have sold out of credits.

Mechanism for transfer of value

Section 404 of the Clean Water Act is the regulatory driver of wetland mitigation, and therefore mitigation banking, in the United States. Both private and government development projects that would fill in wetlands or impact streams or other aquatic resources are required to first demonstrate that the project minimizes its negative impacts, and second compensate for (or mitigate) unavoidable negative impacts, in order to receive permits for development. The US Army Corps of Engineers and the Environmental Protection Agency (EPA) are the two federal agencies that govern permitting authority, though this role has also been devolved to some state agencies. To comply with permits, a project developer may purchase the required number of mitigation credits directly from a mitigation bank.

Each mitigation bank, which may be operated by private companies, non-governmental organizations or the government, is approved by regulators to sell a certain number of credits. Mitigation banks are committed to maintain their wetlands in perpetuity through the use of easements (see Chapter 5 for more information on conservation easements). Credits are generally defined in terms of wetland area, rather than using measures of ecosystem service provision. Often, for every hectare of wetland credit a bank is approved for, the bank is required to restore, enhance or create more than one hectare of wetland. This mitigation ratio (e.g., requiring 5 hectares of wetland mitigation for 4 hectares of credits) is meant to ensure that mitigation adequately compensates for the functions and values of wetlands that are lost due to

development, serving as a form of insurance against the risk of failure and differences in wetland quality between the impacted site and mitigated site.

Each bank has a designated service area, which is the geographic area (usually a watershed) in which credits from the bank can be used as mitigation for impacts. Therefore, credit trading can generally only occur between development projects and mitigation banks within the same watershed. Mitigation banks are listed publicly on the Regulatory In-Lieu fee and Bank Information Tracking System (RIBITS), run by the US Army Corps of Engineers.

To provide a simple example, consider a project developer whose proposed development would fill in 10 hectares. If the developer wishes to fulfill this obligation by purchasing credits from a mitigation bank, they could use the public registry to locate banks with 10 hectares of available credits whose service area includes the project site. The 10 hectares of credit provides might correspond to 15 hectares of restored wetlands at the mitigation bank. The mitigation bank sets the price for its credits. When the project developer locates credits they would like to purchase, they pay the mitigation bank directly and the bank deducts those credits from its ledger. Federal and state regulatory agencies track the use of mitigation credits by developers for permitting compliance. Mitigation banks must also report their credit transactions to regulatory authorities (see *Monitoring and verification* below).

Monitoring and verification

Each mitigation bank is overseen by an Interagency Review Team (IRT), responsible for reviewing, approving and overseeing the bank. Each bank also has a bank instrument, which establishes the number of credits that bank can sell, and the ecological assessment techniques that must be used to verify that the bank is providing the necessary ecological functions. verification happens before credits are released for sale. The instrument also establishes monitoring requirements.

Effectiveness

The rate of loss of wetland acreage in United States has appeared to slow down, but the country is still experiencing a net loss despite mitigation requirements, based on the most recent National Wetlands Inventory. The particular role of mitigation banking in slowing losses is unclear. This is in part because wetland mitigation under Section 404 of Clean Water Act only applies to wetlands over a certain size. The Clean Water Act has also been interpreted in some places not to apply to isolated wetlands. Therefore, small and isolated wetlands are being lost, despite these mitigation requirements.

In addition, trends in wetland acreage or extent do not necessarily reflect trends in ecological function or ecosystem services. In practice, mitigation has often not compensated for the lost ecological values of wetlands. Several studies have shown that in certain areas mitigation banking has led to a transfer of wetlands and their associated services away from urban areas (where a large number of people benefit from the ecosystem services provided) towards rural areas (where fewer people benefit). In some cases, this transfer is associated with a loss of wetlands in poor and minority communities as well. Mitigation that tracks wetland area without

considering who benefits can lead to redistribution of ecosystem services, creating winners and losses and potentially exacerbating inequality.

Key lessons learned

The example of wetlands mitigation banking again highlights how government regulation can set the stage for market-based mechanisms to flourish, creating business opportunities around securing or enhancing natural capital. At the same time, continued wetland losses and redistribution of wetland-associated ecosystem services illustrate the challenges associated with ensuring mitigation is adequately compensating for the impacts of development.

Case 3: Conservation Banking in California

The problem

Inspired by the wetlands mitigation banking associated with the federal Clean Water Act in the United States (Case 2 in this chapter), the state of California created its own conservation banking program for threatened and endangered species and habitats. Started in 1995, it was first of its kind in the United States. As with wetlands mitigation banking, conservation banking is designed to pool resources from multiple development projects to fund more effective conservation of larger and more strategic conservation sites.

The ecosystem service

Conservation banking aims to conserve or enhance threatened or endangered species and habitats. The benefit is biodiversity conservation, which is not an ecosystem service itself but does underpin a diversity of ecosystem services.

Ecosystem service beneficiaries

Biodiversity can be considered a public good, providing broad societal benefits. The particular beneficiaries of biodiversity conservation from conservation banking vary with the specific ecosystem service considered. For example, many people value the continued existence of wild populations of threatened and endangered species, regardless of whether they personally have a chance to see them personally. Conservation banking can also enhance recreational opportunities, both at conservation bank sites and in adjacent areas where wildlife populations have been bolstered by conservation bank activities.

Ecosystem service suppliers

The landowners who create conservation banks are the ecosystem service suppliers. These may be individuals, companies or non-profit organizations. The conservation banks are paid when project developers purchase credits.

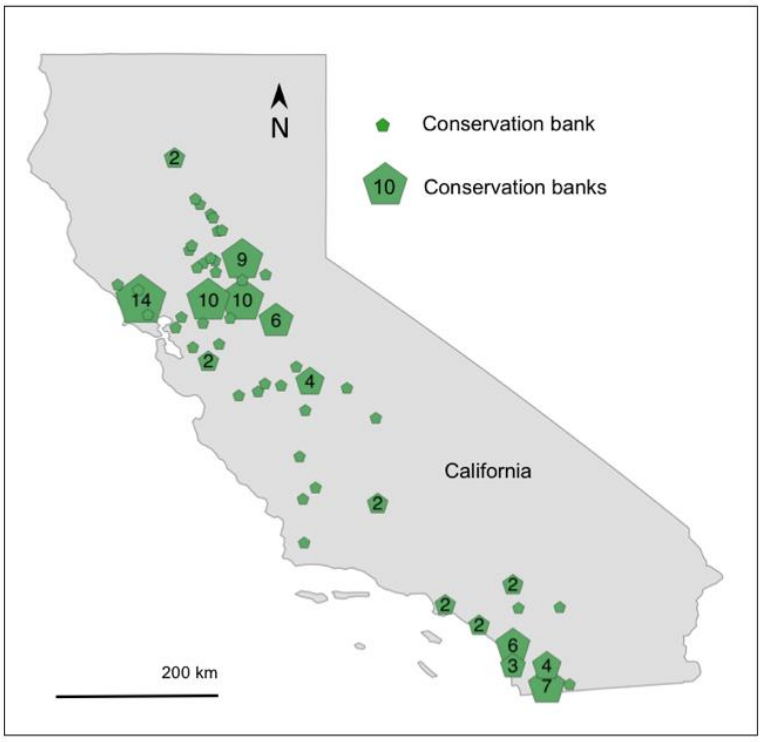

Figure 4.4 Location of conservation banks in California with credits for mitigating impacts to species and/or habitats. These include the 79 banks approved by the California Department of Fish and Wildlife mentioned in the text, as well as banks approved by other agencies. In areas where multiple banks are closely clustered, the number of mitigation banks in that area is labelled.

Terms of the exchange/*Quid pro quo*

The terms of the exchange for conservation banking in California are largely the same as for wetland mitigation banking covered in the previous case study, which is not surprising considering California modeled its program on wetland mitigation banking. Conservation banks generate credits by taking actions to protect threatened or endangered species or habitats in perpetuity, such as through conservation easements. Developers whose activities unavoidably harm those species or habitats must offset their impacts through mitigation, and can fulfil regulatory requirements for mitigation by buying credits from a conservation bank.

One notable difference between conservation banking and wetland mitigation banking, however, is that conservation banking has predominantly relied on conservation of existing habit, rather than restoration, enhancement or creation of new habitat -- the preferred activities for wetlands mitigation. This means that conservation banking in California serves to stem the loss of biodiversity by increasing the amount of area under protection, but it will not (and does not aim to) lead to no net loss of species or habitats. As with wetland mitigation banking, the credits that developers are required to purchase and that conservation banks can offer is generally determined by the area of habitat.

Developers or project proponents benefit from being able to meet regulatory compliance at a lower cost and by shifting responsibility for mitigation to other entities (conservation banks)

with expertise in this area. Again paralleling wetland mitigation banking, the developers pay to offset their environmental impacts by buying credits from conservation banks.

As of January 2017, there were 79 state-approved banks overseen by the California Department of Fish and Wildlife (Figure 4.4). Approximately half of these are conservation banks, offering credits for species and habitats. The remaining mitigation banks may offer credits both for wetlands mitigation and for species and/or habitats. Applications to the state for new banks has declined since 2013, with only 16 applications in 2016. Since its start in California in 1995, conservation banking has spread across the United States. In 2003, the US Fish and Wildlife Service issued federal guidelines for conservation banking. As of 2012, more than 120 banks had been approved, covering 100,000 acres.

Mechanism for transfer of value

Conservation banking in California again functions much in the same was as wetlands mitigation banking. Because conservation banking is a state-, rather than federal-level program, the government agencies involved differ. The California Environmental Quality Act and the California Endangered Species Act are the regulatory drivers of conservation banking. They require compensatory mitigation for projects that "substantially diminish habitat for fish, wildlife or plants" or impact threatened or endangered species. The California Department of Fish and Wildlife reviews and approves conservation banks, determines the number of credits designated, and oversees and monitors bank operations. A list of banks and available credits are maintained online.

As with wetland mitigation banking, a developer who needs to mitigate impacts to species or habitats in order to receive regulatory approval for their project can seek available conservation bank credits that match their needs. The developer then buys the credits from the conservation bank and the bank deducts those credits from its ledger. With approval of the transaction by regulatory authorities, the developer can then receive the permits needed to proceed with their project.

Monitoring and verification

The California Department of Fish and Wildlife verifies the number of credits a bank can offer before credits are released for sale. As mentioned previously, this is generally based on the area of habitat, or area of occupied habitat for a particular species. It may also be based on the number of breeding pairs. The same agency also monitors compliance after credits have been issued. Monitoring tends to include only annual or seasonal surveys of species or habitat-specific factors (e.g., water level in vernal pools) for those species or habitats for which the bank was established. However, particularly for species with large ranges, this kind of monitoring is not particularly useful for evaluating the success of the bank because of the challenge of attributing changes in species abundances to the bank itself as compared to regional factors beyond the bank's boundaries.

Effectiveness

Conservation banks are generally considered an improvement over project-by-project and on-site mitigation. A 2005 study reported that 49% of conservation banks, protecting over 11,000 ha of habitat, would have been destroyed or seriously degraded if not otherwise protected by conservation banking, suggesting that some banks do provide additional conservation value. Nonetheless, many banks are still effectively stand-alone efforts. Ideally, regional conservation plans would guide the location of banks to promote connectivity and other conservation objectives. However, development of these regional plans has been slow.

Bank proposals increased year-over-year from 1995 to 2012, but have declined annually since then. The greatest number of banks were approved in 1996, just after the program started, and no new banks were approved between 2009 and 2013. There are a number of likely reasons for this. A lengthy approval process (2-7 years) was a deterrent, though new banking standards effective since 2013 have shortened timelines. The state temporarily suspended bank review for a year in 2012 due to staff and funding shortages. The Department of Fish and Wildlife began a new fee system in 2013, with the aim for banks and project developers purchasing credits to fully fund the associated government administrative costs. As of 2017, these fees totaled around USD 100,000 across multiple stages of review and implementation. Conservation bankers also report challenges in assessing the costs and financial risks of proposed banks upfront. As of 2005, 35% of for-profit conservation banks reported that they had broken even. Although these numbers are dated, they suggest that profitable operation of conservation banks can be a challenge.

Key lessons learned

California's conservation banking program illustrates how mitigation banking can be extended beyond wetlands to promote preservation of species and habitats. It also highlights the challenges in creating a self-sustaining program, that both provides certainty and financial incentives for private entities to create banks and sufficient resources for the government to provide the necessary review and oversight.

Case 4: Carbon Markets in California

The problem

Climate change poses a number of threats to the health and productivity of California's residents. As the planet gets warmer, the state is expected to experience hotter and more prolonged heat waves, with inland areas already prone to drought experiencing the most severe effects. These heat waves, alongside predicted declines in air quality (meaning more days that exceed the federal standards for ozone), promise to have adverse effects not just on the human population, but on agricultural production as well, a USD 40 billion industry in California. The state is also at

greater risk of wildfire and sea level rise, both of which could compromise the productivity of the natural environment and result in hundreds of thousands of climate refugees.

In terms of greenhouse gas emissions within the U.S., California is second only to Texas. The top three drivers of climate change in California are transportation, electric power, and industrial use, together accounting for over 85% of the state's emissions. Given that these sectors are critical for California's growth and development, the problem the state faces is how to reduce its emissions—and therefore reduce its future risk—without compromising its economy.

To date, the state's primary approach to this problem has been aggressive climate policy. California Governor Jerry Brown has issued a number of Executive Orders aimed at reducing the state's greenhouse gas emissions. These include Executive Order (EO) S-3-05, which sets emission reduction targets of 80% below 1990 levels by 2050 and EO B-16-2012, which specifically targets reducing emissions from the transportation sector to 80% of 1990 levels by 2050.

California's most expansive climate policy came into effect in 2006 with the passage of Assembly Bill (AB) 32 or the "California Global Warming Solutions Act". This bill limits the state to 1990 emission levels by the year 2020, a value that has been at estimated at 431 million metric tons of carbon dioxide equivalent ($MMTCO_2e$). Part of the state's approach to achieving this is through a cap-and-trade market for greenhouse gas (GHG) emissions targeting the state's biggest polluters. Under this program, the state's Air and Resource Board (ARB) sets a limit on total emissions, allowing companies to decide how to comply with the regulation, whether that is through decreasing their emissions, purchasing allowances, or investing in offset credits.

These offset credits can be purchased for verified emission reductions from a number of different initiatives including forest management, elimination of ozone depleting substances, livestock management, methane capture from mines, and improved rice cultivation strategies. This case study will predominantly focus on offsets purchased through forest management, as the vast majority of offset credits made available through AB-32 to date have been from this sector (Figure 4.5).

The ecosystem service

The primary ecosystem service provided by offsets credits is carbon sequestration. Forest management offset credits specifically can generate additional ecosystem services including water filtration and soil erosion prevention. For a more detailed explanation of the ecosystem services provided by forests, refer to Chapter 2.

Ecosystem service beneficiaries

There are two broad groups that benefit from these offsets and the ecosystem services they provide. Communities located near the forest management areas stand to benefit, as many of the regulating services forests provide are local. Additionally, because carbon storage is an ecosystem service that addresses climate change, the global population is a beneficiary of these protected forests.

Ecosystem service suppliers

As defined under AB-32's offset program, the ecosystem service suppliers are parties that choose to undertake emission reduction projects and sell the credits they generate to companies regulated under AB-32. These suppliers are referred to as Offset Project Operators (OPOs) and are the ones responsible for ensuring that projects meaningfully reduce emissions. In the case of forest management offsets, OPOs can be businesses, individuals, or partnerships, so long as they are a forest owner and have the legal authority to implement an offset program there. For an OPO to be paid for their project, they must list it on an ARB approved Offset Project Registry, such as the Verified Carbon Standard, and adhere to all the requirements listed in ARB's Compliance Offset Protocol (discussed in more detail below). Assuming the project is approved, an OPO is issued ARB offset credits which are then made available for regulated companies to purchase.

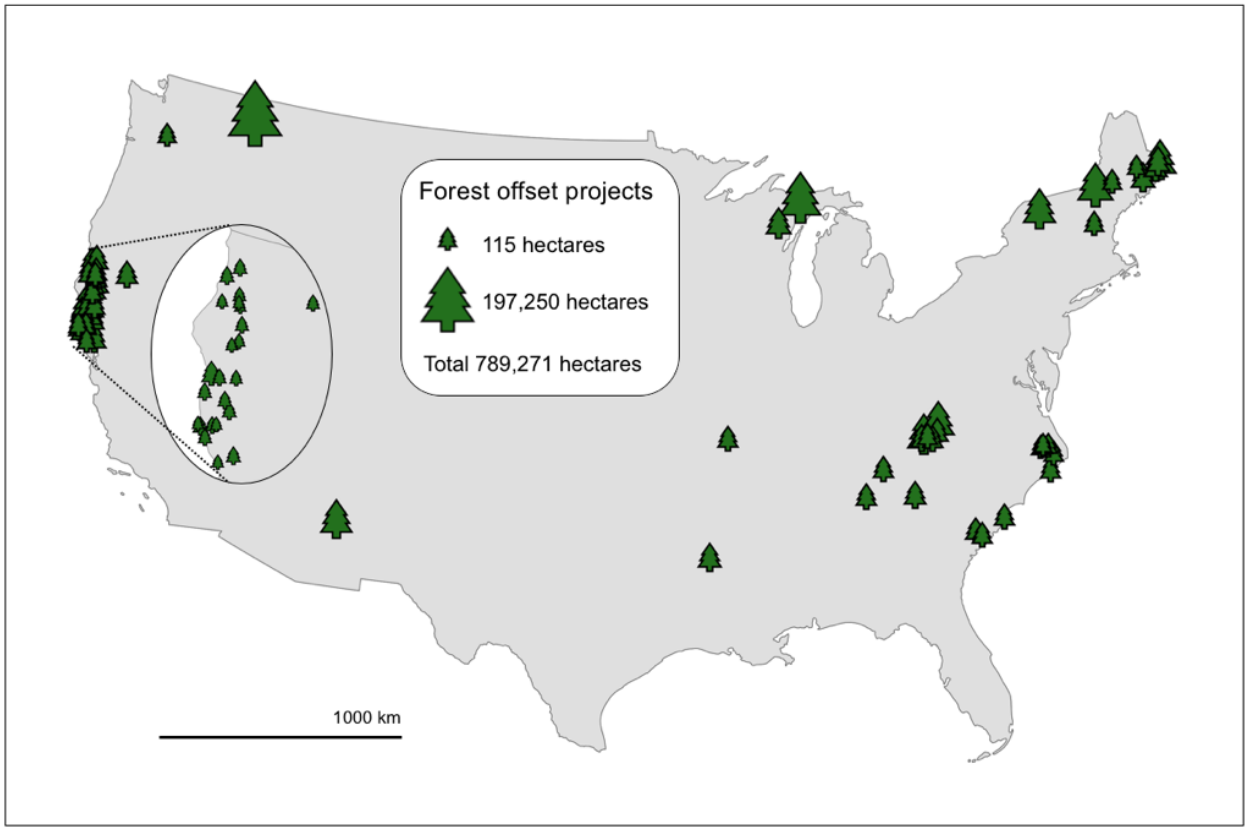

Figure 4.5 Forest Offsets projects under CA AB 32. Close to 800,000 hectares within 59 forest management projects across the continental United States have been approved to sell offset credits under California cap-and-trade market for greenhouse gas emissions.

Terms of the exchange/*Quid pro quo*

Understanding how AB-32 offset credits result in ecosystem services requires background on the cap-and-trade program as a whole. The program covers approximately 350 businesses that

together account for 85% of California's emissions, primarily electricity generating utilities, electricity importers, large industrial facilities, and fuel distributors. The total limit of statewide emissions (the "cap") declines over time to meet state total emissions targets; the 2013 cap was set at 2% below 2012 emissions forecast, declining ~2% in 2014 and ~3% annually from 2015-2020.

At the program's inception in 2012, companies received ~90% of their emissions allowances free (one allowance = 1 $MMTCO_2e$). Emissions beyond these free allowances can be covered by purchasing more allowances through an auction every few months or by purchasing offset credits. Because purchasing additional allowances and purchasing offset credits equally meet a regulated company's requirement, it is expected that the company will purchase whichever is cheaper. AB-32 mandates that the amount of free allowances that are distributed go down over time, forcing companies to either find innovative ways to reduce their emissions, purchase more allowances, or rely more on offsets. To ensure companies are not simply paying their way into compliance without ever actually addressing their own emissions, the amount of offsets that can be purchased is capped at 4% of an entity's emission levels.

Mechanism for transfer of value

As mentioned above, parties interested in selling offset credits must adhere to the specific Compliance Offset Protocols ARB has developed covering each eligible emission sector: forestry, urban forestry, manure digesters, destruction of ozone-depleting substances, capturing and destroying methane from mines, and reducing emissions from rice cultivation. Each protocol has sector specific requirements on which actions generate credits. For forest management these activities include avoiding conversion of forestland, reforestation, and improving forest management.

In addition to these sector-specific requirements, every offset protocol stipulates that all projects be located within the United States and go beyond "business as usual", meaning offset credits cannot be generated for greenhouse gases these projects were already going to sequester with or without the purchase of offsets. Once a company has purchased offset credits and used them to meet their emission reduction requirements, the credits must be "retired" so as to prevent them being counted more than once.

In the case of forestry offset credits, while only national projects have been approved so far (Figure 4.5), there are plans to allow companies to purchase international forest credits in the future. California is currently working with the states of Chiapas, Mexico, and Acre Brazil to get REDD+ initiatives up and running that are compatible with AB-32 requirements to strengthen the offset credit market (see Chapter 2 for more information about REDD+).

Monitoring and verification

Regulated companies must report their total greenhouse gas emissions to the ARB, which undergo a third-party verification process to ensure compliance. In regards to offsets, each protocol specifies a monitoring and verification procedure with different requirements. For

forest management, the protocol mandates that every project site undergoes site visits, has an extensive tree monitoring plan to quantify forest stocks, and submits reports for independent verification by an ARB-accredited body every six years. To protect against reversals of carbon, these monitoring and verification procedures must continue for 100 years following the distribution of offset credits.

Effectiveness

As of 2014, California's emissions were down 10% from their peak in 2004 and the state is currently on track to meet its 2020 target. Although certainly promising, it is unclear how much to attribute this success to AB-32 alone since it has been accompanied by a suite of other emissions-reductions policies.

Regarding the offset program, a 2017 analysis of all the forest management programs registered with ARB identified 39 projects around the nation, each which have been credited with offsetting 654,000 tons of carbon-dioxide equivalent on average. More importantly, the study concluded that the reductions were additional, meaning they contributed beyond what would have occurred without the offset purchases. This suggests that offsets are an effective part of the cap-and-trade program and are making meaningful progress to AB-32's 2020 goal. Although the cap-and-trade program was initially scheduled to expire in 2020, in July of 2017 a super-majority in the state-legislature approved a 10-year extension, indicating state-wide confidence in the program.

Key lessons learned

California's implementation of its cap-and-trade program has produced a number of important insights that can inform similar programs elsewhere. Particularly, the state has succeeded in finding cost-effective ways to administer the program. One of these strategies is to develop strategic partnerships to aid in the costly administrative tasks associated with the program. In 2014 the state linked its cap-and-trade program with Quebec, Canada's own emissions reductions program, simultaneously cutting down on its administrative costs while adding credibility to California's program. Through this partnership the two parties have been able to pool their resources to harmonize regulations and guidance documents and even operate a joint auction platform to sell emission allowances. Ontario, Canada is expected to join the successful partnership in 2018.

Another way the state has found to help cover program costs is to collect fees from the largest sources of greenhouse gases (approximately 250 fee payers, responsible for 330 MMTCO2e/year). Because these fees are based on the payer's emissions (generally USD .14-.18 per metric ton), a policy such as this services to further incentivize emission reductions from these heavy emitters.

California's success also highlights the importance of a well-designed offset credit market. ARB's market is successful because it balances rigorous requirements (ensuring meaningful reductions) with a relatively stream-lined process with guidance along the way (lowering

transaction costs for potential Offset Project Operators). To date, over 40 million offset credits have been verified from approximately 280 projects across the various sectors. It is worthwhile to note that nearly 80% of these credits have come from forest management projects. This indicates a willingness amongst forest owners to participate in offset markets and an opportunity to produce additional benefits beyond carbon storage. In fact, when surveyed, 92% of forest owners operating a project for offset credits indicated at least one co-benefit they perceived as a result of their program, including water quality, recreation, and wildlife.

Conclusions

Looking across case studies here, a few of cross-cutting lessons emerge in addition to those already raised by individual examples. First, mitigation often aims to maintain a certain level of environmental quality relative to an established baseline, whether measured in terms of biodiversity, ecological function or ecosystem services. A common challenge associated with mitigation is how to appropriately measure progress towards this goal, as well as how to design and enforce regulations in order to achieve it. The case studies covered here suggest that progress is easier to track when well-defined metrics appropriate to the end goal are matched with appropriate geographic constraints for mitigation activities. For example, the stormwater regulation services provided by green infrastructure under the Stormwater Retention Credit system in Washington, DC are measured in terms of the volume of stormwater retained, and the contribution of offsets to climate regulation under California's AB-32 are measured in terms of CO2e. This is in contrast to wetland mitigation banking, which has relied predominantly on wetland area as a crude proxy for a wide array for wetland functions and services.

Second and relatedly, the examples in this chapter highlight the varying impacts mitigation can have on social equity and environmental justice. In some cases, mitigation can produce win-wins between environmental outcomes and equity. For example, Washington, DC's program expects to increase green amenities in poor, urban neighborhoods in addition to increasing stormwater regulation services. However, wetland mitigation in the US has had the opposite effect, with the tendency for wetland-based ecosystem services to move away from poor and minority urban areas to wealthier, more rural areas. All this points to the need to explicitly consider the equity implications of mitigation when designing regulations, in order to avoid unintended consequences.

Finally, extending mitigation programs to the largest geographic extent possible, without compromising environmental goals or social equity, is often helpful for creating a robust market. Linking California's emissions credit market with Quebec's means that those interested in selling credits can enter the market with greater confidence that there will be sufficient demand for offsets from regulated entities. In the case of wetland mitigation banking in the US, privately-operated banks have been established by multiple, professional actors with access to private capital. Even though credits can generally only be traded within watersheds, the similarity in systems across jurisdictions as a result of the underlying national policy makes it easier for private firms to scale their approaches. In contrast, because the market for SRC in Washington, DC is only

city-wide and therefore relatively small, a government-operated purchase agreement program was needed to ensure sufficient demand for credits in the market's early days. In sum, issues of metrics, social equity and market scale all deserve careful consideration when designing mitigation programs.

Recommended key references

Case 1

District Department of the Environment and Center for Watershed Protection. 2013. Stormwater Management Guidebook. Available online at: https://doee.dc.gov/swguidebook

TNC and VCS. 2016. Developing a Modular Stormwater Crediting Program to Reduce Stormwater Runoff by Scaling up Construction of Green Infrastructure, Phase 1: Analyzing Existing Initiatives to Inform the Development of a Stormwater Crediting Program. Report to the David and Lucille Packard Foundation.

Case 2

Committee on Mitigating Wetland Losses, Board on Environmental Studies and Toxicology, Water Science and Technology Board, National Research Council. 2001. Compensating for Wetland Losses Under the Clean Water Act. National Academies Press. Washington, DC.

Ruhl, J.B. and J. Salzman. 2006. The Effects of Wetland Mitigation Banking on People. *National Wetlands Newsletter*. 28(2):1, 8-13.

Case 3

Bunn, D., M. Lubell. and C. Johnson. 2013. Reforms could boost conservation banking by landowners. *California Agriculture*. *67*(2):86-95.

Bayon, R., N. Carroll and J. Fox. 2012. Conservation and biodiversity banking: a guide to setting up and running biodiversity credit trading systems. Earthscan.

Case 4

California Air Resources Board. 2014. *U.S. Forest Projects Compliance Offset Protocol*. Available online at: https://www.arb.ca.gov/regact/2014/capandtrade14/ctusforestprojectsprotocol.pdf

California Air Resources Board. 2014. *Assembly Bill 32 Overview*. Available online at: https://www.arb.ca.gov/cc/ab32/ab32.htm

5. VOLUNTARY CONSERVATION

Lisa Mandle

Introduction

In addition to the critical role that governments play in conservation through subsidies and regulatory requirements (see chapters 2 and 4), philanthropically-minded individuals, non-governmental organizations and private companies can contribute powerfully to conservation through their voluntary actions (Figure 5.1).

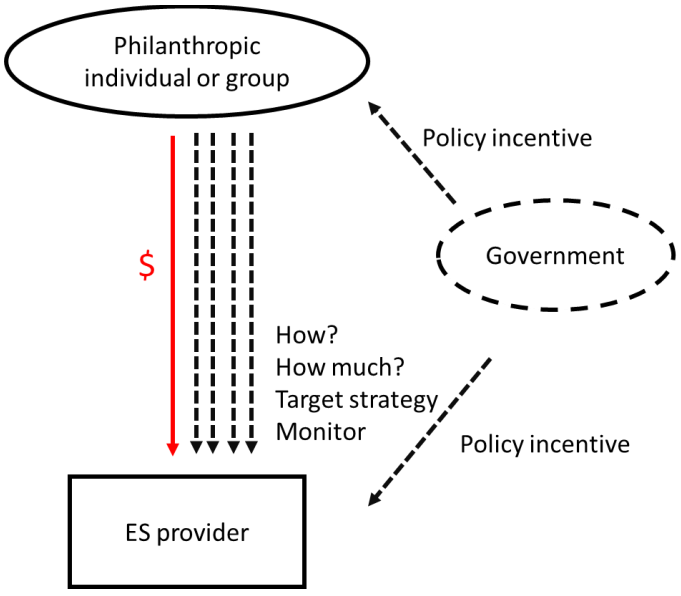

Figure 5.1 In the case of voluntary conservation, philanthropically-minded individuals or groups provide funding directly to ecosystem service providers. Government may play an indirect role in the transaction by providing incentives to ecosystem service providers and/or to the philanthropic actors.

This chapter presents two examples of voluntary conservation: (i) land trusts in the United States and (ii) the Amazon Region Protected Areas program (ARPA) in Brazil. In the case of land trusts, the ecosystem service providers are private landowners, whose actions the government

incentivizes through tax breaks. In the case of ARPA, the Brazilian government is the ecosystem service provider, with international funding from private foundations, companies and other governments providing a catalyst for expanding and strengthening its protected area network.

Case 1: Land Trusts and Conservation Easements in the United States

The problem

Over 70% of land in the United States is privately owned, nearly 10 times the amount of land in IUCN-categorized protected areas (within the 48 contiguous states). Much of this privately-held land has substantial environmental value. What incentives can be provided to private landowners to secure these often public benefits? The land trust and conservation easement mechanism emerged in the 1980s in the United States as a way for private landowners to voluntarily and permanently restrict development on their land to secure its environmental values, in exchange for tax incentives from the federal government. Today, there are over 1,300 active land trusts in the United States and over 17,000 acres protected by conservation easements (Figure 5.2).

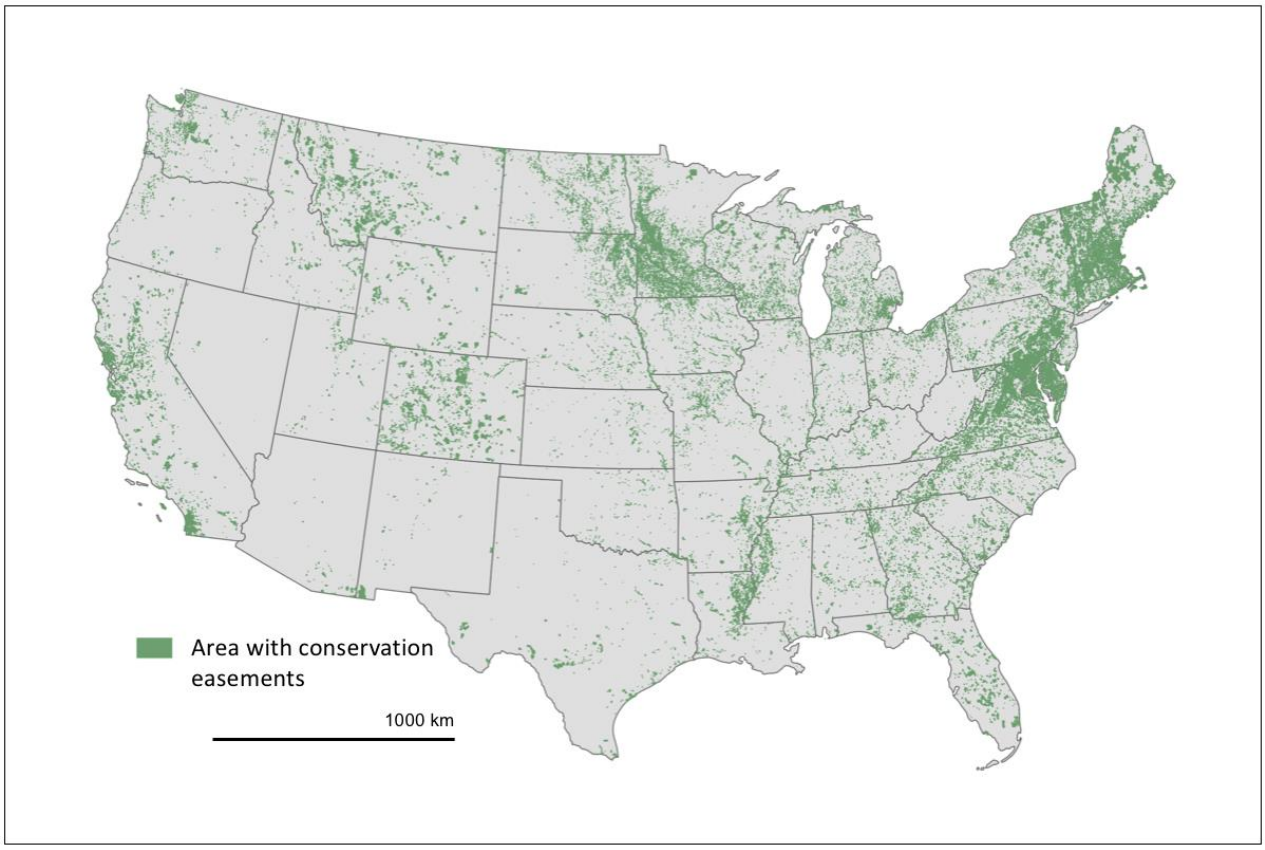

Figure 5.2 Location of conservation easements. Green areas indicate where conservation easements are located but not all areas in green are completely covered by easements.

The ecosystem service

Conservation easements can be used to secure a wide variety of environmental benefits. This includes protecting water resources or other ecosystem services, as well protecting biodiversity, providing corridors between or buffers to protected areas, as well as protecting working landscapes such as farms and ranches.

Ecosystem service beneficiaries

The beneficiaries of ecosystem services provided by a particular conservation easement varies, depending on the service being managed for, the landscape context of the easement and whether direct access to the land is needed to enjoy those benefits. However, conservation easements are required to provide some public benefit in terms of natural, cultural or historic value, in order for the land owner to receive tax benefits.

Ecosystem service suppliers

The private land owners are the suppliers of ecosystem services, and they are compensated through tax benefits. Land trusts contribute to managing easement lands for ecosystem service provision, and operate as non-profit corporations also eligible for tax benefits.

Terms of the exchange/*Quid pro quo*

Land trusts are private, non-profit organizations that acquire and steward land for conservation. When a private land owner wants to place a conservation easement on their land, they enter into an agreement with a land trust. The conservation easement is attached to the property title, permanently restricting future land uses. For example, a negative easement may prevent future development or subdivision of the land. The private land owner then transfers the easement to the land trust, either by selling the easement or donating it. If the easement is donated and the land has public value, the donation counts as a charitable contribution and owner can receive income tax benefits. Even if the easement is sold, the restrictions on future development may reduce the assessed value of the land, which can reduce property taxes for the owner as well.

While the land owner transfers the easement to the land trust, the land itself is still the property of the original owner, who can later sell the land or pass it on to their heirs. However, the easement is permanent and travels with the title. As a result, subsequent owners must continue to comply with its terms.

Mechanism for transfer of value

A conservation easement is a voluntary, legal contract between a landowner and a land trust or government agency. The easement permanently restricts uses of the land to protect its conservation values. Land trusts may acquire land directly (“in fee simple”) or acquire conservation easements and then manage these lands for conservation objectives. Land trusts

vary greatly in terms of the amount of land they hold and their goals in acquiring land. Some land trusts operate at the state or national level, while others focus much more locally. Land trusts may target land based on its value for biodiversity or key species, or may focus on preserving the cultural values associated with working landscapes.

For the conservation easements they hold, land trusts ensure the land is in compliance with conservation objectives and the land use restrictions specified in the easement terms. The particular restrictions associated with a given conservation easement depend on the conservation values the easement is designed to secure, the mission of the land trust and the needs of the landowner. They typically include restrictions on subdividing the property, developing it for housing, commercial or industrial use, or limitations on activities that would damage habitat or reduce affect ecosystem service provision such as mining or development.

The conservation easement mechanism primarily involves an exchange between a private land owner and a private non-profit organization (a land trust). However, government plays a substantial, though indirect role, by providing a variety of tax benefits that subsidize these transactions. The US federal government has also provided funding to land trusts for easement acquisition through a variety of programs, including the US Forest Service's Forest Legacy Program and the US Fish and Wildlife Service's National Fish and Wildlife Foundation. Conservation easements may also be transferred to the government, rather than to a land trust.

Monitoring and verification

Land trusts are responsible for monitoring easement compliance. A survey of conservation easements held by The Nature Conservancy, the largest land trust in the United States, found that TNC routinely audited its own easements for legal compliance with restrictions on development (92% within the past 3 years), but it quantitatively monitored fewer than 1 in 5 conservation targets. There is generally no public accountability or third-party verification of compliance. Effective monitoring, especially of conservation objectives, therefore remains a concern.

Effectiveness

The land trust mechanism has been successful at acquiring conservation easements across a substantial area of land in the United States. According to the most recent land trust census from Land Trust Alliance in 2015, there are 1,362 active land trusts, conserving over 22 million hectares through a variety of mechanisms, including nearly 7 million hectares under easement, as well as direct acquisition of land, and assisting with transfer of land to government agencies or other organizations. This represents nearly a three-fold increase from ~2.5 million hectares under easement a decade earlier in 2005. In 1985, the earliest year with available data, less than 400,00 hectares were under easement.

While the area under conservation easements is impressive, a systematic accounting for the values provided by these lands is missing. The ecosystem service or biodiversity benefits that result from establishing conservation easements therefore are difficult to quantify. A study in the

state of Wyoming found that in areas with high development pressure, there was reduced development on land with easements as compared to without over a 5-year period, as well as higher utilization by some wildlife. However, landscape-scale factors affected wildlife utilization of a given site more than easement status, reflecting the limitation of the easement approach, particularly for mobile wildlife. The conservation easement approach has also been criticized as being too haphazard for effective conservation. TNC's review of its easements, however, found that easement acquisition was generally strategic and increasingly so over time. Although TNC is the largest land trust in the United States, it may be something of an exception, with its explicit aim of employing strategic, science-based approaches to conservation.

On the social side, there is ongoing debate as to whether conservation easements represent a net benefit to the public, given their impact on tax revenue and the (generally unquantified) public benefits provided by lands. The net impact of conservation easements on tax revenue in unclear. On the one hand, easements reduce property values for the property with the easement, and therefore reduce the taxes collected from the property. In this way, the general taxpayer is subsidizing conservation because of foregone tax revenues that have to be made up from other sources. On the other hand, property values have been shown to increase with proximity to open space, so conservation easements could increase taxes in a region. Conservation easements may also affect the equity of the distribution of benefits across society, depending on where they are located and who has access to them.

Conservation easements have the potential to augment or complement protected areas when located in buffer zones or corridors. In addition, the permanence of easements (with some exceptions) may make them more effective than government designation, which can reverse protection due to pressure from interest groups or a lack of funding. The flexibility of conservation easements and the ability of land owners to maintain property rights also make them appealing in many situations, and this approach has spread in Latin America and Europe as well.

Key lessons learned

Land trusts and the conservation easement model have been successful in the United States at enlisting privately owned land for conservation purposes and appears to be reducing development on these areas. Like so many other financial mechanisms for conservation covered in this book, conservation easements again highlight the challenges associated with monitoring the effectiveness of the mechanism, and in particular the trade-off between metrics that are easy to measure (area under easements) and metrics that more precisely reflect conservation values. The role of the government in incentivizing conservation easements through the tax code is also notable. The tax breaks associated with easements means that, in effect, the general taxpayer subsidizes conservation. Land trusts and private land owners together determine where and how to conserve (Figure 5.1), without direct involvement from the government. Some argue that the uncertain fiscal and equity implications of conservation easements for the government, along with the rarity of external verification, calls for greater government oversight.

Case 2: ARPA (Amazon Region Protected Areas Program) with the Transition Fund

The problem

The Brazilian Amazon, which includes around 60% of the total Amazon forest, has lost nearly 20% of its forest cover since 1970, a result of logging, agricultural expansion and other development. This amounts to a loss of over 750,000 km^2 – an area larger than the island of Borneo – and poses a threat to globally important biodiversity and climate regulation functions located there, as well as a threat to water resources and life-support systems in the region, and the livelihoods of communities dependent on forest. In response, the government of Brazil designed protected areas covering nearly half of the Brazilian Amazon. However, many of these areas are effectively "paper parks," existing in name only and without the funding needed to effectively manage the areas to avert deforestation. This challenge led to the development of the Amazon Region Protected Areas program (ARPA) and Transition Fund, based on the Project Finance for Permanence (PFP) model. This program brings together philanthropic organizations and the Brazilian government to enact large-scale conservation measures, with the financial resources needed for long-term conservation.

The ecosystem service

Securing and expanding the protected area network in the Brazilian Amazon will provide a range of ecosystem service benefits, from climate regulation and regulation of water amount and quality, to provisioning services to local communities (including food, fiber and medicine). It will also contribute to global priorities for biodiversity conservation. See the REDD+ case studies in Chapter 2 for more on forest-related ecosystem services.

Ecosystem service beneficiaries

Conservation of the Brazilian Amazon provides benefits at multiple scales, from the global beneficiaries of climate regulation (though carbon storage and sequestration) and biodiversity conservation, to the local communities whose livelihoods are dependent on the forest.

Ecosystem service suppliers

The Brazilian government and indigenous communities who manage lands sustainably are the ecosystem service providers in this example.

Terms of the exchange/*Quid pro quo*

Under the terms of the deal, Brazil will protect 15% of the Brazilian Amazon – 60 million ha, an area 1.5 times the size of California or 3 times the size of all US national parks. Half of ARPA's protected areas are for strict conservation use, while half are for sustainable use, allowing some forms of extraction.

ARPA donors created a Transition Fund, a long-term sinking fund, designed to cover recurrent costs of ARPA for 25 years. The fund has a target of USD 215 million, with nearly USD 211 million committed as of May 2016. Funding is released from the Transition Fund to pay the Government of Brazil for protected area management – including on-the-ground protection (e.g., guard salaries and lodging, flyovers), participatory management, equipment, infrastructure and operations, monitoring and research – assuming the government meets certain targets along the way. There are 11 disbursement conditions, which include creation of new protected areas, implementing biodiversity monitoring, meeting protected area staffing targets, and securing of funding from the government of Brazil.

The Project Finance for Permanence model has been used in Costa Rica (see Chapter 8) and in the Great Bear Rainforest in British Columbia. Similar programs are also being developed in Peru, Colombia and Bhutan.

Mechanism for transfer of value

Under the PFP model, funding is assembled from multiple donors, but no individual donor is obligated to disburse funds until the fund target is met. Donors make a commitment at the fund's "closing." The ARPA Transition Fund is funded by a mix of philanthropic organizations (Gordon and Betty Moore Foundation, Linden Trust for Conservation), government and multi-lateral organizations (World Bank, Global Environment Facility (GEF), the Inter-American Development Bank (IDB), KfW (German Development Bank)), conservation organizations (WWF), and private companies (Anglo-American mining company).

The Transition Fund will be drawn down over time, with its funding dispersed to the government of Brazil as the government meets its agreed-upon conservation outcomes and financial targets. At the same time, the government of Brazil must increase the amount of funding it provides, until it completely takes over funding of its protected areas by 2037.

The ARPA vision was launched in 2002 at RIO +10, with closing for its financial package occurring in May 2014. From 2002-2009, the program focused on created new protected areas. From 2010-2016, new and existing protected areas were "consolidated" (met certain benchmarks for management and monitoring) within the ARPA system. Finally, from 2014-2037, ARPA will transition from being funded by the Transition Fund to being 100% funded by the Brazilian government. By the end of transition funding, the Brazilian government expects to support protected area management largely through environmental compensation funds paid by companies to offset impacts of infrastructure development (see Chapter 4 on regulatory-driven mitigation, and especially in lieu fees), as well as payments for ecosystem services.

Monitoring and verification

The Transition Fund Committee, which includes representatives from donor institutions and the Brazilian government, reviews the status of disbursement conditions and approves bi-annual disbursement from the fund, assuming conditions are met. As mentioned previously, development and implementation of a biodiversity monitoring program is one requirement for disbursement of funds. A Protected Area Management Effectiveness Tool is also used to verify whether protected areas meet achievements for 12 indicators, including land tenure, existence of a management plan, participatory management, and monitoring.

Effectiveness

On the biophysical front, ARPA has met most of its targets, although the federal government has faced challenges designating new protected areas. State governments also fell behind in implementing biodiversity monitoring programs. In 2015, 18 protected areas with 6.9 million ha were brought into the ARPA system, bringing the total size of ARPA to 115 protected areas and 59.2 million ha, nearly at its 60 million ha goal (Figure 5.3). However, this included only one new protected area. ARPA was targeted to create 13.5 million ha of new protected areas by mid-2017, but had reached only 41% of this goal (<6 million ha). ARPA was ahead of schedule, however, on consolidation of protected areas, surpassing its 2017 target by 58%. Based on the government shortfalls in 2015, disbursements in 2016-2017 were penalized 15%.

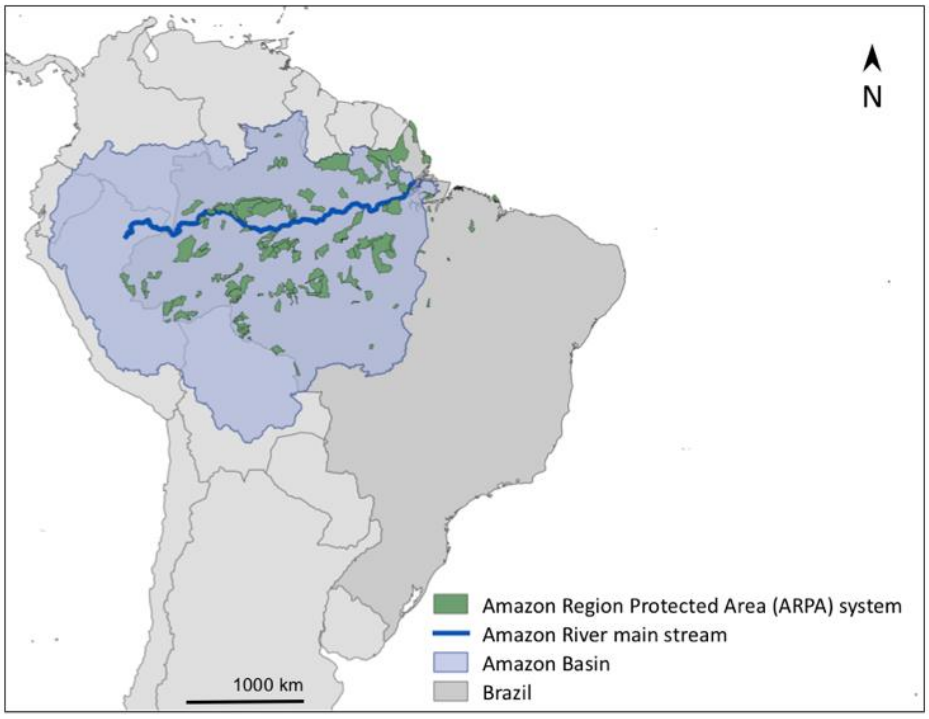

Figure 5.3 The Amazon Region Protected Area (ARPA) system included, as of 2015, 115 protected areas in Brazil, covering 59.2 million ha.

The ecosystem service benefits of ARPA could be large. Based on the observed effect of ARPA on deforestation between 2003 and 2008, a 2010 study estimated that the full expansion of ARPA would prevent the release of 5.1 billion tons CO_2, equivalent to ~16% of global greenhouse gas emissions per year

On the financial side, ARPA experienced some challenges in securing the delivery of funds committed at closing in 2014, though it has commitments to USD 211 million in funding out of its USD 215 million target. Germany didn't finalize its commitment until 2015. Funding from GEF and Anglo-American (a mining company) was later to come in than originally projected. The large expected contribution from Brazil's Amazon Fund is also of concern, especially given Norway's reduction in its 2017 allocation to the Amazon Fund due to rising deforestation rates in the Brazilian Amazon (see Chapter 2 for more about the Amazon Fund). The Brazilian government has also had challenges spending the funding that has been released so far towards consolidation of protected areas, with a lower rate of spending than originally planned. State governments are facing challenges in complying with the financial reporting requirements of ARPA and in securing counterpart funded needed to continue to receive funds from the Transition Trust. Finally, recent political and economic instability in Brazil has unfortunately contributed to slowed progress.

Key lessons learned

The example of ARPA and the Transition Trust illustrates the power of the Project Finance for Permanence model. By bringing together contributions from multiple donors from the private and public sector at once, it is possible to fund significant, coordinated conservation action at a national scale. This would not be possible with funds that arrive bit by bit over time. The model is most likely to succeed at assembling a broad coalition of donors when applied to areas with high value to wide array of actors, such as areas with threatened carbon stocks and high biodiversity of importance internationally.

Two other aspects of the ARPA example that have contributed to its success so far are worth highlighting. First is the conditioning of the disbursement of funds on meeting predefined targets. This pay-for-performance approach makes participation less risky to donors. Second is design of the Transition Trust as a sinking fund that will be drawn down over time as Brazil takes on increasing responsibility for funding. This provides an exit strategy for donors, while giving the Brazilian government time to ramp up its own capacity and funding. With these features, it is easy to see why the PFP model is an attractive option for financing conservation from the perspective of both donors and governments.

Recommended key references

Case 1

Merenlender, A.M., Huntsinger, L., Guthey, G. and Fairfax, S.K., 2004. Land trusts and conservation easements: Who is conserving what for whom?. *Conservation Biology*, 18(1): 65-76.

Owley, J. and Rissman, A.R., 2016. Trends in private land conservation: Increasing complexity, shifting conservation purposes and allowable private land uses. *Land Use Policy*, 51: 76-84.

Case 2

Linden, L., S. McCormick, I. Barkhorn, R. Ullman, G. Castilleja, D. Winterson & L. Green. 2012. A Big Deal for Conservation. *Stanford Social Innovation Review*. 43-49.

WWF. 2015. Project Finance for Permanence: Key Outcomes and Lessons Learned. World Wildlife Fund, Washington, D.C. Available online at: https://www.worldwildlife.org/publications/project-finance-for-permanence-key-outcomes-and-lessons-learned

6. MARKET-BASED TRANSACTIONS

Rebecca Chaplin-Kramer and Lisa Mandle

Introduction

Market-based transactions, in which consumers take on the costs of securing or enhancing ecosystem services, are a mechanism for conservation finance that holds broad appeal. This appeal is based on the potential to generate win-wins for conservation and private enterprises, and to secure a greater pool of funding for preserving or enhancing natural capital than would be available through government or philanthropic funding. Here we focus on two types of market-based mechanisms: eco-certification (the first and second cases) and impact investing for ecosystem services (the third and fourth cases).

In the case of eco-certification, consumers prefer products of superior environmental quality, based on third-party endorsement through certification. We examine this mechanism through two case studies, including place-based certification in the form of ecotourism, and supply-chain certification, with a particular focus on coffee.

In the case of impact investing for ecosystem services, consumers of a financial product pay into an investment vehicle in anticipation of both financial and environmental returns. We provide an overview of the impact investing mechanism, and then focus on two case studies: a private equity example with the case study of the Murray-Darling Basin Water Fund in Australia, and a debt-based example with the case study of an environmental impact bond to fund nature-based solutions to reducing stormwater flows in Washington, DC, USA.

Certification – an overview

Certification is class of market-based mechanisms that can finance conservation of ecosystem services. Certification is meant to reward producers that adopt more just or sustainable means of production and allow consumers to live out their social values through their purchases. Certification can pertain to social responsibility, brand quality, or environmental such as energy efficiency or sustainable production practices. When applied to ecosystem services, certification aims to ensure that the use of land or waters in the production of a good or service maintains or enhance ecosystem services (Figure 6.1).

Most certification is known as "third-party," which means that a separate entity is responsible for evaluating whether a business meets the certification standard's criteria, and continually auditing to ensure that this performance is maintained. These third-party certifying bodies often provide technical or other forms of assistance to producers to facilitate their implementation of the certification standards.

Though not covered in our case studies, it is also worth noting that self-branding by companies that conserve natural capital or ecosystem services as part of their core business model or as a corporate initiative operates in a similar fashion. These individual commitments made by businesses may confer similar benefits in terms of consumer loyalty or willingness to pay, although without third-party certification.

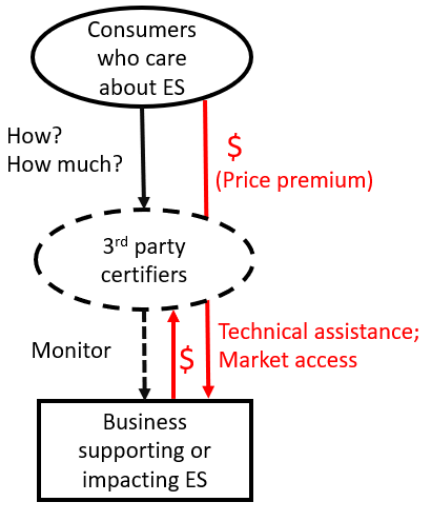

Figure 6.1 With eco-certification, consumers pay a higher price or are more likely to buy a product or service that is labeled sustainable, which then provides higher profitability or revenue to businesses for being more reliable ecosystem service providers. Third-party certifiers provide transparency and credibility to the consumer that the sustainability standards are being honored, and may provide technical assistance or better market access to the producers.

Case 1: Place-based certification: Eco-tourism

The problem

In many parts of the world, rich biodiversity coincides with extreme poverty, and (over)harvesting or clearing natural habitat is often needed for people to meet even subsistence livelihood needs. If local people can receive payment from people wishing to enjoy that biodiversity through sustainable tourism (in a manner that respects the local culture and environment), there is a greater incentive for good stewardship rather than consumptive use of habitat. The potential to find win-wins for conservation and economic development goals garnered the support of many conservationists, national governments and international aid agencies for "ecotourism" in the 1990s. However, the unintended impacts of 'inappropriate' ecotourism on biodiversity has underscored the need to develop standards of practice and certification for ecotourism.

The ecosystem service

Tourism and recreation are the main focus for this mechanism, though, with the incentive provided by payment for these services, the improved stewardship of biodiversity and the ecosystems that attract the tourist visits could also support a number of other benefits, including other cultural and provisioning services, water and climate regulation.

Ecosystem service beneficiaries

The main beneficiaries are the tourists, which could be a local, national, or international audience, depending on the scale of the attraction. But to the extent that there are secondary benefits supported by the ecotourism scheme, the beneficiaries may include local communities who gather cultural or subsistence products or derive other social benefit from the natural areas or rely on the area for drinking water, flood mitigation, etc.

Ecosystem service suppliers

Tourism operators are obviously an important component of the delivery of this ecosystem service, but it is the users of the ecosystems to which tourists are drawn that are the suppliers of the biophysical supply of nature-based tourism. These users could have legal rights to the land, or they may be illegal users. For ecotourism to be an effective scheme, the suppliers - the people who are otherwise incentivized to clear or degrade the habitat - need to be incentivized to maintain it in a healthier state that will continue to attract tourists.

Terms of the exchange/Quid pro quo

While eco-tourism is not a new concept, its certification is still somewhat nascent. The assumption of ecotourism enterprises is that by joining certification schemes, they will attract more patrons or at a higher price point than enterprises that are not certified. Another advantage of certification may be that certified operators gain preferential treatment from regulatory authorities, such as better access or longer operating licenses in parks and reserves.

In 1991, the Mohonk Agreement suggested a basic operational scheme and broad criteria for ecotourism certification. More recently, the Global Sustainable Tourism Council followed up with a set of more specific global criteria for certification and a plan to become the international authority for ecotour accreditation (i.e. certification for the certifiers), while allowing national or regional entities to assess how and to what extent each criterion should be met within their jurisdictions. GSTC specifies criteria and performance indicators to achieve the following goals: Demonstrate effective sustainable management; Maximize social and economic benefits to the host community and minimize negative impacts; Maximize benefits to cultural heritage and minimize negative impacts; Maximize benefits to the environment and minimize negative impacts. The latter includes Conserving Resources, Reducing Pollution, and Conserving Biodiversity, Ecosystems and Landscapes.

While the GSTC standards are intended to encompass local or regional standards, they are too recent to evaluate. It is thus perhaps more instructive to look to local case studies of accreditation and operation to better understand how such programs work. The Costa Rican Certification for Sustainable Tourism (CST program) was the first performance-based voluntary environmental program created by a developing country government. Hotels certified through this program as having superior environmental performance tend to also have other differentiation advantages (e.g., higher luxury) that yield price premiums, but participation in the CST program alone is not enough to boost prices and sales (Rivera 2002). A more recent analog in the US is Hawaii Eco-Tourism, which provides third-party certification of sustainable tourism across the state.

Mechanism for transfer of value

The mechanism of eco-tourism and its certification can be best demonstrated through a profile of a particular business, and for this purpose Hawaii Forest and Trail (HFT) provides an excellent example. Certified by Hawaii Eco-Tourism, HFT licenses much of the lands on which they operate from private landholders, and in so doing raises awareness in both land-holders and tourists of the value of maintaining the biotic integrity of such lands. HFT pays a gross-percentage of their revenue to the land-holders, and that payment often dwarfs other revenue generated by the land (for example, ranching), which creates an incentive better stewardship. “There’s intrinsic value in those resources,” owner Rob Pacheco notes. “We’re the mechanism that’s converting that value into dollars.”

HFT also operates within protected areas such as Volcanoes National Park, and have developed excellent partnerships to extend the interpretive experience beyond what the Park Service can offer, building a service element into much of their programming. Invasive ginger is widespread and poses a threat to many native plants, and the limiting factor in keeping it contained is labor. HFT initiated a program to teach their clients about the invasion and then give them a chance to pull up the ginger (which many guests called the “highlight” of their vacation). This enabled the Park Service to spend limited staff resources on other areas, and made them eligible for grants that required matching volunteer effort.

One important mechanism for the transfer of value in eco-tourism for HFT is to have exclusivity of access – not only to differentiate their brand, but to keep the land-holder partner invested so that it doesn’t turn into a tragedy of the commons. However, HFT believes what makes their program unique, what makes their clients willing to pay more for their services than for other competing operators, is the interpretative experience--that HFT offers them the best opportunity to connect to the resource. They can charge more not only because they take their clients to private places they would otherwise not be able to see, but because of the more intimate experience with nature. HFT prides themselves on transforming clients from “trophy-seekers” into stakeholders, who continue to return and provide financial and political support for the continued protection of the resource.

The ideal corollary to exclusivity is for the revenue generated to go directly back to the resource. If exclusivity is based on the assumption that only certified sustainable operators are able to take tourists in because of the sensitivity of the resource, the most effective way to ensure the maintenance of the resource is to connect the financing back to it. In the case of Hawaii, HFT pays fees for permits to the state of Hawaii, but there is no guarantee that this revenue will go back to the specific park providing the benefits.

Monitoring and verification

Little information exists in either the scientific literature or the certification material itself about what constitutes conformance to a standard (how many of the criteria they need to meet) or how regularly a company will be audited to maintain its status. GTSC requires the application of "standard, transparent, and impartial verification procedures, and auditors who are technically competent in sustainable tourism and conformity assessment" and follows ISO trends in verification and conformity assessment procedures. There are no published compliance statistics for Hawaii Eco-Tourism, but the most successful operators like HFT tend to go above and beyond their standards.

Effectiveness

There is a great need to evaluate the performance of ecotourism certification with respect to conservation, but the majority of publications on ecotourism have been related to impacts on social issues such as indigenous culture or distribution of tourism revenue. There have been very few quantitative studies measuring the impact of ecotourism on biodiversity, and even if the local effects of ecotourism on biodiversity are positive, there is still the consideration of whether the global and cumulative effects of increasing long-haul travel (if ecotourism is more expensive and thus caters more to wealthy and remote westerners) has on carbon emissions and thus climate change.

Eco-tourism has been found to deliver significant social, environmental, and economic benefits in the Osa Peninsula, Costa Rica: reducing disparities in access to resources, providing financing for national parks and tree-planting programs, and resulting in higher and more stable earnings. CST-certified Lapa Rios Eco-Lodge showed increase in forest cover on its property and nearby (within 5 km), reversing a trend of deforestation, while areas further away continue to lose forest.

To return to our example of HFT, the dividends to nature and local communities have been many-faceted. Ongoing stewardship projects at their tour locations include the previously mentioned invasive-species removal at Hawai'i Volcanoes National Park, bird count surveys at Hakalau Forest National Wildlife Refuge, Pu'u O'o Rainforest and Pu'u La'au Dry Forest, and the restoration of unique Hawaiian wetlands in Kohala. In addition to the percentage of gross-revenues paid to land-holders to incentivize further conservation practice, HFT contributes a portion of their net profits to the community through in-kind and outreach programs focused on conservation, including the Grow Hawai'i Festival, Hakalau Forest NWR Open House, Waikoloa

Dryland Forest Initiative. Finally, beyond their certification with Hawaii Eco-Tourism, HFT have formed strategic partnerships with several local, national, and international organizations devoted to conservation and sustainable tourism.

Key lessons learned

Hawaii Forest and Trail provides an excellent example, and there are many others world-wide, of eco-tourism that can enhance and conserve natural capital. Eco-tourism at its best provides income for people stewarding the natural resource that supports the activity providing that income, and builds a strong ethic in the tourists themselves to protect the place they have come to see. However, the role of certification in eco-tourism is still too early to assess. It remains to be seen whether third-party certification will influence traveler preferences sufficient to provide a competitive advantage for certified properties. The importance of a third-party certifier may be greater in the next case study, supply chains, where consumers do not have as direct a relationship with the place or the producer.

Case 2: Supply-chain certification: food and fiber

The problem

Growth of consumption of agricultural, forest, and ocean products places strain on the ecosystems in and surrounding where these products are grown or harvested. The size of large consumer-goods companies is on par with that of many nations – and therefore adjusting their practices or the practices of producers comprising their supply chains could make a huge impact. Consumers can pay firms to internalize the externalities of their production or harvest, by purchasing product for a higher price with an eco-certification label.

The ecosystem service

There are many ecosystem services supporting, and impacted by, production landscapes and seascapes. Agriculture and forestry (and aquaculture) certification standards tend to focus on some combination of five targets: soil, water, agrochemicals, land cover, and biodiversity. “Land cover” can of course impact the other targets, determining whether vegetation intercepts pollutants before they enter the water and whether biodiversity can be maintained in a landscape, and also provides co-benefits that are often assumed by the program, like carbon storage and sequestration for meeting climate mitigation goals.

Fisheries certification standards typically focus on four targets: stock status, impacts on non-target species, effects on endangered and threatened species, and ecosystem integrity. The latter likely affects the first three, as coastal habitats such as mangroves and coral reefs provide important nurseries to maintain fishery populations, and also provide other important ecosystem services that are not necessarily specifically defined by the program, like tourism or storm surge protection.

Ecosystem service beneficiaries

As for the case of eco-tourism certification, commodity certification supports two different levels of ecosystem service beneficiaries. Consumers benefit from the knowledge that they are supporting more sustainable systems (especially for more global benefits like carbon sequestration, or existence value of forest or biodiversity conservation). People who live in the watersheds, landscapes or coastal systems where the production or harvest has been improved benefit from more locally produced benefits like erosion control or water purification.

Ecosystem service suppliers or mediators

The supply of ecosystem services in this case is maintained or reduced by the producers in these production landscapes and seascapes - farmers, foresters, fishers. Rather than supplying ecosystem services, these actors may contribute to problems of pollution or overharvest if they are poor managers.

Terms of the exchange/*Quid pro quo*

Producers or consumer-goods brands pay for certification in exchange for using a seal of approval on their product, with the expectation that this leads to economic benefits (price premium or brand value) and ecological benefits (more sustainable production, for enhanced biodiversity and ecosystem services). The market for certification is rapidly growing but still occupies a relatively small share of overall production, with the exception of coffee (for which certification now accounts for 38% of all production). Other major sectors of certification adoption include cocoa (22%), palm oil (18%), tea (12%), wild-capture fisheries (10%), and growing production segments for aquaculture (4%), cotton (3%), sugar (3%), soybeans (2%), and bananas (3%).

Mechanism for transfer of value

There are many models for certification. A common mechanism is for producers to meet a series of standards, often with third party verification. In exchange, they are allowed to use the certification seal in their marketing or others can market the certification (for example, when the certified product is an ingredient). In other cases, companies develop their own certification (e.g., Starbucks CAFE standard, Unilever palm oil). For some certification schemes, the standards take the form of a menu from which producers can select to reach a certain number of points, some of which are required, with many more that are optional, and typically more focused on practice than performance.

As coffee is the most established commodity for certification, it provides an excellent case study for what is possible to achieve through this mechanism. One of the most successful certification programs for coffee is managed by Rainforest Alliance (RFA). As an environmental group, RFA developed their own seal aiming to preserve biodiversity while enhancing people's livelihood, first used for timber in the late 1980s and later expanded to bananas and coffee.

Today, more than 300,000 metric tons of RFA-certified coffee are produced annually around the world, representing 2% of the global market. The RFA certification requires the implementation of a management system for the farm, ecosystem protection (e.g., forest remnants and riparian vegetation), wildlife protection, water conservation, integrated crop management, soil conservation, and integrated waste management, along with several social dimensions.

Monitoring and verification

A third-party certifies that regulations are being followed, often with "improvement" shown at each audit. These audits are almost uniformly conducted at the farm scale, despite many programs touching on impacts that accrue more at the landscape scale (such as biodiversity protection).

Effectiveness

There are many motivations for certification. Companies may hope it will justify a higher price from consumers supporting products more aligned with their values, enhance brand reputation, satisfy corporate sustainability commitments, reduce operational risk, or provide greater access to market. In comparison to eco-tourism the ecological benefits of commodity certification have been well studied. In fact, 23 of 30 scientific studies investigating the ecological effectiveness of certification found a positive effect for services or biodiversity. Coffee and seafood show the most positive results, while the effects of timber are mixed. The most commonly measured outcome is forest cover, followed by biodiversity, but no studies have documented impacts on soil and water.

Continuing to use RFA-certified coffee as an example, certification has had especially beneficial results in Latin America and Africa. Certified farmers in Colombia adopt significantly more environmentally friendly practices than noncertified farmers, such as tree diversity, watershed protection through fencing and reforestation, and infrastructure for water-use efficiency and wastewater management than non-certified farmers. RFA-certification has also led to enhanced tree cover and greater landscape connectivity in the Colombian eastern Andes. Similar effects have been seen in Ethiopia, where RFA-certification increased the probability of forest conservation by 20% relative to forest coffee areas lacking certification. This effect was even stronger (nearly 30%) with lower-income producers, suggesting that certification significantly impacts the behaviors of economically poor producers, motivating them to conserve the forest.

The other aspect of effectiveness of the program is economics benefit. While it is not evident that producers consistently receive a price premium for selling under certification, they benefit in many other ways. In Peru, RFA farmers did receive a small price premium, but its economic importance was far overshadowed by the increase in yields that came through technical assistance in this program. In Colombia, the initial premium paid for RFA-certified coffee in 2002 represented an additional income of 40%, but the economic incentive was substantially reduced over time, as the global supply of sustainable coffee grew and international prices for

Arabica coffee increased. While the promise of a premium for their coffee is often the reason why many certified farmers decide to join a certification program, it is rarely the reason the remain.

Other incentives to join certification cooperatives include increased access to capital, technology, or knowledge. For example, while RFA in Nicaragua has a fairly small price premium (3%), it has much larger positive effect on community/ organization participation and satisfaction with technical support and commercial assistance. Farmers participating in RFA in Colombia noted that gaining managerial skills, access to technical assistance, and higher productivity were key incentives for joining the program, but new motivations also became prominent in the farmers' commitment to certification over time: learning better farming practices, developing stronger family and community ties, improving treatment to workers and their overall quality of life, and playing a leadership role in their community.

Key lessons learned

Commodity certification is growing in popularity for both consumers and business, and has been linked to noteworthy improvements in biodiversity and ecosystem services for at least certain commodities (such as coffee). It also provides an important mechanism for consumer goods firms to meet their sustainability commitments without having full chain of custody over their whole supply chain. Unlike for eco-tourism, where the consumers interact directly with the producers, consumers of commodities are often many steps removed from the producers. Certification provides an important mechanism for incentivizing better production despite that lack of traceability.

It is less well established that producers adopting certification standards benefit financially, and even when price premiums have been instituted, they tend diminish over time or with market fluctuations. However, it appears that many other social benefits accrue to producers from participating in certification programs, which suggests that these schemes are durable mechanisms for securing biodiversity and ecosystem services in production landscapes and seascapes.

Impact investing for ecosystem services: overview

Impact investing is a second class of market-based mechanisms that can finance conservation of ecosystem services. In its broadest form, impact investing aims to generate financial returns in combination with social and/or environmental benefits (the so-called double- or triple-bottom line). When applied to ecosystem services, investors invest in a financial vehicle that spends funds in order to generate both cash flows and secure or enhance ecosystem services (Figure 6.2). The financial returns go back to the investors, while non-financial returns benefit the environment and society more generally. The impact investing model can be applied to a diversity of financial vehicles, from bonds to private equity funds**.** Some investors and vehicles aim to achieve risk-

adjusted market rates of return, whereas others may accept a lower (also called "concessionary") rate of return in exchange for the environmental and social co-benefits.

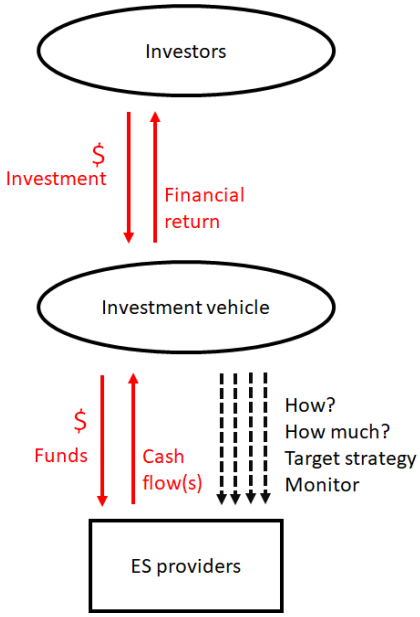

Figure 6.2 With impact investing, investors make financial contributions to an investment vehicle (e.g., bond, investment fund), which then provides funding to ecosystem service providers. The ecosystem service providers generate cash flows back to the investment vehicle, which provides financial returns back to the investors. The investment vehicle determines where and how to invest in securing or enhancing ecosystem services, and monitors project compliance.

A 2016 report by Credit Suisse projects that the conservation finance market (which includes impact investing for ecosystem services and other environmental benefits) could reach USD 200-400 billion in private finance from institutional investors and high net worth individuals by 2020. The attractiveness of conservation finance relative to other investments has been bolstered by low interest rates and the lack of more attractive investment options. Conservation finance is also potentially attractive to investors as a means of diversification, because its returns are not expected to be correlated with other asset classes.

Many of the ecosystem service mechanisms covered in other chapters can also create opportunities for private finance. For example, regulatory-driven mitigation (Chapter 4) creates opportunities for investment in mitigation banks, where large investments are needed up-front to establish banks, and profits are generated as credits are sold. Eco-certification (case study 2, this chapter) of commodities such as timber can also provide opportunities for private finance, with initial funding needed to change operation practices and attain certification, and profits generated over the longer-term once production is underway.

Here, we focus on two case studies: the Water Sharing Investment Partnership (WSIP) in the Murray-Darling Basin in Australia as an example of private equity, and District of Columbia Water and Sewer Authority's Environmental Impact Bond as an example of debt-based impact investing. Private investment that blends financial and conservation goals has existed in the United States for nearly twenty years, although investing specifically for ecosystem services is a

newer and narrower subset of impact investing. A number of other promising examples -- funding everything from green infrastructure for stormwater retention to improved forest management for water supply and hydropower -- are in development but not yet fully implemented. With a few more years of progress, it will hopefully be possible to learn from and evaluate the success of a wider array of investments.

Case 3: The Murray-Darling Basin Water Sharing Investment Partnership

The problem

The Murray-Darling Basin is known as Australia's food bowl (Figure 6.3). The region contains 20% of the country's agricultural land area and produces one-third of its food supply, including nearly AUS$7 billion in irrigated produce. With an arid climate, the region experiences high inter-annual variation in rainfall, as well as high losses of water through evaporation, which poses a challenge to meeting agricultural and other demands for water. Australia experienced a record-breaking drought from 1997-2009 (known as the Millennium Drought). Although the drought took a toll on agricultural production, the Basin's water market, which allows farmers to trade water rights, mitigated the economic impact: Water went to high-value crops and perennial crops that could not be fallowed, while low-value annual crops were let fallow until water availability increased. However, the drought also took a toll on wetlands and freshwater and estuarine ecosystems, whose allocations of water were reduced or eliminated during this period of water scarcity. The challenge remained of how to efficiently allocate water to support agriculture in the region, while also maintaining water-dependent ecosystems and the services they provide. To address this challenge, The Nature Conservancy (an international non-governmental organization), the Murray Darling Wetlands Working Group (an Australian not-for-profit company) and Kilter Rural (an Australian asset management firm) collaborated to create a Water Sharing Investment Partnership (WSIP) called the Murray-Darling Basin Balanced Water Fund. By buying water rights, then leasing some of water rights back to farmers and donating the remaining water for environmental purposes, the fund aims to secure water for agriculture, restore threatened wetlands and generate returns for investors.

The ecosystem service

The allocation of water influences the provision of ecosystem services from agriculture and ecosystem services from wetlands. Water that is allocated to agriculture promotes the production of food and fiber. The Murray-Darling Basin produces more than 50% of Australia's irrigated produce, including cotton, hay, livestock, almonds and stone fruit. Water allocated to wetlands promotes the conservation of biodiversity, with a specific focus on birds, wildlife and threatened species. Wetlands also provide cultural ecosystem services for Australia's Aboriginal (indigenous) people, supporting a diversity of social, cultural and spiritual values.

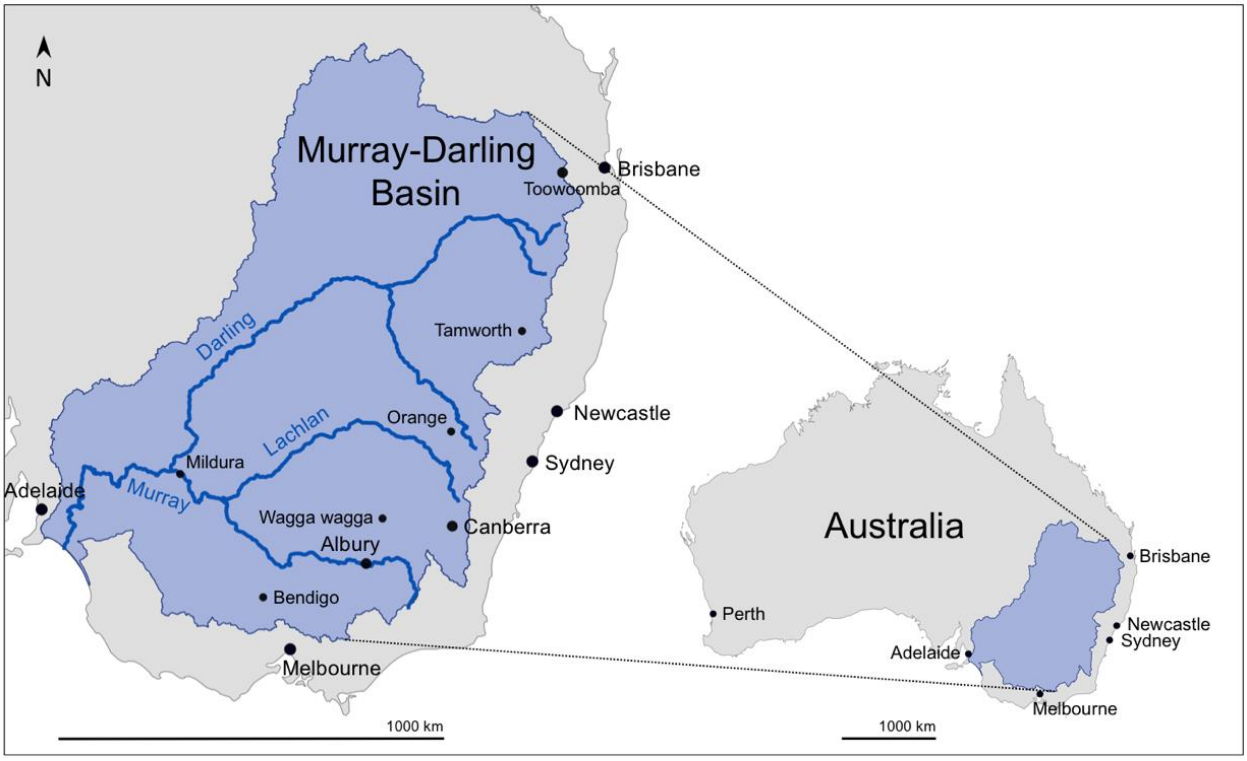

Figure 6.3. The Murray-Darling Basin produces one third of Australia's food supply. Located in an arid region susceptible to drought, allocating water between agricultural uses and the environment is a challenge. The Murray-Darling Basin Balanced Water Fund aims to secure water for agriculture and increase the allocation of water to environmental purposes while generating a profit for fund investors through its acquisition and management of water rights.

Ecosystem service beneficiaries

Farmers and consumers benefit from the water that is allocated to agriculture. The water that is allocated to wetlands provides benefits globally to those who care about biodiversity conservation, as well as locally to Aboriginal communities. Water dedicated to the environment also provides greater system sustainability, which ultimately should increase the sustainability and longevity of agricultural production in the region.

Ecosystem service suppliers

By holding water rights and deciding how they are allocated between agriculture and environmental uses, the WSIP functions as the ecosystem service supplier. The farmers and wetland landowners who receive water also contribute to the provision of ecosystem services.

Terms of the exchange/*Quid pro quo*

The Murray-Darling Basin Water Fund buys water rights and each year leases between 60-90% of its water to farmers for agricultural purposes. Profits from leasing water rights go back to fund investors. The Fund donates the remaining 10-40% of its water holdings to wetland restoration,

with a focus on wetlands or floodplain forests with high conservation value on private land that would not otherwise receive water from government programs.

The fund raised about USD 20 million from investors in its first round of funding, which closed in December 2015, and aims to scale up to USD 75 million in four years. As of May 2016, the fund owns the rights 8.5 gigalitres of water. The fund has achieved 2.3% Net Operating Profit and Distribution since inception and is aiming for 7-9% returns over the long term.

The fund has contributed to one environmental watering event so far, in April 2016, when 950 megalitres of water went to wetlands on Tar-ru Traditional Lands in New South Wales. In this case, the WSIP provided capacity for the Murray Darling Wetlands Working Group to plan, administer and deliver water that was provided by the government (Commonwealth Environmental Water Holder), rather than providing the water itself. The water went to wetlands on what is currently state land that will be returned to Aboriginal ownership and management.

Mechanism for transfer of value

The Water Sharing Investment Partnership (WSIP) has two main parts: a Balanced Water Fund and Environmental Water Trust. The Balanced Water Fund is managed by Kilter Rural. Fund investors include foundations, mission-driven pension funds and high-net-worth individuals; the National Australia Bank also provided a loan to the Fund.

The Fund buys permanent water entitlements, then leases a portion (60-90%) of these entitlements back to farmers in dry years. The Fund donates 10-40% of water entitlements to the Environmental Water Trust, which is a tax-deductible not-for-profit organization. More water is allocated for environmental purposes in wet years when demand from agriculture is lower, which also helps to mimic natural patterns of water provision to wetlands.

Finally, a Scientific and Cultural Advisory Committee helps the Environmental Water Trust achieve its environmental and cultural objectives. These objectives include conservation benefits such as improved health of vegetation and threatened species, as well as social and cultural benefits to Aboriginal communities.

This WSIP is enabled by the existing water rights market in the Murray-Darling Basin, as well as by the conditions associated with water rights. In Australia, water is delivered to the holders of water rights proportionally based on water availability. So, for example, in a dry year, water rights holders might all receive only 75% of their water entitlements. This is in contrast to Western United States, where those with the oldest rights receive their full allocation of water first. Since 2007, it is possible to own and trade water rights without owning land in the Murray-Darling Basin.

A monitoring program to evaluate environmental and cultural outcomes is being set up, according to fund literature, but no results are available yet. In general, the impact investing field lacks a standard approach to monitoring conservation and environmental impacts in impact investment. The fund is supporting training for people from indigenous communities to enable their participation in monitoring.

Effectiveness

On the environmental side, the WSIP has contributed to one watering event, although in this case the Fund provided capacity rather than the water itself. The Fund is ahead of its anticipated schedule in returning profits to investors but has not reached its target of 7-9% returns. Given that the fund has been in operation only since 2015, its long-term effectiveness across its financial, environmental and social/cultural objectives remains to be seen.

Key lessons learned

The example of the Murray-Darling Basin Water Sharing Investment Partnership highlights the roles for, and importance of, multiple types of actors and institutions in impact investing. In this case, the government plays a key role in enabling the WSIP mechanism by setting water rights and water market conditions, for example by allowing entities to own and trade water rights without owning land in the Basin. Private investors, including some with philanthropic aims, provide the Water Fund with the capital needed to purchase water entitlements, while not-for-profit companies/non-governmental organizations like the Environmental Water Trust are critical to carrying out the WSIP's environmental and social objectives on the ground.

Based on its experience in the Murray-Darling Basin and with water rights and water markets globally, The Nature Conservancy has proposed a number of enabling conditions that are needed for successful implementation of the WSIP model. These include the existence of legally-defined and enforceable water rights, the ability to trade conserved water, the ability to transfer permanent water rights and short-term water access, a cap on total consumptive water use, buy in from the agricultural community and other stakeholders, and monitoring and enforcement to ensure compliance. These can be used to identify where WSIPs could provide an opportunity for private investment to help balance the allocation of water across multiple societal benefits, including agricultural production and biodiversity conservation.

Case 4: DC Water Environmental Impact Bond

The problem

The area of paved and impervious surface in Washington, DC – and many other cities – has grown, preventing rainfall from being absorbed into the soil (see Chapter 4, Case 1 for more detail). As a result, the city's combined sewage/stormwater run-off system overflowed regularly, sending 10 million m3 of runoff and untreated sewage flowing into local water bodies, and ultimately the Chesapeake Bay, every year. This has degraded the water quality of DC's local rivers, as well as the Chesapeake Bay. These overflows are a violation of the federal Clean Water Act. In 2005, the U.S. Environmental Protection Agency, Department of Justice, District of Columbia and District of Columbia Water and Sewer Authority (DC Water) agreed to allow DC Water to address the problem by constructing a USD 2.6 billion tunnel system that would capture overflows and allow them to be treated before entering waterways.

Since then, nature-based solutions to reducing stormwater flows have emerged as a viable option, and DC Water was able to modify its agreement with the federal government to allow the use of green infrastructure to reduce its combined sewer overflows. In 2016, DC Water issued an Environmental Impact Bond to fund construction of green infrastructure to reduce stormwater runoff. The bond includes an innovative pay-for-performance structure in which payments to investors depend on the level of success achieved in reducing stormwater runoff.

The ecosystem service

Under normal circumstances, stormwater and sewage flow together in DC's combined sewer system, and this wastewater is treated before being discharged into local water bodies. In heavy rainfall events, the amount of stormwater and sewage generated exceeds the sewer system's capacity, and excess wastewater is discharged without treatment. Green infrastructure – such as rain gardens and green roofs – contributes to reducing these overflow events by increasing infiltration and slowing storm flows. This reduces the likelihood of the sewer system becoming inundated after a storm, with the resulting release of untreated sewage. If green infrastructure is successful at reducing stormwater, it is possible that the size (and therefore cost) of the planned additional tunnel system could be reduced. Green infrastructure also provides co-benefits that the tunnel system would not, including aesthetic values, recreational opportunities and health benefits associated with green spaces.

Ecosystem service beneficiaries

The improved water quality from avoided combined sewer overflows benefits everyone downstream using the DC rivers and Chesapeake, particularly those involved in recreational and commercial fishing and water-based tourism in the area. DC residents pay for the stormwater regulation service indirectly, through the portion of their taxes that go towards repaying bond investors. If green infrastructure proves to be more cost effective than the planned tunnel system, DC residents could additionally benefit from reduced costs for financing that.

Ecosystem service suppliers

The ecosystem service supplier is DC Water, which is constructing the green infrastructure that provides stormwater regulation services.

Terms of the exchange/*Quid pro quo*

DC Water is using the proceeds from the sale of the bond to construct green infrastructure (specifically, permeable pavement and rain gardens) on 8 hectares of land, in order to pilot test its effectiveness. DC Water pays bond holders annual interest, and will repay the principal after 30 years. In 2021, after 5 years, there may also be performance-based payments between DC Water and bond holders (see "Mechanism for transfer of value" below for more details). Stormwater runoff will be monitored at the site before and after construction of green

infrastructure. The amount of payment depends on how successful the green infrastructure proves to be at reducing stormwater flows.

Mechanism for transfer of value

DC Water's funding for constructing green infrastructure comes from the proceeds of the USD 25 million bond, which was sold to Goldman Sachs and Calvert Foundation (a nonprofit investment firm, now Calvert Impact Capital)**.** The bond is a 30-year bond with a 3.43% coupon rate (annual interest). This rate is comparable to the historic rate for other 30-year bonds that DC Water has issued.

Under the bond's pay-for-performance structure, however, payment back to investors depends on the environmental success of the green infrastructure at the 5-year mark. If the green infrastructure meets expectations (reducing runoff between 18.6 and 41.3%), then no performance-based payment occurs and the bond functions as a conventional bond. DC Water and its partners modeled a range of possible outcomes and used the middle 95% of those outcomes as the expected range. If the green infrastructure outperforms expectations (exceeds 41.3% reduction), DC Water will pay an additional USD 3.3 million to bond investors. In this case, the green infrastructure would prove to be more cost effective than expected, and so DC Water would be able to save money when it scales by reducing the amount of green infrastructure needed, and possibly grey infrastructure as well, to manage the same amount of stormwater. On the other hand, if green infrastructure drastically underperforms (reduces runoff <18.6%), the investors will pay DC Water USD 3.3 million, essentially covering the cost of DC Water's interest payments for the first 5 years. This serves as a sort of insurance policy for DC Water, should its green infrastructure pilot fail.

Ultimately, this pay-for-performance structure distributes the risk associated with green infrastructure between DC Water and bond investors. If the pilot succeeds, DC Water expects to spend USD 90 million to construct 120 hectares of green infrastructure for stormwater management.

Effectiveness

The effectiveness of the permeable pavement and rain gardens at reducing stormwater flows will be independently verified. All water from the pilot site is channeled into a gauged pipe to allow for direct measurement. Stormwater flows have been measured for 12 months before installation of green infrastructure as a baseline, and will be compared against 12 months of data after the green infrastructure is built. The 95% range for the expected outcome is meant to cover, among other things, potential differences in weather between years that could influence the results. Results will be available by 2021.

Key lessons learned

As with the Murray-Darling Basin Water Sharing Investment Partnership, this example of impact investing shows the complementary roles that government and private interests can play. Washington, DC's interest in using green infrastructure for stormwater management stems from the regulations set by the federal government under the Clean Water Act. Private investors then provided the up-front capital DC Water needed to pilot test the use of green infrastructure, in exchange for anticipated returns over the next 30 years.

The performance risk associated with green or nature-based infrastructure has been one major limitation to its adoption over gray or engineered infrastructure. The pay-for-performance model employed by the DC Water Environmental Impact Bond provides a way of transferring some of that risk from governments, with limited funds and a need to deliver results cost-effectively, to investors who are willing to take on risk when it is associated with adequate financial returns. Such a model requires the ability to sufficiently quantify project risk up front and to measure project performance.

Recommended key references

Case 1

Buckley, R. 2009. Evaluating the net effects of ecotourism on the environment: a framework, first assessment and future research. Journal of Sustainable Tourism 17(6): 643-672.

Medina, L. K. 2005. Ecotourism and certification: Confronting the principles and pragmatics of socially responsible tourism. Journal of Sustainable Tourism 13(3): 281-295.

Case 2

Chaplin-Kramer, R., Jonell, M., Guerry, A., Lambin, E.F., Morgan, A.J., Pennington, D., Smith, N., Franch, J.A. and Polasky, S, 2015. Ecosystem service information to benefit sustainability standards for commodity supply chains. Annals of the New York Academy of Sciences 1355(1): 77-97.

Rueda, X., and Lambin, E. 2013. Responding to globalization: impacts of certification on Colombian small-scale coffee growers. Ecology and Society, 18(3).

Case 3

Huwyler, F., J. Käppeli & J. Tobin. 2016. *Conservation Finance From Niche to Mainstream: The Building of an Institutional Asset Class.* Credit Suisse and McKinsey Center for Business and Environment.

Richter, B. 2016. Water Share: Using water markets and impact investment to drive sustainability. The Nature Conservancy: Washington, D.C.

Case 4

Martin, A. 2017. A Pioneering Environmental Impact Bond for DC Water. *Conservation Finance Network.* Available online at:

http://www.conservationfinancenetwork.org/2017/01/02/pioneering-environmental-impact-bond-for-dc-water

Quantified Ventures. 2016. *DC Water's Green Infrastructure Environmental Impact Bond Overview*. Available online at: http://www.quantifiedventures.com/s/DC-Water-EIB-Overview.pdf

7. BLENDED MECHANISMS: THE CASE OF US COASTAL RESILIENCE & CLIMATE ADAPTATION

Katie Arkema, Rick Bennett, Alyssa Dausman, Len Materman

Introduction

Globally, coastal flooding and sea level are expected to increase significantly by midcentury, with potentially severe consequences for coastal populations around the world. In the United States--where 23 of the nation's 25 most densely populated counties are coastal--the combination of storms, rising seas, and degraded ecosystems put at risk valuable property and large numbers of people (Figure 7.1 and 7.2). In the past, efforts to protect communities from coastal hazards primarily involved constructing seawalls, levees, and other hard infrastructure. However, the cost and failure of these traditional structures and their negative impacts on coastal processes and ecosystems, has led to a growing interest in natural and nature-based strategies for shoreline protection.

The overarching goal of natural and nature-based approaches is to enhance the resilience of coastal communities to sea-level rise and storms, while maintaining or restoring the multiple benefits of ecosystems for people now and in the future. Natural approaches to coastal protection include conservation of existing wetlands, coastal forests, dunes, reefs and other ecosystems that have the ability to attenuate waves, reduce water levels, and trap sediments. Nature-based approaches include restoration of degraded ecosystems and hybrid approaches that combine natural features and traditional structures (e.g., saltmarsh coupled with rock groin). Through buffering shorelines from coastal erosion and flooding, ecosystems and hybrid solutions have the potential to mitigate the effects of coastal hazards (Figure 7.2).

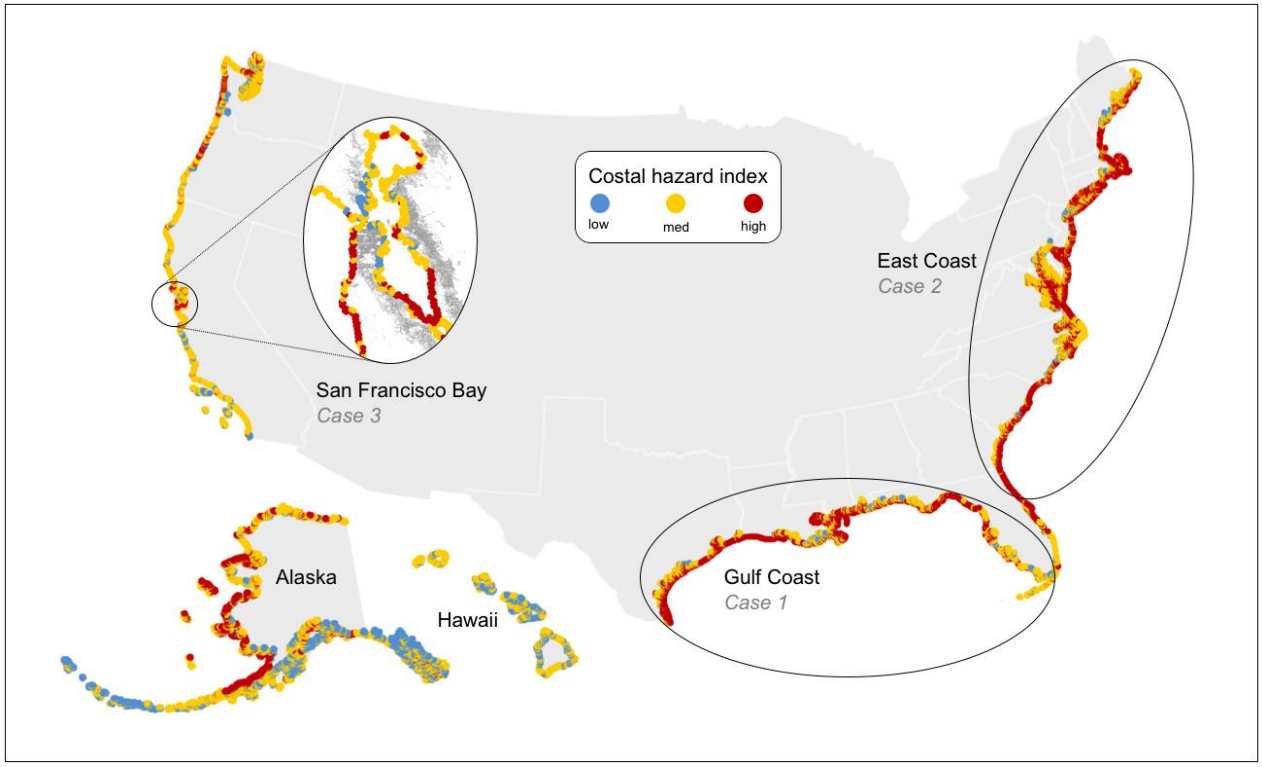

Figure 7.1 Exposure of the US coastline and coastal population to sea-level rise in 2100 and storms. Warmer colors indicate regions with more exposure to coastal hazards. Black ovals indicate the locations of the three case studies: Ecosystem Restoration in the US Gulf Coast, Post-disaster investments for coastal resilience along the eastern US, and Watershed and floodplain planning and investments in the San Francisco Bay Area, US. Data depicted in the inset maps are magnified views of the nationwide analysis. A version of this figure first appeared in Nature Climate Change (Arkema et al. 2013).

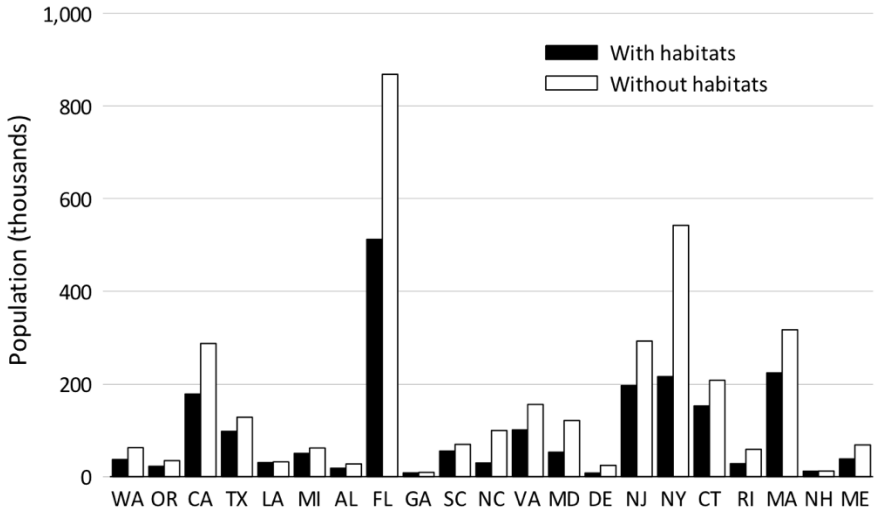

Figure 7.2 Population living in areas most exposed to hazards (red 1 km coastal segments in the map in Figure 7.1) with protection provided by habitats (black bars) and the increase in population exposed to hazards if habitats were lost owing to climate change or human impacts (white bars). The difference between these bars represents the number of people benefiting from reduced risk to coastal hazards provided by ecosystems. Letters on the x axis represent US state abbreviations. A version of this figure first appeared in Nature Climate Change (Arkema et al. 2013).

National, regional, and local government agencies, non-governmental organizations, industry representatives, and waterfront residents around the world are beginning to invest in conservation and restoration of ecosystems to achieve coastal resilience and other goals. In this chapter we describe three examples of how these investments are being made in the United States. The first example comes from the US Gulf Coast, where Hurricane Katrina first ignited global interest in the role of wetlands for providing coastal protection and where litigation following the Deepwater Horizon Oil Spill has provided funds for ecosystem restoration. The second example is from the northeastern United States where government subsidies following Hurricane Sandy in 2012 elevated the importance of ecosystem restoration for coastal resilience in post-disaster reconstruction. The final example is from the west coast of the United States in the San Francisco Bay Area where a single government entity working across multiple jurisdictions directs public-private investments in ecosystem restoration to achieve coastal resilience and climate adaptation.

Case 1: Ecosystem Restoration in the US Gulf Coast

Description of the problem

The Gulf Coast ecosystem is vital to the people, environment and economy of the United States, providing abundant seafood, valuable energy resources, diverse recreational activities, and a rich cultural heritage. Its waters and shorelines are home to thousands of species, including ecologically and economically important fish and invertebrates, birds, sea turtles, and marine mammals. Over 22 million Americans live on the Gulf Coast, many of whom work in crucial industries like commercial seafood and tourism. With 10 of the nation's 15 largest ports, nearly a trillion dollars in trade each year flows from the region (Council 2016). Much of this value is built upon the Gulf Coastal environment and the many benefits it provides to people in the region and beyond.

These benefits, and the Gulf Coast ecosystems that underlie them, were significantly degraded by the Deepwater Horizon Oil Explosion and subsequent spill. The explosion occurred on April 20, 2010, killing 11 people working on the rig and injuring many more. The spill that followed affected more than 650 miles of Gulf Coast habitat and reduced the abundance of key species throughout the marine food web. Impacts from oil on coastal and marine ecosystems also affected key industries, leading to the closure of more than a third of federal waters to commercial fishing and an estimated $3.6 billion in losses to the tourism sector. The degradation from the spill, and other past and on-going natural and human activities, represents a serious risk to the cultural, social, and economic benefits derived from Gulf Coast ecosystems.

In response to the *Deepwater Horizon* oil spill, President Obama signed the RESTORE Act into law on July 6, 2012. The Act calls for a regional approach to restoring the long-term health of the valuable natural ecosystems and economy of the Gulf Coast region. The RESTORE Act dedicates 80 percent of civil and administrative penalties paid under the Clean Water Act to a Gulf Coast Restoration Trust Fund (Trust Fund) for ecosystem restoration, economic recovery, and tourism promotion in the Gulf Coast region. This effort is largely federally managed.

In addition to efforts under the RESTORE Act, there are two other major restoration efforts that direct funds flowing from litigation related to the Deepwater Horizon Oil Spill. The second effort aims to restore natural resources injured by the spill through a Natural Resource Damage Assessment (NRDA) under the Oil Pollution Act. This effort is being coordinated among Gulf states and the federal government. The third effort is being administered by the National Fish and Wildlife Foundation (NFWF) using monies from the settlement of criminal charges against British Petroleum and Transocean Deepwater, Inc. put into a Gulf Environmental Benefit Fund (GEBF). The three efforts are administered in different ways by different combinations of state and federal agencies, but in all cases, seek to direct funds from the Deepwater litigation process to restore ecosystems and the benefits they provide for the economy and people of the Gulf.

The ecosystem service

Ecosystem restoration contributes to coastal resilience from storms and sea-level rise in two main ways. First, restoring natural processes and degraded shoreline habitats can reduce coastal erosion and flooding. Ecosystems such as mangroves and other types of coastal forest, saltmarshes, oyster and coral reefs, dunes, and seagrasses attenuate waves and water flow, trap sediments, and retain soils. Second, these coastal ecosystems provide a suite of other ecosystem services, beyond coastal protection. Wetlands and reefs provide recreational enjoyment through snorkeling, kayaking, hunting, and fishing; habitats provide homes for early life-stages of key fish and shellfish which in turn support coastal livelihoods and economies, and vegetation sequesters and stores carbon and takes up nutrients and other contaminants, mitigating climate change and enhancing water quality.

In the case of the Gulf, if coastal protection services are not maintained through coastal restoration and management, communities will increasingly need to rely on hard infrastructure approaches such as levees and seawalls. Such hard infrastructure can further exacerbate coastal erosion and flooding (e.g., the levees in Hurricane Katrina) and negatively impact ecosystems that support fisheries, tourism, carbon, and water quality benefits.

Identification of the beneficiaries

The beneficiaries of reduced flooding and erosion are coastal property owners and residents, as well as people using public land along the water and the agencies that manage that public land. In addition, beneficiaries of restoring Gulf ecosystems include commercial and recreational fishing industries, the tourism sector, and recreational hunters, fishers, swimmers, and beachgoers, among others. Finally, the contractors and environmental engineering firms that implement the restoration projects, benefit from the employment opportunities.

Identification of the suppliers

Restoration investments are often on public land and in nearshore waters and include restoring coastal wetlands, beaches, dunes, oysters, and other types. However, projects also occur on private land. For example, restoration investments are made in coastal watersheds with agricultural communities or through working with more urbanized communities, for example that

are on septic systems discharging into Gulf estuaries, to get them hooked into centralized sewer systems. The Restore Council and other institutions leading restoration efforts work closely with private land owners to identify, permit, and complete restoration projects. They also work with a variety of government agencies and local entities to implement restoration on public lands and in nearshore waters, including multiple large-scale coastal wetland restoration projects throughout the Gulf.

Terms of the exchange/*Quid pro quo*

The total funding for ecosystem and economic restoration in the Gulf Coast from the Deepwater Horizon Oil Spill amounts to more than US$20 billion, with the major funding streams being ~US$5.5 billion from Civil Penalties under the Clean Water Act to be dispersed according to the RESTORE Act, just over US$2.5 billion to be administered by NFWF, and no more than $8.8 billion from NRDA. Funding has gone to a variety of restoration activities, with the NRDA and NFWF processes directly tied to restoring natural resources damaged by the oil spill, and the RESTORE Act programs focusing more broadly on connections between natural resources and the economy.

Some of the funding contributes directly to adding coastal habitat to the land and seascape. For example, funds go to replanting of seagrass, saltmarsh, dune grass and construction of nearshore oyster reefs using various techniques such as reef balls, spat, and shells. Funding also supports identifying locations suitable for habitat restoration and monitoring the biophysical changes on the landscape after restoration. In addition to direct addition of new habitat to the landscape, funds go towards activities that will indirectly restore coastal and marine ecosystems. Examples include eradication of invasive species, investment in storm water infrastructure, protecting and restoring riparian corridors to ensure nearshore water quality improvements necessary for seagrass and oysters, interventions to restore coastal hydrology, and projects to increase or decrease sediment, as appropriate, to address land loss or water quality and/or clarity issues. Some funds also go to economic development, job opportunities, and educational activities in coastal communities as well as land acquisition for conservation at a fair market value from willing landowners.

Recipients of the funds are usually a variety of state and federal agencies, and in some cases, NGOs or other implementing entities based on consultation with the agencies. These government agencies are the stewards of the public and the threatened and endangered species and it is their job to restore the resources the public has the right to.

Mechanism for transfer of value

The transfer of funding to service providers depends on the funding stream. The $5.5 billion designated under the RESTORE Act from the Civil penalties under the Clean Water Act goes to the Gulf Coast Restoration Trust Fund. The restoration funding is administered by the Restore Council, an independent federal agency, as well as by the U.S. Department of Treasury. The Restore Council includes the governors of the five states in the Gulf of Mexico (Texas, Louisiana, Mississippi, Alabama, and Florida), and the Secretaries of five federal agencies (Secretaries of Agriculture, Army, Commerce, Homeland Security, Interior) and the Administrator of the EPA. The RESTORE Act restoration funding managed by the Council and/or Treasury administers the

funds through grants and interagency agreements, according to US federal law and can only be given to the five Gulf states and/or six federal agencies on the Council. The states and agencies then implement the projects and programs, or often, in turn, pay local businesses, contractors, and environmental consulting firms to implement the work. While the federal granting process has tremendous oversight, it can also be a lengthy process to get funding out for implementation. In addition, all projects administered by federal funding are held to federal environmental laws, such as the National Environmental Policy Act.

The funds from the Criminal Penalties under the Clean Water Act, total approximately US$2.5 billion to NFWF, are spent on restoration related to oil spill damages. NFWF has a granting program they run and collaborate with local entities and government agencies. The process for granting is written into the criminal consent decree. NFWF is not held to federal granting law, but they have a robust review and approval process for projects. In addition, depending on the implementing entity, they are not always subject to all federal environmental laws.

Finally, the largest stream of funds over US$8 billion comes from the Natural Resources Damage Assessment. In this process the states and federal government work together to decide how to invest the funds. The NRDA funding stream does not involve a granting process and thus has less oversight. However, because of the approval and involvement of federal agencies, all projects are subject to NEPA.

Monitoring and verification

The US federal government has new, extensive guidance for restoration monitoring. Every project has to submit a monitoring plan and make the data from the monitoring activities available to the public. Typically granting programs focus on tracking restoration "outputs" such as acres acquired, built, or restored. Monitoring efforts may not capture "outcomes" from restoration, which would be defined as what the restored acres provided over the long-term in terms of ecosystem function, services, and human well-being.

Effectiveness (from biophysical and social perspectives)

It is too soon to know the effectiveness of the projects funded since the Deepwater Horizon Oil Spill for achieving coastal resilience and other related social and economic goals. In the past the focus has been on monitoring biophysical factors, such as area of habitat restored, but increasingly institutions and people in the Gulf are interested in the effectiveness of restoration to achieve economic and human-wellbeing goals.

Key lessons learned

- Coordination among multiple federal agencies and states take time, but is important to define restoration goals and find consensus before moving forward to project selection. Developing science-based tools to inform project selection would expedite and improve decision-making, resulting in projects with more co-benefits.

- Mechanisms to get funding out for implementation need to find a balance of adequate oversight, while also being efficient and effective. Grants can be overly burdensome if not implemented properly. In addition, complying with grants often means monitoring "outputs", which are not always useful, instead of monitoring "outcomes", which are more meaningful. Monitoring restoration outcomes, such as social/economic improvements, not just biophysical outputs, is important because the public and funders want to know what the restoration is actually achieving beyond "acres restored".
- Federal laws are created to protect the environment. But these laws can also be expensive to comply with, and therefore create inefficiencies in restoration, specifically when projects are to restore the ecosystem, not damage it. Often states and other local governments do not want federal agencies involved because it requires additional regulatory compliance. Working to streamline and find regulatory efficiencies is important for achieving multiple ecological and social objectives.

Case 2: Post-disaster investments for coastal resilience along the eastern US

Description of the problem

Hurricane Sandy was one of the deadliest and most costly hurricanes in United States history. When it hit the eastern seaboard as a Category 2 hurricane, it became the largest Atlantic hurricane on record. At least 223 people were killed, including 160 in the US alone, and damages amounted to more than $75 billion. A total of 24 states were affected by Hurricane Sandy, with New York, New Jersey, Pennsylvania, Delaware, Maryland, and West Virginia suffering much of the damage and loss of life. Numerous relief efforts and fundraisers emerged after the storm, including the Disaster Relief Appropriations Act passed in January 2013.

The Disaster Relief Act included two primary streams of funding. The first was a more traditional stream of funding directed towards rebuilding based on damages caused by the storm. In contrast, the second stream was more forward looking with a goal of increasing the resilience of the east coast of the US to future storms and hurricanes. This latter stream of funding was appropriated to the Department of the Interior and a portion was subsequently managed by the National Fish and Wildlife Foundation (NFWF). Investments were targeted towards projects that would reduce communities' vulnerability to growing risks from coastal storms, sea level rise, flooding, erosion and associated threats through strengthening natural ecosystems that also benefit fish and wildlife.

The ecosystem service

As highlighted in the previous case study in the US Gulf Coast, ecosystems play a role in coastal hazard mitigation. Saltmarshes, seagrass, oyster reefs and other shoreline habitats have the ability to reduce wave energy, attenuate water flow, and trap sediment and soil through their

three dimensional structure. By extracting wave energy and accreting sediments along the shore and underwater, they can reduce coastal flooding and erosion that would otherwise threaten coastal communities and infrastructure.

Furthermore, the same biological structure (e.g., roots and shoots of saltmarsh and seagrass, coastal dunes and beaches) that influences coastal processes also provides habitat for ecologically and economically important species. One of the mandates of the Department of the Interior, and in particular, the US Fish and Wildlife Service, is management of critical species and the habitats that support their populations. Thus, in addition to enhancing coastal resilience, a central goal of the Disaster Relief Appropriations Act was investments in restoration and conservation for ecological benefits. For example, projects involved restoration of seagrass habitat, not only for its ability to attenuate waves and stabilize shorelines, but also for its importance as soft-shell crab habitat. Dam removal projects had goals of both opening habitat for American eels and river herring, which are under consideration for federal listing, as well as limiting the potential for catastrophic dam breaches and flooding. Similarly, several projects involved restoring beaches and barrier islands that buffer shorelines from storms, are popular with tourists and locals, and in addition are home to ecologically, economically, and recreationally important shoreline creatures such as shorebirds and the horseshoe crab. Horseshoe crabs, for example, are used in the biomedical industry in assays for bacteria contamination from endotoxins; a substitute has not yet been successfully manufactured.

Identification of the beneficiaries

The primary beneficiaries of the conservation and restoration projects implemented with funds from the Hurricane Sandy Disaster Relief Appropriations Act are coastal property owners and residents that would otherwise need to invest in hard infrastructure approaches or suffer property damages and the broader public that uses infrastructure (e.g., schools, roads, emergency services) and open spaces within coastal areas. In addition, commercial and recreational fishermen and the associated industry benefit from more sustainable populations of key species, such as the soft-shell crab in Chesapeake Bay. Furthermore, a variety of people benefit from recreational opportunities fostered through restoration and conservation. Many visitors are drawn to open spaces (e.g., beaches, wetlands) and wildlife, like shorebirds in Delaware Bay, for recreational and physical activities.

Identification of the suppliers

Most of the projects funded by government subsidies through the Disaster Relief Bill tend to occur on public land, especially within the National Seashores, National Wildlife Refuges, and state and local parks and open spaces. But several projects were proposed and funded on private land, especially land with obsolete and high liability dams. In the northeast many of the dams require significant maintenance costs, but operations cover only a small part of the costs. Thus many private land owners with dams on their property were interested in dam removal and investments in restoring habitat quality and connectivity as a way of eliminating aging infrastructure and liability for downstream safety.

Terms of exchange/*Quid pro quo*

The Hurricane Sandy Disaster Relief Supplemental Appropriations Act of 2013, Public Law 113-2 (also referred to as Sandy Supplemental), appropriated $829 million to the Department of the Interior to respond to and recover from Hurricane Sandy. Included in the appropriation to Interior was $469 million appropriated directly to the National Park Services, Fish and Wildlife Service, and Bureau of Safety and Environmental Enforcement for response and recovering, rebuilding lands and facilities, and grants to States for historical preservation (i.e., the traditional stream of funding). An additional $360 million was appropriated to the Office of the Secretary of the Interior with authority to transfer funds to bureaus and offices and to enter into financial assistance agreements for mitigation. The Act provides explicit direction to use mitigations funds to restore and rebuild national parks, national wildlife refuges, and other Federal public assets with the goal of increasing the resilience and capacity of coastal habitat and infrastructure to withstand, and reduce damage from, storms.

Government subsidies through the mitigation stream of funding from the Relief Bill were directed at a variety of projects. Many of these involve reconnecting fragmented rivers to contribute to the recovery of species and resilience to riverine flooding. Other projects included repairing and installing culverts to allow for sufficient mixing and fish passage and dam removal to facilitate fish passage and reduce flood risk. Some projects involved restoration of riparian habitat for critical and endangered species, invasive species removal, clearing large debris, rebuilding pools and ponds, and restoring saltmarsh and oyster reefs. For beaches and dunes, projects included restoring and enhancing beach, stabilizing critical nesting islands, and installing living shorelines. Additional funds were granted to inform project design and coastal resilience assessment. Outcomes from these planning grants were used to inform restoration projects implemented in a second phase of the funding. Lastly, some of the funding was retained for administration and future cross project monitoring.

Mechanism for transfer of value

Of the $360 million appropriated to the Department of the Interior for mitigation and strategic investments in future coastal resilience, sequestration reduced 5% of these funds and $30.5 million were allocated to the Bureau of Ocean Energy and Management and US Geological Service for inventory and identification of sand and gravel resources. With the remaining $311 funds, DOI provided $204 million to support 113 DOI Bureau projects designed to reduce ecosystem and communities vulnerability to growing risks from climate related threats (including coastal storms, sea-level rise, flooding). In addition, DOI partnered with NFWF (National Fish and Wildlife Foundation) to administer an external competition to support similar projects led by state and local governments, universities, non-profits, community groups, tribes, and other non-Federal entities. Through this process, $100 million in DOI funding from the Sandy Supplemental was invested in 54 projects along with more than $2.7 million in private funding leveraged by NFWF and allocated through the competitive grant program.

Monitoring and verification

The programs under the mitigation funds from the Hurricane Sandy Disaster Relief Appropriations Act incorporate a monitoring and verification process whereby each project submitted a plan for monitoring. However, these monitoring plans were largely designed before the projects were funded and before the DOI and other agencies collaborated to develop a set of standard metrics of monitoring coastal resilience and other ecosystem service goals. Fortunately, the DOI decided to take a novel approach and save some of the funds for later allocation towards monitoring. Thus, last year the agencies instated a competitive process for $16 million for the previously awarded projects to apply for funds to monitor and evaluate the existing project thus far. The agencies were interested in ecological metrics and performance, but also interested in socio-economic benefit. They wanted to assess whether the overarching goals of the government subsidies through the Disaster Bill had been met -- to improve ecosystem and community resilience and to factor resilience into community planning and future project management.

Effectiveness (from biophysical and social perspectives)

Many of the projects funded under the Disaster Relief Appropriations Act of 2013 are just coming to completion and the Department of the Interior is in the early stages of assessing effectiveness. Restoring the resilience of the east coast of the US is a massive undertaking and developing accurate and sensitive performance metrics is a major challenge. Nevertheless, preliminary data suggest positive results. For example, reports suggest that after dam removal, various species of fish are being found upstream of the restoration project sites. Many agency scientists and program managers assumed the coastal resilience outcomes would take longer to emerge than the ecological ones. However, data collected from one of the larger saltmarsh and barrier beach restoration projects (i.e., the Prime Hook National Wildlife Refuge), in which more than 4,000 acres, 2.5 miles of beach, and 22 miles of channels were restored, demonstrate that Plovers are returning and terns are occupying areas from which they had been absent for years. Moreover, several anecdotes from community members suggest that the large storms in 2016 caused less damages than storms in previous years when the ecosystems were still heavily degraded.

Key Lessons Learned

- Communication and collaboration among jurisdictions and agencies is key to a successful restoration funding program, project implementation, and realization of shared goals. To foster collaboration, the Department of the Interior founded an executive council (including the Secretary and Director of various agencies). This executive council made the majority of programmatic decisions. In addition, a regional leadership team was established, including regional directors from the US Geological Service, US Fish and Wildlife Service, National Park Service, Bureau of Ocean Energy Management, and a technical team.
- One way to insure funding for monitoring and verification is to retain a portion of the government subsidy to allocate to monitoring at a later date. To achieve its

monitoring goals, 85% the Hurricane Sandy budget was directed towards project implementation and 15% was retained for assessment and monitoring.

- To understand how investments in ecosystem restoration made at the project scale influence social and economic outcomes at the landscape scale, the Hurricane Sandy program has developed social and economic metrics that link back to biophysical changes and metrics. The program is collecting empirical information at the project scale and using models to scale to the whole northeastern and mid-Atlantic coastline to understand the overall change in habitat for key species and change in resilience of coastal communities as a result of restoration investments.

Case 3: Watershed and floodplain planning and investments in the San Francisco Bay Area, US

Description of the problem

The watershed and floodplain of San Francisquito Creek, California encompasses approximately 130 square kilometers from the Santa Cruz Mountains to San Francisco Bay. The Bay is central to the regions' financial and tourism sectors, as well as major ports and heavy industry. San Francisquito Creek lies near the southern end of San Francisco Bay, and its floodplain is largely comingled with the Bay floodplain. Within or adjacent to these floodplains lies major regional assets related to transportation, water supply and treatment, electrical and natural gas transmission, and businesses, including the headquarters of Google, Facebook, Hewlett-Packard, and other technology giants. Surrounded by residential and commercial development, an extensive system of coastal wetlands, and other open spaces, the area around the Creek supports numerous species of animals and plants and a variety of recreational activities enjoyed by local residents and visitors. However, despite the region's natural and financial wealth, these communities have frequently experienced riverine and coastal flooding. In fact, within the poorest areas, homes sit below sea level and roofs lie below non-engineered berms that serve as levees. Because it forms the boundary between cities and counties, and because of its history of disasters, San Francisquito Creek was historically viewed as a liability. Without a single organization through whom to manage the Creek and the surrounding watershed, multiple jurisdictions struggled to achieve shared objectives.

After major flooding in 1998 which damaged approximately 1,700 properties, five local agencies from two counties—the cities of Palo Alto, Menlo Park, and East Palo Alto, the County of San Mateo, and the county-wide water agency in Santa Clara County called the Santa Clara Valley Water District—joined together to create a new regional government agency, the San Francisquito Creek Joint Powers Authority (SFCJPA) named for the natural feature that divides and unifies them. Elected officials represent these jurisdictions on the SFCJPA Board. The Authority also employs an executive director and three professional staff, who are assisted by consultants and staff from its founding agencies. The overarching goal of the SFCJPA is to transform the San Francisquito Creek into unifying asset, addressing cities' shared flooding, environmental, and recreational interests.

The SFCJPA has three large projects that exemplify its emphasis on multi-benefits (flood protection, ecosystem restoration, and recreation) across multiple jurisdictions in Silicon Valley. These include the "S.F. Bay – Highway 101" and "Upstream of highway 101" Creek projects, and the "Strategy to Advance Flood protection, Ecosystems and Recreation along the Bay" project known as SAFER Bay. These projects are funded through a combination of public and private funding and incorporate both natural and hardened infrastructure to enhance resilience, habitat, recreation, water quality, access to recycled water, viewshed and other values for San Francisquito Creek and surrounding coastal areas.

The ecosystem service

The SFCJPA plans, designs, and implements projects from the upper watershed to tidal marshes. Many of the projects include natural and nature-based approaches to coastal resilience, including conservation and restoration of saltmarsh, creeks, and other ecosystems. As in the Gulf of Mexico and U.S. East Coast cases, ecosystems in and around the Bay can reduce the risk of coastal erosion and flooding by attenuating waves and trapping sediments. However, in the Bay, a primary issue is flooding from rainwater, high tides, and sea-level rise. Conserved and restored open spaces can provide a place for water to flow to keep it from flooding infrastructure and residential properties.

In addition to coastal resilience, an important consideration for the SFCJPA is providing outdoor recreation for residents living in the urban areas adjacent to the Creek. The "Baylands," as the coastal wetlands and tidal creeks are fondly called, provide an opportunity for physical exercise and a mental rejuvenation in an otherwise highly urbanized setting. The wetlands, beaches and mudflats also are home to numerous endangered and threatened species, drawing bird watchers and outdoor enthusiasts. In addition, the coastal vegetation can help to filter pollutants and nutrients to maintain water quality, and store and sequester carbon for climate regulation. The importance of these co-benefits has motivated the investigation of – and it will likely enable – new approaches to shoreline protection, which is why the SFCJPA is exploring a variety of natural, nature-based, and hybrid approaches to reducing risk to coastal communities and infrastructure.

Identification of the beneficiaries

Beneficiaries of investments in habitat restoration and conservation include coastal property owners with infrastructure at risk of damages from flooding and erosion. Of particular importance are those people with properties in FEMA's flood hazard areas, which are delineated in Flood Insurance Rate Maps. Other beneficiaries include the residents of the region that commute, walk, run, birdwatch and pursue educational activities throughout the Baylands. Many property owners adjacent to the shoreline are concerned about viewshed and property values. Businesses in the area include Facebook's headquarters campus within a marsh, hotels, law firms, and other commercial sectors. However, not all benefits go to the private sector. In addition to the approximately 2,700 homes in the Bay floodplain, the area surrounding the Creek includes the primary highway linking San Francisco and Silicon Valley, an airport, regionally significant water supply and treatment infrastructure, gas and electrical transmission lines, as well as schools and post offices.

Identification of the suppliers

Similar to the other two case studies, the investments in conservation and restoration of coastal habitats and traditional flood control structures (e.g., levees and floodwalls) are largely on public lands. However, the projects are required to acquire some key private holdings, including easements on several private properties to implement the S.F. Bay to Highway 101 and Upstream of Highway 101 projects, and the engagement of Facebook and other private developers along the Bay shoreline. For its S.F. Bay to Highway 101 Creek project, in an area that was marsh prior to human development, the SFCJPA has recreated marshland within a new broad channel from diverse public and private properties that until recently were part of a golf course, post office parking lot, private school, autobody shop, storage facility and other holdings, that in some cases contained hazardous materials.

Terms of the exchange/*Quid pro quo*

For the planning, design and construction of the projects listed above, over the past five years the SFCJPA has raised over $95 million, including $50 million from local cities and water districts in two counties, $34 million from the State's water and transportation agencies, and over $10 million from private sources, including a utility and Facebook. These sources have provided much greater funding for SFCJPA projects than the federal government, which is a traditional source of funding for major water infrastructure projects (though it remains a long-standing partner of the SFCJPA). The SFCJPA is pursuing additional funding for its Creek and SAFER Bay projects from new sources, including aggregating private flood insurance, a Bay Area wide shoreline restoration tax, a new finance district, and the carbon cap and trade market. For the latter, SFCJPA is reaching out to staff at the National Oceanic and Atmospheric Administration (NOAA) to better understand and quantify the carbon sequestration and storage benefits that will be provided by the marshes it creates.

Funded activities and structures include widening of the Creek in the Palo Alto Municipal Golf Course, for which $3 million was paid to that City. Other examples are private land acquisition including permanent and temporary construction easements. In one case, in lieu of a cash payment for an easement, the SFCJPA is moving a fire hydrant off of a private property, which benefits the property, fire department and nearby businesses, thus illustrating the flexible approaches the SFCJPA takes towards project financing and implementation. At the Bay shoreline of the three cities in which it works, the SFCJPA has estimated the potential for approximately 7 km^2 of restoration of ecosystems for coastal resilience, which they refer to as "green infrastructure." An example of this green infrastructure is the construction of a "horizontal" levee, which has a very gradual slope into the marsh with several habitat zones corresponding to different tidal elevations – a new approach to shoreline levees that can help to sustain both marsh and levee, capture and store more carbon, and reduce levee height and cost. When complete, the SFCJPA estimates its projects will significantly reduce flood risk from record creek flows and sea level up to nine feet above today's daily high tide for more than 5,000 properties across 18 kilometers of shoreline in two counties and thee cities.

Mechanism for transfer of value

In the case of the private easements, the transfer of monies is most often made through a single check to a private landowner. In only one case was a payment made for public land, to the City of Palo Alto for the use of municipal golf course land for the widened Creek channel.

Monitoring and verification

The projects include funding for monitoring endangered and critical species and habitats, especially to assess compliance with the Endangered Species Act. In general the existing monitoring plans tend to focus on ecological metrics. Tracking human wellbeing and economic information related to recreation, access to open space for disadvantaged communities, and coastal resilience metrics would help to elucidate the societal outcomes of coastal habitat restoration.

Effectiveness (from biophysical and social perspectives)

It is still too soon to know the outcome of the SFCJPA projects from a biophysical and social perspective. However, from a governance perspective the intergovernmental approach to raising and allocating funds across jurisdictions appears to have traction with the many public and private interests in the region.

Key lessons learned

- Coordination among multiple local, state and federal agencies takes time, but is important to define restoration goals and find consensus before moving forward with project selection, design and implementation.
- Funding for large, multi-jurisdictional, multi-benefit projects can be secured from the project's various beneficiaries, both public and private – this broad sharing of the costs and benefits leverages their investments.
- Even in settings with substantial constraints related to jurisdictional boundaries, land use, sensitive species, utilities, and other infrastructure, projects can be permitted and built that achieve substantial protections against flooding and sea level rise, and enhancements to ecosystems and recreation.
- Along much of the Bay in Silicon Valley, restoring the ecological function of the shoreline and protecting people and property are co-dependent.

Recommended key references

Arkema, K., G. Guannel, G. Verutes, S. Wood, A. Guerry, M. Ruckelshaus, P. Kareiva., M. Lacayo, J. Silver. 2013. Coastal habitats protect people and property from sea level rise and storms. *Nature Climate Change* 3:913–918. http://dx.doi.org/10.1038/nclimate1944

Disaster Relief Appropriations Act. (2013). Public Law 113-2 https://www.congress.gov/113/plaws/publ2/PLAW-113publ2.pdf

Gulf Coast Ecosystem Restoration Council (Council). (2016). Comprehensive Plan Update 2016: Restoring the Gulf Coast's Ecosystem and Economy. https://www.restorethegulf.gov/comprehensive-plan

Hurricane Sandy Coastal Resiliency Competitive Grant Program http://www.nfwf.org/hurricanesandy

National Fish and Wildlife Foundation. Developing Socio-Economic Metrics to Measure DOI Hurricane Sandy Project and Program Outcomes. December 11, 2015 https://www.doi.gov/sites/doi.gov/files/uploads/Socio_Economic_Metrics_Final_Report_11DEC2015_0.pdf

Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act (RESTORE) Act. (2012). Subtitle F of Public Law 112-141 https://www.treasury.gov/services/restore-act/Documents/Final-Restore-Act.pdf

San Francisquito Creek Joint Powers Authority, sfcjpa.org

The Department of the Interior Metrics Expert Group. Report for the Department of the Interior Recommendations for assessing the effects of the DOI Hurricane Sandy Mitigation and Resilience Program on ecological system and infrastructure resilience in the Northeast coastal region. June, 2015 https://www.doi.gov/sites/doi.gov/files/migrated/news/upload/Hurricane-Sandy-project-metrics-report.pdf

8. BLENDED MECHANISMS: MAINSTREAMING VALUES OF NATURAL CAPITAL INTO POLICY AND FINANCE: THE CASE OF COSTA RICA

Dr. Alvaro Umaña Quesada

Introduction: historical perspective, the frontier mentality

Costa Rica is unique in several ways. A key factor is the country's geographic location as narrow land bridge between the great landmasses of North and South America. Its rugged topography includes mountains that rise up to 3800 meters above sea level, and its land bears two different seasonal regimes that contribute to its extremely varied habitats. Costa Rica's biological diversity is outstanding in the Americas as well as in the tropical world as a whole. With a land area of only 51,000 square kilometers, it contains nearly 5% of all plant and animal species known to exist on the planet. In addition to this rich biodiversity, the country's long-standing efforts in conservation are well known. They include a system of national parks and protected areas, many of which are World Heritage Sites. The country has devoted considerable financial resources, both internal and external, to conservation and forest management. In its recent history, Costa Rica has used many different financial incentives and mechanisms, including debt-for-nature swaps. Costa Rica is the country that has used this mechanism most extensively, both with commercial as well as with bilateral debt.

Christopher Columbus landed in what is now Port Limon in 1502, on his fourth trip. Impressed by the abundance of gold gifts, he named the territory "Costa Rica". Although the country has some gold deposits, mining has been banned and Costa Ricans have become aware that the real richness lies in its "green gold": its biological endowment. This change in values and attitudes did not come easy and it has taken a long time to evolve.

In the early 1520's, when the first Spanish *Conquistadores* and settlers arrived, they found natural forests from coast to coast. Extensive fixed farmlands of indigenous tribes mixed with dry forest in the Nicoya Peninsula of the Northwest. In wetter areas, shifting agricultural systems were widespread, and their common characteristic is that they allowed the forest to grow back.
The arrival of Spanish settlers brought new diseases that decimated the indigenous population, and as the Spanish culture slowly started to dominate most of Costa Rica, the agronomy of native cultures was abandoned. This process took place in most of the country, except the Southern mountains of Talamanca (what is now Amistad National Park), where the Spanish were never able to conquer the native tribes.

Before the arrival of the Spanish, Costa Rica's population was estimated to be in the hundreds of thousands, most likely near to 500,000 people. Afterward, the impact of land theft and disease was so catastrophic that the indigenous population had shrunk to 17,000 in 1569 and 8,000 in 1801. Living primarily in the valleys and plateaus of the interior, the diminished mixed population remained isolated and poor.

Toward the middle of the 19th century the fertile Central Valley was almost completely occupied, and colonists moved into the forests. Waves of settlers and immigrants destroyed large tracts of the country's forests and started a culture and frontier mentality that persisted until recent decades among the rural population. There are two traditional myths about tropical forests: that the forest is the enemy of the peasant and that lands where all these lush forests grow must be productive. In addition most laws in tropical countries require "improvements" (i.e., removing the forest cover) in order to get legal title over the land.

The development of coffee agriculture on the land's fertile volcanic soil had a major impact on land colonization and by the mid-1850's Costa Rica started exporting coffee to Europe. The penetration of these markets caused a major social transformation and initiated a process of integrating Costa Rica into the world economy. Traditional coffee plantations kept large canopy trees for shade and they planted nitrogen-fixing trees, so the overall impact of coffee not as damaging as the new shadeless varieties that replaced some of the old plantations. Today, however, a lot of producers are going back to the traditional system and they market their coffee through fair trade or organic markets.

Forest cover in Costa Rica has undergone dramatic changes, decreasing from close to 95% when the Spanish arrived to 70% in 1950 and to below 30% in the late 1980's. During the decades of 1940-1980, very rapid deforestation took place, reaching over 1% per year. This was one of highest deforestation rates in Latin America.

This massive transformation in the landscape resulted from a combination of policies affecting land use, as well as international markets and political pressure. The early period of deforestation saw forests rapidly converted into agricultural or cattle ranching areas, which benefitted from

generous land titling and cheap credit. Even the World Bank gave Costa Rica a credit to expand cattle production in the 1970's. High international prices for beef and other expansive crops like coffee and bananas exacerbated these policies impact on deforestation.

The development of a road network throughout the country also had a significant impact of deforestation. When any new roads were built, deforestation followed closely and forests near the new roads were gone within five years. This happened, for example in the Perez Zeledon area and adjacent valleys in the Southwest when the Interamerican Highway was completed in the 1950's.

A critical problem was the fact that forest owners perceived little value in standing trees, and the legal and institutional structure reinforced this concept. Trees were not capital goods equivalent to cattle or tractors. One could go to the bank and borrow against these assets but trees were not acceptable as collateral. Only dead trees were valued, and only for their wood. Loggers focused on high valued trees of precious woods and did considerable damage to the remaining forest to extract only a few trees per hectare.

This trend was stopped by a number of significant pressures which emerged in the 1980's. Political and economic instability created by wars in Central America and the collapse of global meat, sugar and coffee markets led to the abandonment of significant agricultural and cattle land. At the same time, Costa Rica had begun to develop conservation policies like the creation of national parks and protected areas. An emergent conservation movement started to call for change.

Costa Rica begins to develop conservation policies

The need to preserve key examples of Costa Rica's extraordinary natural resources began to be felt as early as the middle of the 19th century after settlers had colonized most of the Central Valley. Early decrees introduced the concept of inalienable areas (lands that could not be privately owned and should be preserved).

In 1913 the crater and lake of Poas Volcano were protected. In 1945 the words "national park" appear for the first time in Costa Rica legislation and this same law declared that two kilometers on each side of the future Pan American Highway were to be protected. In 1955, a law created the Tourism Institute and gave it the right to establish and maintain national parks. At the same time, the law also declared that those areas within a radius of two kilometers from volcanic craters were also national parks.

These early measures were not well enforced, primarily owing to the lack of resources. For example, the oak forests near the Pan American Highway vanished in a few years, mostly having been converted to charcoal by local residents. Nevertheless, the idea of protecting national parks

continued to gain strength and in 1969 a new forestry law established a National Parks Department.

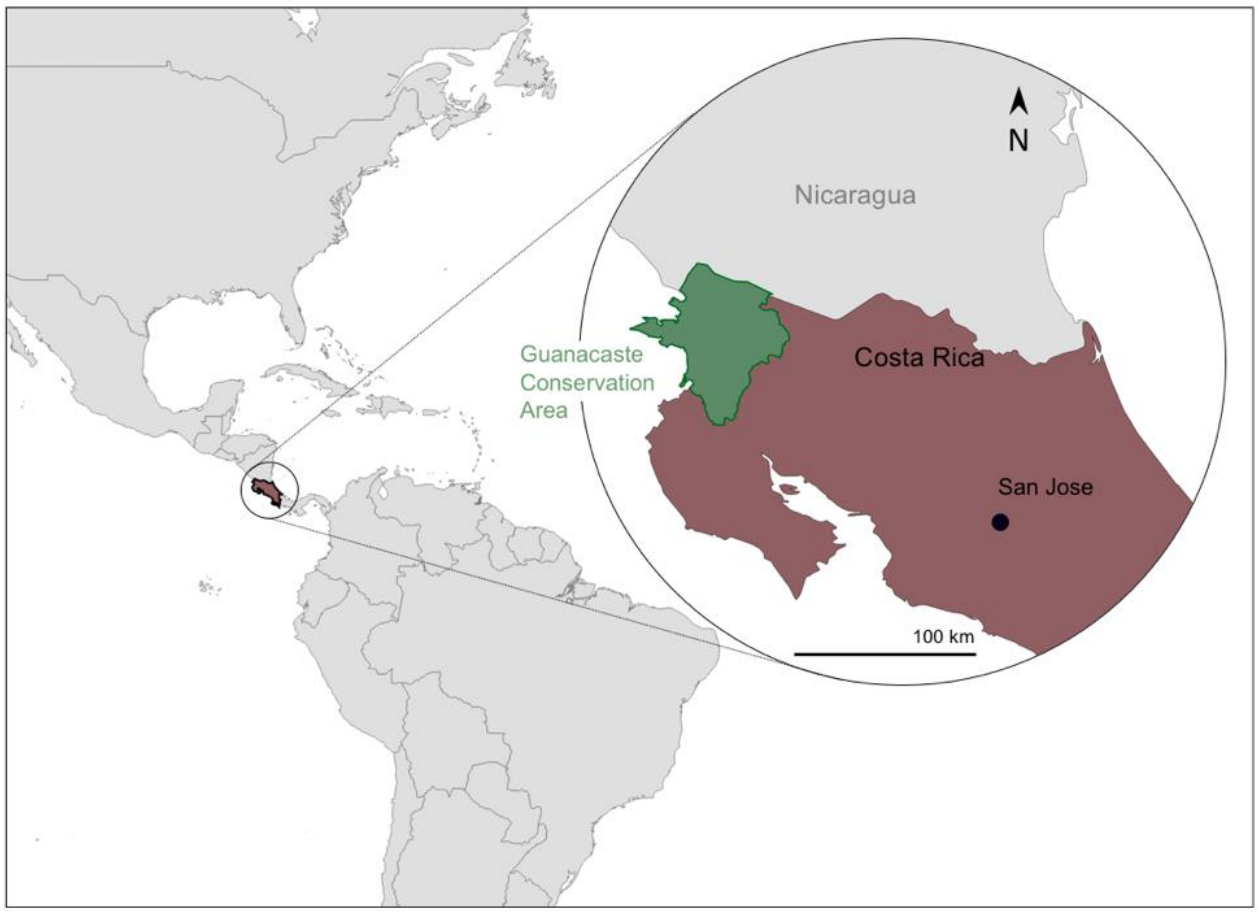

Figure 8.1 Guanacaste Conservation Area, Costa Rica. Costa Rica's importance for global biodiversity is far greater than its area would suggest, due to its location on the land bridge between North and South America, along with its rugged topography and climatic variability, The country hosts nearly 5% of the world's plant and animal species. The Guanacaste Conservation Area plays an especially important role, covering less than 2.5% of Costa Rica's land area but home to two thirds of the country's biological diversity.

Efforts to create and manage a system of national parks and protected areas have received political support from all subsequent governments. The following year, the José Figueres administration (1970-1974) started declaring a number of national parks: the Cahuita, Santa Rosa, Poás, Irazú, Manuel Antonio and Rincón de la VIeja National Parks, as well as the Guayabo National Monument, the only archeological park in Costa Rica. The Daniel Oduber administration (1974-1978) gave greater independence to the National Park Service and added key new parks: Barra Honda, Chirripó, Corcovado, Tortuguero and Braulio Carrillo, as well as the biological reserves Hitoy-Cerere, Carara and Caño Island.These efforts were continued by the Rodrigo Carazo administration (1978-1982) which added Cocos Island, Palo Verde and La Amistad national parks.

In 1978 two important events took place. The first was the creation of the National Parks Foundation (NPF) by the government. Under Costa Rican law, foundations operate as private entities, with three members appointed by the founder, a representative of the government and a representative of the municipality where the foundation is based. Since the government created the foundation, it had control over four out of five of its members. The NPF was the first of a number of foundations that have been created for conservation.

The second important event was the start of a fiscal incentive program for reforestation paid by the state through tax deductions. The loss of forest cover was the most important environmental issue at that time and the government decided to support reforestation. The program worked by allowing anybody who had a tax liability to buy a reforestation contract and take the tax deduction (50% in the first year and the other 50% over the next four years). Forest entrepreneurs were allowed to buy land, reforest it and sell the tax deduction. In turn they would keep the land and the trees. Unfortunately, since the buyers were only interested in the tax break and you could deduct half in the first year, many of the plantations failed.

The Luis Alberto Monge administration added several protected areas such as La Selva, which extended Braulio Carrillo national park to the northern plains, and the Pacuare River, which protected a major white-water attraction threatened by hydroelectric development. During this period, the US Agency for International Development started to play an important role in the natural resources area and the first project in the forest sector included subsidized credit to entice farmers to go into reforestation.

Through these sustained efforts, Costa Rica's system of national parks and reserves protects the nation's most outstanding examples of its natural and cultural diversity. The national parks and reserves, which account for over 6,000 square kilometers (12% of the country's land area), constitute the core of the system. An additional 15% of the territory falls under different categories of protection, such as forest reserves, protected zones, wildlife refuges and indigenous people's reserves. This critical conservation effort spearheaded by the state is complementary to the policies related to payment for ecosystem services (PES) that would be developed later.

Creation of the Ministry of Environment and Energy

The creation of the Ministry of Natural Resources, Energy and Environment (MIRENEM) in 1986 during the administration of President Oscar Arias (1986-1990) was an important political landmark. National parks and all forestry and wildlife related agencies, which were originally under the Ministry of Agriculture, were consolidated under the new ministry that would later be named Ministry of Environment and Energy (MINAE). For the first time in Costa Rican history, environment had a Cabinet level position, and this was an important political triumph for conservation and launching sustainable development. A new Forestry Law had been passed at the end of the Monge administration and became effective as the new Ministry took over.

The new administration also launched a participatory process to establish a national strategy for sustainable development, decentralized and regionalized the system of protected areas, developed new financial mechanisms for conservation that attracted new bilateral donors, initiated the National Biodiversity Institute, and spearheaded the Guanacaste National Park project as well as creating Arenal national park.

By the time the Arias administration took over in 1986, the program of fiscal incentives for reforestation had gotten out of hand. The Finance Ministry had complained that they could not know how much people would deduct until after they had presented their tax declarations and the size of the program had gone into the billion colones range.

At the same time, the new ministry became aware that supporting reforestation through fiscal incentives had been a mistake from the start. The priority should have been to protect the remaining forests, not to support wealthy individuals or corporations who were benefitting from the program. Yet, it was necessary to create a culture of reforestation and to develop policies that would give value to standing trees and forests.

A new program needed to be designed and the focus was small landholders and peasant organizations. The Finance Ministry continued to support the program but they would give a budgeted amount that was used to support organizations, like cooperatives or agricultural centers who had members who would be the beneficiaries of a new named CAF (a forestry certificate introduced by the new law) that would provide funding in advance so that peasants and farmers could plant trees. The maximum size allowable was 5 hectares, so that the priority remained on small landholders.

This effort got a considerable boost when Costa Rica started to experiment with debt-for-nature swaps in 1988. This mechanism started to be implemented in the late 1980's with developing country debt held by commercial banks, which was then sold at a discount in secondary markets. In a typical transaction, a donor (private, NGO's, developed country government) would purchase debt at a considerable discount, and then take to the Central Bank of the recipient government and exchange it for local currency bonds or future payments, also in local currency. The idea is that all parties are better off: the country reduces its debt, the projects receive local funding and the donor magnifies its impact.

After an initial wave of commercial debt-for-nature swaps, the mechanism was taken up by several donor countries that used it with their own bilateral debt. For example, the Unites States passed a Tropical Forestry Conservation Act that allows its debt to be swapped for conservation. As we will see, Costa Rica is the country that has benefitted the most from this act. Today, developing country debt is over $1 trillion, so there is considerable potential for this mechanism to be used throughout the world.

Through this new mechanism, Costa Rica also attracted two new bilateral donors: Sweden and the Netherlands. They provided the funds for the two largest commercial debt-for-nature swaps. The Swedish debt-swap went to Guanacaste National Park, while the Dutch debt-swap was dedicated to create a fund to finance forest management and reforestation. This added considerably to the resources provided by the government. Donations and grants totaling approximately $12 million cash were used to purchase Costa Rican commercial debt titles equivalent to $75 million face value. In exchange for the titles, the Central Bank returned more than $35 million in local currency bonds that were very liquid (short-term maturation period). Therefore the donors almost tripled the value of their contribution, while the government reduced its foreign debt. Since the government was not allowed to buy its own commercial debt, the National Parks Foundation played a key role because the debt was purchased through NPF.

The magic of the debt swaps created two large endowment funds, one for Guanacaste National Park managed by NPF, and another one for forestry managed directly by the governments of the Netherlands and costa Rica.

Evolution of forest incentives to PES

Costa Rica experimented with a wide variety of financial instruments including soft loans, a fiscal incentive program, the CAF forestry certificates, as well as other measures like restricting forest permits and promoting sustainable forestry. In fact, in 1985 the Central Bank had approved a debt-for-equity swap for a company that was going to do sustainable forestry. Although a wide variety of incentives were implemented, they had limited success in stopping deforestation and encouraging reforestation. Nevertheless, these early incentives provided the experience and lessons, as well as paving the way for the creation of the program of payment for ecosystem services.

A new Forestry Law 7575 was approved in 1996 and introduced new mechanisms and instruments. First, it banned conversion of forest lands punishable by prison sentences rather than fines, effectively lowering the opportunity cost forest conversion to pastures or agriculture. And second, it introduced payments for protecting the forests, managing forests sustainably or undertaking reforestation projects, effectively creating the basis for the PES program.

The forestry and biodiversity laws use the term “environmental services” and Forestry Law 7575 defines four different categories of services:

- Carbon sequestration, capture and long-term storage of carbon dioxide.
- Hydrological services, water and protection of water catchment areas.
- Biodiversity conservation and sustainable use.
- Scenic beauty, aesthetic values.

Through the National Forestry Financing Institute (FONAFIFO), also created by Law 7575, PES became operational in 1997 and it is the primary institution created to manage the PES system. The system is land-based and FONAFIFO signs 5 year contracts with individual private forest owners, with a priority to those that hold clear land titles, agreeing either to maintain existing forests or undertake reforestation. Forest engineers monitor compliance on a yearly basis.

In exchange for the payments, the landowners transfer the "rights" to the ecosystem services to FONAFIFO, who acts as a wholesale intermediary for these services. Initially, it was expected that an international carbon market would develop quickly and that the credits held by FONAFIFO could be sold in these international markets. However, this assumption turned out to be wrong and Costa Rica has only sold $2 million in carbon to Norway, in an effort to spark the private carbon market.

Structure and design of PES: institutional architecture, complementary policies

The PES program started on a first-come first-serve basis and the challenge was to get people to enroll, so during the first phase there was no targeting. An important source of support came from a World Bank loan and GEF grant to develop and provide financing complementary to that provided by the government. The main source of support from the government came in the form of a 3.5% tax on fuels that is managed by FONAFIFO. There would be a follow-up loan with the World Bank, known as Ecomarkets II that had similar structure and provided advice on targeting biodiversity corridors and introduce a differential payment for water. Initially only carbon sequestration was valued, and land areas that are important sources of water did not receive any additional payment. This was changed later through differentiated payments.

FONAFIFO relied on existing NGO's like Fundecor, a foundation established with AID funds to work on the Central Volcanic mountain range, and other cooperatives and regional agricultural centers to act as intermediaries to reach their associates, which were the individual landowners. These intermediaries provided technical assistance and monitoring of the projects.

The program was regionalized from the beginning and FONAFIFO established seven offices throughout the country to be able to handle, and decide on individual applications that would get funds from the Finance Ministry, loans and grants to run the program. In 2009 the Comptroller General decreed that FONAFIFO should be integrated directly into the government structure, which resulted in an increase of personnel (from 60 to over 80) due to government regulations related to procurement and other issues.

The PES program has received widespread attention due to the fact that it was, and still is, the world's only country-level program, open to anyone with suitable land, across Costa Rica. The PES approach has been widely criticized and debated by researchers and academics. Some

considered that it was redundant and did not have a clear focus, other argued that it had little value in stopping deforestation, while others considered that that it was a necessary to keep standing forest due the low level of enforcement. For a more detailed discussion, the reader might consult a publication on "Learning from 20 years of payment for ecosystem services in Costa Rica" (Porras, et al, IIED, 2013).

One important fact to have in mind is that PES was not acting alone. There were a number of critical complementary policies. They most important was the creation of the system of national parks and protected areas, initially by decree and later ratified by Congress, so only Congress can revert national parks. Costa Rica has invested hundreds of millions of dollars in the purchase of inholdings and the management of the park system, recognized as one of the best in the world.

A second one was the ban on land-use change from forestry to pasture and agricultural lands. Another had to do with the establishment of private conservation reserves of which there more than 200 in Costa Rica. A shining example is the Monteverde Reserves, which are all technically private and were started by U.S. Quakers (a religious group) in 1954. The area received critical support from Swedish children and many others and another two private reserves, the Eternal Children's Forest and the Santa Elena reserve, have been established with private contributions. They are run by NGO's, in one case by the Tropical Science Center, established 55 years ago and the oldest scientific and conservation NGO in Costa Rica.

A third key complementary policy was the ban on sustainable forestry and the decision that only educational, research and tourism activities could be carried out in protected areas. It is difficult to weigh the relative importance of these measures, which also contributed to slowing and eventually reversing the deforestation process, so we cannot isolate the impact of PES.

The PES program started as an experiment because a political window of opportunity opened when the Figueres administration (1994-1998) had agreed to a 5% tax on fuels for PES (later the tax figure was lowered to 3.5%). It is also a fact that the Finance Ministry exceeded its counterpart contribution to the World Bank loans, so its support has been invaluable. Although it cannot be formally considered a carbon tax, since CR does not use coal, it is a good proxy. It has the additional advantage that the revenues go to forest protection and reforestation; in that sense it is unique.

The PES has been the subject of considerable attention, analysis and criticism. It was not a program designed from scratch by researchers. It was a political and institutional experiment that evolved with time, so the design was far from perfect. However, the program has become much more focused and evolved considerably since its inception over 20 years ago.

The reversal of tropical deforestation in Costa Rica is one the product of many policies acting together, and the PES has played a key role, having had the political support of all governments

since the early 1980's This continuity has been essential to the success of the program. It is undoubtedly an achievement that has served as an example to other programs like those and Mexico and Ecuador. Over 80 countries have sent delegations to Costa Rica to study this effort.

Financing and impact of the PES program

The program has been financed primarily by the government through earmarked tax revenues (3.5% tax on fuels, equivalent to $12-16 million per year depending on oil prices) and two World Bank loans totaling over $80 million as well as grant contributions from the GEF and KFW of Germany. Costa Rica is the only country to have financed such a program with loans.

There is also a water fee that started to be charged in 2006 when taxes were increased with 25% of collections destined for PES in strategic water catchment areas, and contributions from the private sector. There is one municipal water company, Empresa de Servicios Publicos de Heredia (ESPH), that has incorporated PES in their rate structure and actually charges a fee to customers. Some private hydroelectric projects also contribute, but only about 3% of the program is financed by private funds.

Today FONAFIFO has a staff of around 90 people, including the regional offices that continue to run the PES, and is a decentralized organ of the Ministry of Environment and Energy (MINAE).
It operates directly with the Finance Ministry, and has other sources of international funding and the capability to create other funds. This was achieved through the Ecomarkets II program, which included a clause creating an environmental bank foundation (FUNBAN) that can create funds like the Sustainable Biodiversity Fund.

The international carbon markets were an important target for FONAFIFO, and the initial $2 million transaction with Norway led to "Certified Tradable Offsets" (CTO's) as the carbon credits were known at the time. These CTO's were offered in the Chicago Climate Exchange but never sold. The international carbon markets were a disappointment because the official markets failed to develop. The forestry issue became very complex in the climate negotiations, so official transactions were not possible, and the voluntary markets offered very low prices. In fact Costa Rica's internal price, estimated to be near $8 per ton of carbon dioxide equivalents, always exceeded the voluntary international carbon markets by almost 50%. A REDD+ market, which is consistent with what Costa Rica's PES can provide, basically all four biodiversity services, has failed to materialize.

The PES program focuses on five types of private land: 1) forest protection 2) commercial reforestation 3) agroforestry 4) sustainable forest management and 5) regeneration in degraded areas. As it was mentioned earlier, option 4 related to sustainable forest management was not implemented. These types of land use served as a proxy for providing the four ecosystem services mentioned earlier. Water recharge areas were recognized and a differential payment system

introduced. For example, the basic payment is $64/ hectare per year for a period of five years. Originally this payment was calculated based on the opportunity cost of cattle ranching as an alternative. Properties located in conservation gaps receive $75/hectare per year and those in water recharge areas receive $80/hectare per year.

Today, the program has become more focused and applications are ranked on a point-based system. There are many more applicants than the program can handle and only three out of every ten applicants make it to the program. This is mostly due to legal and financial constraints.

The yearly cost of the program has been in in the $15-20 million. An important feature of the program is that about 10% of the beneficiaries are indigenous communities that apply to the program as a community, not as individual landowners. During the last 5 years, this has resulted in a transfer of more than $25 million to these communities, who use the funds to build schools or health centers.

Other important beneficiaries have been conservation projects outside formal protected areas, run by private funds as is the case of the Guanacaste Dry Forest Conservation Fund, which receives PES for a portion of the lands they have bought for conservation in the areas surrounding parks in the Guanacaste area. We will consider this case next in the Guanacaste Conservation Area.

The Sustainable Biodiversity Fund (SBF) is a key innovation and it was created with grants from the GEF and later the German Cooperation Bank (KFW) ($7.5 million each), as well as local contributions from green credits cards and compensation schemes for clean travel. The SBF was capitalized to a level of $18 million and in 2016 started making payments for biodiversity in hotspot areas. The SBF is attempting to work with specialized conservation groups, for example birdwatchers, to establish a mechanism whereby private contributors could support PES biodiversity payments in biological corridors or hotspots.

There has been a considerable number of publications dealing with PES and showing how it could be improved. They show how the Costa Rica PES program served as a template for better designs. However, as the 20 year evaluation of PES points out, there is overall agreement on the positive nature of the program, as Porras et al. (2013) point out in their assessment:

“The program has had positive impacts since its inception. Between 1997 and 2012, it has protected more than 860,000 hectares of forest, reforested 60,000 hectares and supported sustainable forest management in almost 30,000 hectares. More recently it promoted natural regeneration of almost 10,000 hectares. This totals nearly one million hectares under the PES scheme at one time or another, as well as 4.4 million trees planted under agroforestry systems since 2003. This is a substantial achievement for a developing country of just 51,100 square kilometers. By 2010, roughly 52 percent was under some sort of forest cover…”

Overall, Costa Rica has invested over $400 million on this program over the course of almost 20 years, purchasing ecosystem services from over 16,000 private providers including indigenous communities (around 10% of the program). This is a highly significant achievement for a small developing country, and consistent with its comparable conservation investments.

The Guanacaste Conservation Area (ACG)

The Guanacaste Conservation Area (ACG) is one of the most ambitious ecological restorations in the world. Encompassing 1260 square kilometers (almost 2.5% of Costa Rica's land area), in includes tropical dry forest, rain forest, cloud forests and 430 square kilometers of marine protected areas. It is home to 375,000 macrospecies, which represent two thirds of Costa Rica's biological diversity and 2.4% of Earth's (Pringle, 2017).

It grew from the original Santa Rosa national park, one of Costa Rica's first generation of national parks declared in 1971 by President Jose Figueres. In 1980, President Rodrigo Carazo added another park, Murcielago, which was expropriated from the Somoza family. This left a wedge in the Santa Elena Peninsula, the 12,000 hectare Hacienda Santa Elena, where an illegal airstrip was built in 1986 and led to a confrontation between the Costa Rican government, led by President Arias, and the Reagan administration which was trying to covertly support the Contras. For a detailed account of the history of Guanacaste National Park Project see Umaña (2016).

Tropical dry forest is one of the most endangered life zones in Mesoamerica, and the Guanacaste National Park Project (GNPP) was intended to protect the largest remaining tract of dry forest from California to Panama. The project needed to be large enough to maintain habitats for healthy populations of all animals and plants that are known to have originally occupied the region, and to contain enough duplicate habitats to allow intensive use of some areas by visitors and researchers. The effort included the restoration of large areas of species-rich and habitat-rich tropical dry forest, and the main mechanisms utilized were fire control by managers, grass control by cattle, and tree seed dispersal by wild and domestic animals. In addition to being a major cultural resource, the park has made significant scientific contributions, developed the concepts and practice of "para-taxonomists", and "bioliteracy", focusing on all schoolchildren that inhabit the conservation area.

Para-taxonomists are hybrids between cultures that have traditionally been apart and unable to talk to or work with each other. On the one hand they are in the world of science, communicating and providing new data to global experts on taxonomy and ecology. On the other hand, they are members of their communities without official scientific credentials: peasants, school parents, churchgoers, etc. Para-taxonomists are trained to collect specimens and many acquire impressive scientific and practical knowledge, and it is not unlikely that their sons and daughters will end up

as professional biologists. For example, Roger Blanco, the coordinator of the ACG research program is a graduate of the first para-taxonomists course in 1989.

The second area in which the ACG has made important innovations is in their bio-literacy efforts, supported by GDFCF and the national school system in the area. This program started in 1987 with students from fourth, fifth and sixth grades, teaching them the essentials of biodiversity conservation as well as how they can use it to improve their livelihoods.

Building on this basis, the ACG has benefitted from the long-term intellectual and scientific leadership of biologists Daniel Janzen and Winnie Hallwachs. Today the ACG includes the entire Santa Elena Peninsula in Northern Costa Rica and reaches all the way to the Rincon de la Vieja and Miravalles national parks, and stretches in the wet Caribbean rainforests. The original proposal for GNPP was for a total of 82,500 hectares, and a total cost, including land purchases, of approximately $12 million. Today we can be proud to see that the land area target has been exceeded by a factor of two, and over five times in terms of resources donated.

The ACG received critical political and financial support from the Arias Administration (1986-1990). Since then the ACG has utilized a variety of financial mechanisms and both public and private funds and contributions. A critical boost came from Sweden in 1988, which provided a $3.5 million grant which was used to purchase $24.5 million of Costa Rica commercial debt, for which the Central Bank provided $17 million in liquid government bonds. This transaction was executed through the National Parks Foundation (NPF) and created a trust fund that has provided additional support to ACG throughout almost thirty years. This fund is almost entirely exhausted.

The ACG has also been the recipient of funds from the two bilateral debt-swaps that Costa Rica has done with the United States under the Tropical Forestry Conservation Act (TFCA). Costa Rica obtained $26 million for conservation from the first operation in 2007. This operation included a grant for land purchases in the ACG. The second one in 2010, for $27 million to create the Costa Rica Forever Fund (CRFF), which will be considered later. These debt-swaps also leveraged private funds, $2.5 million in the first transaction and $3.9 in the second one. The ACG has laso received funds from the CRFF.

Another important landmark was the creation of the Guanacaste Dry Forest Development Fund (GDFCF), a tax-exempt organization incorporated in the United States to raise funds for the ACG. The GDFCF has been capitalized by private donations to a level of $13 million and provides from $1 to 1.5 million per year to support activities in the ACG. The GDFCF has bought lands around the Rincon de la Vieja national park and stretching into the Caribbean rainforests.

The lands owned by GDFCF have also been long-standing beneficiaries of the national PES system and they presently receive approximately $120,000 in PES payments for these lands. This shows

how closely interconnected the objectives of PES and conservation have been, with PES providing significant resources to these private wildlands.

In addition to the scientific, educational and cultural contributions, the ACG provides considerable economic benefits in a variety of ways. The ACG is the most important source of water for the entire Guanacaste province, the driest in the country. It also serves as gene and seed bank for dry and wet forest plants and animals. It provides examples of watershed protection, examples of reforestation and natural regeneration technologies and sites for ecotourism and conventional tourism.

Overall, over one hundred have been purchased by the ACG or GDFCF since 1986, all of them voluntary transactions. The case that stands alone is that of Hacienda Santa Elena, where it was never possible to reach an agreement with the owners and was sent to international arbitration.

Dan Janzen estimates that from 1985 to 2015, a thirty year span, the "off-the-shelf" cost of ACG has been approximately $107 million, excluding efforts related to the National Biodiversity Institute (INBIO). The Costa Rican government made a contribution equivalent to $17.5 million through the debt-swaps and then had to pay $16 million for Hacienda Santa Elena, for a total of $33.5 million. In turn, external fundraising efforts have yielded over $65 million. This impressive figure is almost twice as much as the government contribution, so in effect external donors matched Costa Rica's contribution on a two-to-one basis.

Even more remarkable is the fact that this effort has been the result of a partnership between the government, national and international NGO's, and key donors. In total, there have been more than 15,000 individual donors to this project, supporting this as a global restoration effort. Its network also includes over 300 Costa Rican government specialists and forty para-taxonomists.

Currently, the ACG has a staff of approximately 100 people, plus the para-taxonomists which are paid the GDFCF. It operates with a $4 million budget from the park system, plus more than $1 million from GDFCF including the PES payments. The ACG also operates 11 biological stations.

As far as scientific contributions, the ACG has built a network of 400 taxonomists from all over the world that have participated in the biological inventory of the ACG. The number of in-country researchers, students and volunteers easily surpasses 2,000. Over 1,000 scientific papers have been written about or invoking ACG. For example, on the inventory of *Lepidoptera* and their parasites, researchers at ACG have found over 5,000 new species of butterflies, moths, or their parasites. The intense inventory of Lepidoptera now ongoing has already identified 10,500, of a new total estimated of 15,000 species, which is equivalent in number to those found in 70 percent of the US and Canada combined.

Genetic analyses have been performed on over 400,000 insects. This process uses a small section of the DNA, just like supermarket bar code to identify the organisms, representing 12,500 species of moths and butterflies. This new DNA bar-code catalogue is now used by scientists to refine traditional taxonomy.

The ACG has benefitted from a number of innovative financial instruments, most prominently both commercial and bilateral debt swaps that created funds targeted to support the project. In addition the creation of GDFCF, as a private foundation dedicated to support ACG is also a unique feature of this critical effort that spearheaded the development of other conservation areas in Costa Rica.

The Costa Rica Forever Association

The Costa Rica Forever Association is one of the most recent types of conservation focused institutions that have characterized Costa Rican conservation. It administers the Costa Rica Forever Irrevocable Trust Fund and the II Debt-for-nature swap between Costa Rica and the United States. Together these resources amount to approximately $56 million. It is worth noting that it is an association under Costa Rican law, not technically a foundation, although it operates in ways similar to a foundation, like having requests for proposal for different activities.

The Forever Costa Rica program was developed by a public-private partnership with the Costa Rican government, The Nature Conservancy, the Gordon and Betty Moore Foundation and the Linden Trust for Conservation. This enabled the establishment of a permanent mechanism for provision of resources for its activities. At the same time the Costa Rica Forever Association manages the resources and monitors the program's implementation.

The association has signed a five-year agreement with SINAC, the entity that manages the system of protected areas, to define priority areas for its work program. This strategy is based on scientific analysis of the protected areas and their gaps and focuses on:

1. Closing the gaps in ecological representativeness
2. Increasing management effectiveness
3. Identifying and incorporating adaptation and mitigation activities related to biodiversity in the terrestrial and marine protected areas vulnerable to global climatic variability
4. Establishing a sustainable source of funding for existing and/or future protected areas

Costa Rica's conservation had traditionally prioritized terrestrial protected areas, although a marine conservation area was part of the Santa Rosa national park declaration in 1971, and over 200 square miles of marine park were added in that same area in 1987. Nevertheless, the design and development of marine protected areas had lagged their terrestrial counterparts. Through the establishment of Costa Rica Forever, the country had the resources to assume the challenge

of doubling the size of the marine protected areas. Efforts were also undertaken to improve the management of both terrestrial and marine protected areas, to secure permanent financing for these systems in perpetuity, and prepare them to adapt to the challenges of climate change.

In June 2007, President Oscar Arias launched his visionary "Peace with Nature" initiative, which encompassed several environmental initiatives like the Carbon Neutrality proposal. At the invitation of the President, the Linden Trust for Conservation established a partnership the Betty and Gordon Moore Foundation and The Nature Conservancy to work with the government in one of its initiatives: the creation of a long term mechanism for funding the nation's protected areas. Later the Walton Family Foundation joined the effort.

A salient feature of Costa Rica Forever is that it is structured as a deal from the highest level of government and its private partners. At the more transactional level, the deal is expressed in terms of the "single closing" that took place on July 27, 2010 and launched implementation. The "single closing" technique has the benefits that it motivates the donors by creating leverage and a sense of urgency; it ensures that all the project objectives are fully funded; and it ensures that key governmental actions are taken before the funds are released. Once the project had met these milestones, a trustee, a Costa Rican NGO was established to fulfill this role. This effort was partly modeled on two predecessors: the Great Bear Rainforest project in British Columbia, and the Amazon Region Protected Areas project in Brazil.

The Costa Rica Forever Association is the administrator of the Second Debt-for-Nature Swap between Costa Rican and the United States under the Tropical Forestry Conservation Act. This bilateral agreement provides funding for the consolidation of the system of protected areas, within the framework of the commitment assumed by the Government of Costa Rica with the UN Convention on Biological Diversity. The thematic areas included in this program include ecological representativeness, management effectiveness and adaptation to climate change. The resources made available through this bilateral debt swap amount to $27 million.

As far as governance, the Oversight Committee is the highest body governing this Second Debt-for-Nature Swap, and it is composed of five members: the Government of Costa Rica, represented by SINAC, the Government of the United States, the Nature Conservancy, Earth University and the Organization for Tropical Studies (OTS).

One of the large impact projects that has been undertaken by the Costa Rica Forever Association was the installation of a radar in Coco's Island national park. The radar included the installation of a 30 meter tower as well as a mini-hydroelectric plant to power the radar installations on a 24 hour basis. This project posed quite a significant challenge in terms of institutional coordination because it required coordination of several ministries including environment and energy, transportation and public security, the protected area itself, the national electric institute ICE, the national power and light company (CNFL) and the Costa Rica Forever partners. This project

was concluded in 2016 and it represents an important advance in protecting the area against illegal fishing, which is still a common threat.

Another feature of the operational strategy of Costa Rica Forever is the calls for proposals to develop management plans in key marine protected areas. A joint effort between the Costa Rica Forever association and the Arenal Tempisque conservation area was the effort to save the Palo Verde lagoon, a biologically valuable wetland, from invasive species. The integrated plan proposes actions in the 3,150 hectare of wetlands in the parks between 2013 and 2018. By 2018, the Costa Rica Forever Association will have intervened 300 ha in the Palo Verde Lagoon with funds from the Save Palo Verde campaign. Another recent undertaking, along with key media companies in Costa Rica was the All Onboard Campaign to buy an interceptor boat to pursue illegal fishing in Coco's Island.

Pacifico is a platform for environmental funds for the Tropical Eastern Central Pacific, from four countries: Costa Rica, Panama, Ecuador and Colombia. Its purpose is to contribute to the sustainable conservation of the Tropical Eastern Central Pacific. This partnership of funds from several funds is innovative and required to deal with problems of marine conservation.

The Costa Rica Forever strategy is based on maintaining a permanent dialogue with the government, as the main partner in the implementation of conservation goals. They are also focused on implementing high impact private sector initiatives across a range of intervention strategies.

During the last three years they have funded studied to increase the management effectiveness of 49 protected areas with an investment of $2.25 million, in addition to the consolidation of a national ecological monitoring program.

Other environment related funds

During the Monge (1982-1986) administration, U.S. aid to Costa Rica had been very high, on the order of $200 million per year. When the U.S. Agency for International Development (AID) left Costa Rica in 1989, it had considerable funds deposited in Costa Rica Central Bank and several trust fund were created. These include trust funds for Earth University, CATIE, the US-Costa Rica foundation and Fundecor.

Fundecor was a foundation created to support activities in the Central Volcanic mountain range. Fundecor has also acted one of FONAFIFO largest regional partners in the PES program in the Sarapiqui area. The fund was capitalized with $9 million and the philosophy of this fund was to maintain its value, so today it has almost doubled to $17 million, providing on the average an average allocation of $1 million per year for part of the operational costs of the organization.

Over the life of the organization, the trust fund has provided resources to the organization of approximately $17 million, equivalent to the corpus of the trust fund.

CATIE, the Tropical Agronomic Center for Higher Education and Research, located in Turrialba has an endowment fund of approximately $13 million and uses the returns to support its educational and research programs.

The funds created by AID have a more complex governance architecture. In addition to the Boards of Directors of their respective organizations, there is a separate committee to oversee the funds and make yearly allocations. In general, the funds set up by AID for Earth University, Fundecor, CR-US foundation and CATIE have been successful and continue to yield benefits.

We have seen how Costa Rica has utilized a large variety of funds, each with a unique history and governance mechanism, almost always combining public sector, both national and international NGO's and private sector.

Conclusions

During the last thirty years, the utilization of innovative financial instruments for conservation has been critical to complement strictly governmental efforts. The commercial and later bilateral debt-swaps make Costa Rica one of the countries that has utilized this novel mechanism more intensely to increase the support of conservation and PES efforts. For example, Costa Rica is the country that has benefitted the most from the Tropical Forestry Conservation Act, having executed two debt-swaps under the agreement.

In fact, debt-for-nature swaps have been a salient characteristic of Costa Rica's conservation efforts and have led to the creation of a variety of trust funds: both public and private with a variety of governance mechanisms. In order to accomplish this, Costa Rica has established many different partnerships, with donor governments like Canada, Holland, Spain, Sweden and the US. In addition to the debt-swaps with the U.S., Costa Rica also executed bilateral debt-swaps with Canada and Spain that also led to additional trust funds.

The partnerships have included all major international NGOs (Conservation International, TNC, WWF, etc.) and private foundations and individuals, who have often supported Costa Rica in developing innovative initiatives. Other critical support has come from US private foundations like the Tinker, MacArthur and W. Alton Jones Foundations, which have played a key role at critical times.

Another key pillar has been the ability to establish partnerships with scientists and conservationists throughout the world, aided by organizations like the Organization for Tropical Studies (OTS). OTS has taken thousands of biologists to its courses at La Selva and throughout the

country for many years, and continue to do so. In fact, most tropical biologists throughout the world have been to Costa Rica at one time or another.

Many of these have been long-time friends and some have become Costa Rican citizens, such as the U.S. Quakers who started the Monteverde Reserve in 1954. Another salient example is the case of Leslie Holdridge and Joseph Tosi who established the Tropical Science Center (TSC) 55 years ago. TSC is the oldest and one of the most prestigious conservation NGO's in the country. Holdridge and Tosi both became Costa Rican citizens and made huge contributions in terms of conceiving the system of protected areas. In addition, Holdridge's farm in Sarapiquí became La Selva Biological Station, since operated by OTS. Other prominent examples of these partnerships exist in the ACG with GDFCF, as well as in the Osa Peninsula, with a NGO named Osa Conservation, which buys land for conservation and works on educational and training issues.

In summary, Costa Rica has experimented with a large number of financial instruments, and it has often blended public and private funds to accomplish conservation objectives. Many of these have been highly successful and have provided the resources and stability for critical projects. No assessment of forest conservation efforts would be complete without an analysis of how these efforts have impacted rural communities. Since Costa Rican law allows for only limited development inside the national parks, the communities surrounding the parks provide many of the services in terms of food and lodging, as well as other eco-tourism opportunities like bird-watching, white-river rafting and adventure tourism. A study by CATIE has shown that communities surrounding national parks have at least 10% more income than other similar communities.

The PES system can also be considered as a fundamental effort to transfer resources to rural areas and a large part of the program was administered through cooperatives or community agricultural centers. Over 10% of the program has gone to indigenous communities, who hold their land communally and also apply the program based on their priorities like schools or health centers.

Recommended key references

The Gordon and Betty Moore Foundation, The Linden Trust for Conservation, the Walton Family Foundation, The Nature Conservancy "Forever Costa Rica" July 2011.

FONAFIFO, 2015, *Annual Report 2015*, San José, Costa Rica.

FONAFIFO, 2017. Personal Communication.

Perez, Isaac and Alvaro Umaña. 1996. "El Financiamiento del Desarrollo Sostenible" INCAE.

Porras, Ina, David Barton et al. 2013. “Learning from 20 years of payments for ecosystem services in Costa Rica” IIED, London.

Umaña, Alvaro. 1990. “Costa Rica’s Fight for the Tropics”, *Encyclopaedia Britannica Science Yearbook*.

Umaña, Alvaro. 2016. “Point West: The Political History of Guanacaste National Park Project” CLAVE CRUSA, San José, Costa Rica.

9. BLENDED MECHANISMS: PUBLIC AND PRIVATE SECTOR PAYMENTS FOR ECOSYSTEM SERVICES: INTEGRATION, VALUATION, TARGETING AND EFFICIENT DELIVERY IN THE UK.

Ian Bateman, Amy Binner, Brett Day, Carlo Fezzi, Alex Rusby, Greg Smith, Ruth Welters

Introduction

We demonstrate how different payment mechanisms can stimulate the efficient delivery of key, high-value ecosystem services which are either not produced, or are under-produced, by the normal operation of the market. Two payment mechanisms are considered: payments from the public sector to private businesses; and payments between private businesses. Public to private funding provides the most common Payments for Ecosystem Services (PES) mechanism in the UK and most other countries. By contrast private to private (i.e. business to business) PES mechanisms remain relatively novel; yet, because they tap into private sector funds, they have great potential for incentivising environmental improvements, particularly in cases where there is a profit opportunity arising from such improvements.

Permutations of these mechanisms are illustrated through three case studies: (i) public to private funding of natural capital improvements for national level decision making (referred to as the "national level case study"); (ii) public to private funding of natural capital improvements at catchment level (the "catchment level case study") and; (iii) business to business funding of natural capital improvements again at a catchment level (the 'business to business' case study). Together these form a matrix of decision level and funding source exemplars which provide wide applicability.

The UK and Natural Capital

The term natural capital refers to those stocks of assets, provided for free by nature which, either directly or indirectly, deliver wellbeing for humans. These assets include stocks of freshwater water, fertile soils, clean air and living things. Natural capital stocks in turn deliver flows of services, called ecosystem services, which (often in combination with flows from other capital including human labour, ingenuity and manufactured goods) produce the benefits upon which humans depend for economic wellbeing and indeed their very existence. Economic activity both draws and depends upon natural capital whilst also affecting the stock of those assets.

This intimate relationship between the environment, the economy and human wellbeing has prompted the UK Government to adopt the overarching policy goal to be "the first generation to leave the natural environment in a better state than it inherited.". As part of this ambition, the UK has invested in research seeking to develop a 'natural capital approach' to decision making, which explicitly recognises the dependence of economic value and wellbeing on the natural capital stocks provided by the environment and the ecosystem service flows which those assets provide.

To help guide this process, the 2011 Natural Environment White Paper set up the world's first independent Natural Capital Committee to advise on the restoration and improvement of natural capital as a means of sustaining and enhancing economic growth in the UK. Importantly, while it has a close relationship with the UK's environmental department (the Department for Environment Food and Rural Affairs), the Natural Capital Committee (NCC) actually reports to HM Treasury, the UK's finance ministry. Indeed, the UK's Chief Finance Minister, the Chancellor of the Exchequer, chairs the Economic Affairs Committee which the NCC formally advises.

At an institutional level, therefore, the UK explicitly recognises the role of natural capital within economic growth. The NCC has reported extensively on methods to 'mainstream' consideration of natural capital into both policy and business decision making. Furthermore, it has also provided extensive advice on the valuation, accounting and financing of natural capital enhancement.

Mainstreaming Natural Capital: The Drivers of Change

Mainstreaming natural capital involves bringing nature's stock and flows of goods and services into decision making. A key element of this is to provide decision makers with an understanding of the factors that drive change in natural capital resource use. A common failing is that analyses consider the advantage of moving from current to alternative resource use without consideration of how the move between these two states is to be effected. For example, in the case of land-use it is relatively easy to demonstrate that a move from current intensive agricultural production practices to lower input systems will deliver improvements to water quality, greenhouse gas (GHG) emissions, wildlife habitat, greenspace access etc. These advantages are often rigorously demonstrated, however without guidance as to how such change should be delivered.

Box 1: The Drivers of Change

Changes in human use of natural resources are driven by a variety of factors. These can be grouped as follows:

1. Socio-economic and market forces including:
    a. Demand and supply of goods
    b. Related prices of outputs and costs of inputs
    c. Technology and its impact on the production process, in particular its effects upon costs

2. Policy drivers including:
    a. Regulations – e.g. The EU Drinking Water Directive which regulates the levels of pollutants deemed safe in drinking water.
    b. Subsidies – e.g. The Common Agricultural Policy whose payments are in excess of £2.5billion per annum in the UK, a sum which represents more than half of farm income in a typical year (National Statistics, 2017).
    c. Taxes – e.g. The Landfill Tax which is paid by a business to get rid of waste using landfill sites. The standard rate is currently £84.40 per tonne.
    d. Payments for Ecosystem Services (PES) – e.g. Countryside Stewardship provides grants to foresters and land managers for creating and managing woodland to sustain and increase the public benefits from woodlands.
    e. Other incentives – e.g. The European Union's Emissions Trading Scheme created a market to enable the trading of Greenhouse Gas emission allowances to reduce emissions across Europe.

3. Natural environment drivers including:
    a. Spatial variation (the changes in the natural environment and its ecosystem services across locations) including:
        i. Immediate environment of production area
        ii. Soil types
        iii. Rainfall
        iv. Temperature
        v. Wider environment (catchment conditions)

    b. Temporal variation (the changes in the natural environment and its ecosystem services across time) including:
        i. The dynamics of certain wild species populations such as pollinators.
        ii. On-going climate change and its myriad impacts

Given this, the chapter begins with a case study explicitly tackling this challenge. It acknowledges that land-use change is driven by a wide array of forces which can be gathered together under three broad headings; socio-economic and market forces, policy drivers, and environmental drivers, as overviewed in Box 1.

Any study that fails to provide analysis of the drivers of change simultaneously fails to provide decision makers with clear guidance regarding the strategies and policies they should adopt to bring about desirable change. Understanding the drivers of change and the consequences brought about by policy decisions is arguably just as important as demonstrating the benefits of preferred states.

Decisions, trade-offs and valuation

If decision makers are interested in the overall impact which changes will have upon society then appraisals need to consider all of the impacts of an investment. A substantial challenge to comprehensive assessment of investments which affect natural capital is that impacts are often most naturally measured using an array of differing metrics. So, flood control is most obviously assessed in terms of risk per household, drinking water quality in mg/litre of pollutants, greenhouse gases in tonnes of carbon equivalent, recreation as the number of visits, and so on. These measures are typically non-commensurate; for example how many recreational visits should be given up to sequester an additional tonne of a given greenhouse gas? It is effectively impossible to trade-off ecosystem services without making them commensurate.

Given that the overall objective of natural capital investments is to improve wellbeing, then the logical approach to commensurability is to assess the extent to which each trade-off contributes to wellbeing (either positively or negatively). What is the best unit with which to assess changes in wellbeing? Ideally, we would want a pure unit of wellbeing. Absent this, using money as a unit of wellbeing has important benefits for making commensurate the multiple trade-offs associated with natural capital change. Money is not the perfect common unit; conversion problems among diverse benefits abound, but these are even more challenging when other units are used.

The long term failure to assess the benefits of investing in the natural environment in monetary terms has coincided with long term over-use and degradation of natural capital. Is this pure spurious correlation, or at least in part causality? By insisting that environmental investments are assessed in a myriad of non-economic, non-commensurate terms, the wellbeing generated by such investments cannot be compared with that of the other spending a government undertakes. This has resulted in the environment being seen as a net cost yielding little obvious benefit.

While marketed goods are often valued with reference to their prices, a range of methods have been developed for valuing non-market goods, broadly divided into three categories: production function methods; revealed preference methods; and stated preference methods.

While the majority of environmental costs and benefits can be robustly assessed using economic values, a few remain particularly challenging – especially the valuation of impacts on wild species and biodiversity. While some benefits of biodiversity are readily measured, biodiversity also generates non-use value; the value that individuals enjoy simply from the knowledge that wild species continue to exist and will be bequeathed to future generations. The

lack of output effects or observable behaviour means that production function and revealed preference methods are not applicable to estimating non-use values. In theory, the non-use values associated with biodiversity can be directly estimated using stated preference methods such as contingent valuation and choice experiments. In practice, such exercises face severe challenges, such as low awareness and poor understanding of what biodiversity means for human well-being.

In the UK, extensive survey and legal evidence shows that people hold high values for avoiding the loss of wild species. This provides us with a simple yet effective way of incorporating this preference information into decision analyses: we require that any potential change to natural capital should avoid any losses in wild species. This approach is applied in practice within our national level case study.

Three UK cases

The rest of this chapter presents three case studies of natural capital decision making. Our initial, national-level case study examines alternative land-use futures to 2060. It highlights the advantages of valuing both the market and non-market effects of change and the importance of spatially targeted policies and. This example also illustrates the importance of understanding the drivers of change, thereby allowing decision makers to see where a shift in a particular policy is likely to result in changes in land-use, ecosystem services and values. The second, catchment-level, case study examines the chain of drivers and knock on behavioural responses triggered by climate change and the resultant impacts on land use and its various benefits. Our third and final, business to business, case study presents a novel approach to the funding of natural capital change showing how mutually beneficial business to business payments can be used to enhance private profits through the delivery of environmental improvements.

Case 1. Public to private funding of natural capital improvements: National-level decision making

Description of the problem

In response to the Millennium Ecosystem Assessment (2005), the UK's major response was through its National Ecosystem Assessment (NEA) -- the first comprehensive assessment of the country's ecosystems and a systematic environmental and economic analysis of the benefits they generate. The NEA sought to assess the consequences of natural capital use and land-use change and showed that *over 30% of the services provided by the UK's natural environment are in decline.* The NEA data provided highly detailed, spatially referenced, time series, environmental data covering all of Great Britain, ranging from soil characteristics (e.g. susceptibility to water logging), climate variables (e.g. temperature and rainfall) and land-use (e.g. agricultural output). This was complemented by similar spatially and temporally referenced data on market variables (e.g. prices and costs) and policy (e.g. incentives such as subsidies, and regulations such as land use constraints).

The resultant analysis linked environmental, policy, market and other economic factors to examine both the market and non-market consequences and values generated by land use changes. The spatially sensitive nature of these analyses also demonstrated how future policy can be targeted to most efficiently allocate available resources to maximise their net benefits.

Biophysical explanation of the relevant ecosystem services in the specific case

The different ecosystem services in the analyses were a mixture of market, non-market and cost-effectiveness valued services:

- Food output provides the key, market valued, ecosystem service determining approximately 75% of land-use in the UK, including cropland, grassland, mountain, moor and heathland environments.
- The sequestration of greenhouse gases (GHG) has a non-market value and includes the direct and indirect emissions from land use and land management, annual flows of carbon from soils due to land-use changes, accumulations of carbon in terrestrial vegetative biomass and emissions.
- Open-access recreational visits have a non-market value which varies across environments (e.g. mountains, coasts, forests, urban greenspaces, city centres etc.) and locations (with visitation declining with increasing distance from populations).
- Urban green space has a non-market value reflecting aesthetic, physical and mental health, neighbourhood, noise regulation and air pollution reduction benefits.
- Wild bird-species diversity was used to represent the biodiversity across the UK because they are high in the food chain and are often considered to be good indicators of wider ecosystem health.

Identification of the beneficiaries

The same change can yield very differing consequences to different groups. Both the market and non-market services benefits farmers, foresters, recreationalists, wildlife enthusiasts, etc., indeed all members of society.

- Farmers: While climate change will deliver a negative impact on agricultural production in many areas of the world, the latitude and generally colder climate of the UK means that an increase in temperatures is likely to increase profits from agriculture in those areas which are not liable to. However, this in turn is likely to negatively impact upon water quality and hence water supply customers as higher agricultural intensification leads to increased nutrient pollution in waterways necessitating higher treatment costs. Lower river water quality will also impact negatively upon freshwater biodiversity and river related recreational values.
- Recreationalists: Open-access recreational sites have a benefit to individuals who visit them.

- Urban residents: Typically increasing access to urban greenspace generates significant social benefits. However, the distribution of benefits can be uneven and can result in the gentrification of areas which has the potential to push poorer families out to less advantaged areas.
- Biodiversity beneficiaries: Improvements in wild-species diversity not only benefit the species directly or indirectly conserved (e.g., through food chains), but also any people who value such improvements. These include people who hold use values (e.g. those who engage in hunting or fishing as well as those who enjoy viewing wild species) and those who hold non-use existence values. Biodiversity also indirectly delivers value through roles such as pollination and through diverse contributions to the maintenance of ecosystems.
- National and global beneficiaries: Both the conservation of biodiversity and the reduction of climate change through the sequestration of greenhouse gases through land-use change not only benefits the UK but has spill-over effects worldwide.

Identification of the suppliers

Ecosystem services can be supplied by either the public or private sector. The supplier with the most potential to supply ecosystem services in the UK are private agricultural landowners and farmers who control the large majority of land.

Terms of the exchange/*Quid pro quo*

This case study focuses on the use of modelling based on NEA for six different policy scenarios each of which ran from 2010-2060 to see the effects each would have on the land use across Great Britain. For simplicity, here we consider the two most extreme policy scenarios. The World Markets (WM) scenario prioritises economic growth by completely liberalising trade. Here trade barriers are dissolved, agricultural subsidies disappear and as a result farming moves towards large scale, intensive production methods. By contrast, the Nature@Work (NW) scenario's main priority is enhancing and maintaining the output of all ecosystem services. Adapting to climate change is also a priority.

When looking at alternative land-use decisions for Great Britain, examining only the agricultural values suggests that it is optimal to more intensely use the land and increase farm output by as much as possible. However, as soon as the analysis is extended to incorporate the non-market values of ecosystem services this result is reversed and an approach which seeks a modest reduction in agricultural intensity proves beneficial. Spatial targeting of these land-use decisions can also greatly increase their efficiency and raise the value for money of public spending in this area. When we look at wild bird species diversity, increasing agricultural production without increasing conservation areas causes decreases in the levels of biodiversity.

Considering the particular results of this analysis, the WM scenario fails both in terms of its cumulative contribution to social value and its overall impact upon our biodiversity objective. In contrast the NW increases social value substantially and provides an overall improvement to biodiversity.

Mechanism for transfer of value

The most common current method for transferring farming related values in the UK is via Government funded subsidies. There is already a massive intervention in agriculture in the UK with regard to subsidies paid through the EU Common Agricultural Policy (CAP). These currently make up over 50% of UK farmers' income. The present approach towards agricultural subsidies makes payments on a per hectare basis. While this might be argued as favouring most efficient producers, farm size is a poor proxy for such measures and from a political economy perspective the distributional consequences of such an approach, which results in almost three quarters of subsidies flowing to one quarter of farms, including some of the richest in the country, are difficult to defend. From an environmental perspective, these payments are unconnected to the degree of ecosystem service value generated and therefore offer relatively low value for money to taxpayers. Given this, the potential for reform seems very strong.

Our analysis illustrates the potential for major improvements in social value and the efficiency of public funding through the spatial targeting of subsidies. By mapping which areas offer superior value for money for agriculture and which would be best turned over to the production of other ecosystem services and targeting funding accordingly the overall efficiency of subsidies can be greatly enhanced. From a policy point of view, the adoption of such spatial targeting offers a major and potentially costless increase in taxpayer value for money simply by redirecting the current level of subsidy according to the benefits it generates.

Monitoring and verification

In this case study we consider payments from the public to private sector (in contrast to our final case study which considers PES schemes both paid for and provided by the private sector). The payments which are made in exchange for various ecosystem services are awarded, in this instance, on the inputs the provider makes to the service, i.e. on actions rather than their effect. For example, a farmer may be paid for reducing fertiliser applications on the assumption that this might reduce eutrophication in local rivers (the subject of our subsequent case study) but there is no linkage of that payment to the monitoring of river water. This means that farmers have no incentive to vary their actions away from those prescribed and payments may be inefficient in delivering the benefits they are intended to generate.

One important PES, the UK Countryside Stewardship Scheme (CSS), opened for the first time in 1991 covering only 25,000 hectares. By the time it was paused in 2004 the scheme covered over 530,000 hectares and its payments to farmers were in excess of £52million per year. The scheme was aimed at sustaining the beauty and diversity of the rural landscape and offered incentive payments to farmers for the preservation and provision of wildlife habitat. It made payments to farmers for arable land reversion, establishing and maintaining grasslands, as well as managing and preserving footpaths and bridleways. Participating farmers had to sign a contract which usually lasted 10 years and required them to maintain certain land-uses for that time. They were monitored through a series of checks including farm visits to see if the farmers

were in breach of their contracts and if they were not providing the ecosystem service their contract was terminated and fines were sometimes issued. The payment authority set an objective to inspect 10% of the farms every year, but the actual inspection rate never reached this.

Further improvements could be achieved through a move towards payments by results. In some cases this may be reasonably straightforward to implement, for example the quality of water running off a field is something that, in some respects (e.g. pesticide or fertiliser content) a farmer can influence. However, other payment by results schemes are more difficult to implement. For example, with respect to wildlife, a farmer may provide food sources for birds to thrive, yet the bird roosts on another farmer's land. Questions then arise over who should be paid for such services. Despite this, payment by results has important advantages over the input based approach:

- Outcome based approaches incentivise land-use that will produce the best environmental result.
- It allows farmers more flexibility in the management of their land because restrictions imposed by the input based system are removed. Appropriately designed this could lead to a greater uptake of participants in the scheme and greater improvements if targeted appropriately on expected environmental outputs.
- Farmers are permitted to innovate and incorporate their existing knowledge into environmental provision which can lead to a greater efficiency of production. Extensions of this knowledge could be delivered through training schemes.

The ongoing incorporation of drone based information, earth observation satellite data, and other 'big data' systems to monitor farmland-uses and certain consequences (e.g. tree planting and growth) offer further considerable potential for enhancing PES schemes.

Effectiveness

Fundamentally the most important finding of this research is that methods now exist to unite the natural sciences with economic assessments so that decision makers can be informed about the changes in value that will arise through different policy decisions. This allows policy makers to consider multiple land-use decisions in detail and select those options which yield the most desirable outcome. There are however a few limitations and challenges that need to be faced, these are:

- Simplifications had to be made because of uncertainties in predicting the future influence of certain drivers of change. Technological change represents this problem well, because advancements often do not follow a linear path and technological breakthroughs can revolutionise industries in unforeseen ways. Assumptions therefore have to be made.
- A further challenge is how to efficiently target payments when the costs of delivering these services differ across land managers but are unknown to the

funding authority. The business to business case study presented subsequently addresses this issue by implementing a new approach to contracting between farmers and funding authorities which incentivises farmers to reveal their true costs.

Despite these caveats, the model remains an effective tool for policy makers. The results presented here were central to the UK NEA which in turn provided the principle empirical input to the UK Government's Natural Environment White Paper and subsequent policy action leading up to the current formation of a 25 Year Environment Plan.

Key lessons learned

This analysis has built on our understanding of land-use decision making in a number of ways. Specifically, when making decisions about land-use change it is important to:

- Carefully determine the spatial extent of the area for analysis taking into account ecological, economic, policy and administrative jurisdictions.
- Understand the drivers of change; Policy, Market and Environment variables. This is important so that decision makers can understand which levers of change are available to them, and which are exogenously determined.
- Capture all of the major effects that changes in land-use can have upon ecosystem services; without this any attempt to estimate the overall consequences of policy change will be limited and can be potentially misleading.
- Make sure the different units used to measure changes in ecosystem services are commensurable. This is most readily achieved by expressing changes in both market and non-market goods in monetary economic values.
- While the large majority of values can be robustly assessed in monetary terms, some are not currently amenable to robust valuation. Biodiversity is a particular challenge here and we argue that generally agreed objectives (drawn in part from legislation but also from other preference measures and informed by ecological knowledge) should be incorporated into analyses by identifying and rejecting investments which violate those objectives. The costs of securing these objectives can be estimated and the effectiveness of options for their delivery assessed, but such costs should not be interpreted as indicators of the value of delivering sustainable biodiversity or other objectives.
- Account for temporal variation by ensuring that changes in drivers (for example those arising from the effects of climate change) are incorporated into analyses.
- Account for spatial variation across the study area, given the heterogeneity of land characteristics and responsiveness to change, to permit the targeting of policies.
- Allow for the modelling of different policy scenarios to see the different outcomes that can occur from varying the inputs. This is one of the most useful tools for policy makers to use. Ideally one would move from pure reliance upon scenarios towards

the refinement of optimal policies given resource constraints and objectives (Bateman et al., 2014b).

This study is part of a series of inputs to the policy process which resulted in a new White Paper and is at the forefront of research into ecosystem services and land-use decisions within the UK. The Government is taking these findings very seriously and together with the NCC is moving towards a 25 year plan to improve the environment.

Case 2. Public to private funding of natural capital improvements: Catchment level decision making

Description of the problem

While national-level decision making is vital for directing overall and longer term strategy, most practical environmental management decisions are made at a more restricted and local scale. Nevertheless, the need for environmental coherence in decisions remains and in recognition of this there has been a noticeable movement towards consideration of catchments as an important decision making unit). Irrespective of the scale however, the key principle for decision making is that all of the major effects of a proposed change should be incorporated into analyses, including relevant overspill benefits and costs arising outside the immediate locus of activity.

This case considers improvements to conventional public to private PES decisions at the catchment level by analysing the effects that climate change is likely to have upon the Aire catchment in Yorkshire, UK. The increase in average temperature generated by climate change induces land-use responses as farmers exploit the potential for increased agricultural intensification. This in turn generates higher food production but this needs to be balanced against the impacts of induced land-use change in terms of increased nutrient application, higher river pollution and lower ecological quality. This generates a non-market externality with relation to recreational visits to the river catchment. The problem is that if we consider only the direct market-priced effects of land-use change, which is an increase in agricultural production, it appears that the temperature rise would increase the value to society. Extending our analysis to include induced indirect effects on water quality and recreational value provides a richer picture of the overall balance of benefits and costs.

Biophysical explanation of the relevant ecosystem services

The 86,000 ha catchment of the River Aire encompasses highly heterogeneous land-uses, water qualities and socioeconomic characteristics. The upstream western half of the catchment has low population density with its mainly upland landscape being dominated by rough grazing and pastoral agriculture. The downstream eastern half of the catchment has some mixed and arable farmland but is dominated by high density urban areas which are themselves a major determinant of river ecology and the major source of recreational visitors.

With rural land-use ranging from extensive pastoral to intensive arable farming across the catchment, the Aire is subject to significant levels of diffuse pollution including high nutrient loadings. The arable and root crops are strongly and positively associated with high levels of eutrophication which rises in areas of high stocking density. Conversely, extensive grassland systems are associated with less eutrophied waterways.

Identification of the beneficiaries

The general public benefit from the river in two ways. First, they have a use value associated with river related recreation. This includes any activities done in and around the river e.g. walking along the riverbank, nature watching, canoeing, fishing, swimming, walking, cycling, running, etc. Second, they have a non-use value associated with the biodiversity levels in the river catchment quite separate from their direct enjoyment of wild species. Water quality improvements also benefit water companies through reductions in treatment costs.

Identification of the suppliers

Farmers and landowners in the river catchment exert a major influence over river water quality. Climate change is predicted to induce increased intensification of agricultural production and hence greater applications of inputs such as fertiliser. This will in turn reduce river water quality through diffuse pollution. Conversely, farmers could maintain or even improve water quality by adopting more extensive production methods.

As such, farmers are the potential suppliers of improved water quality. This in turn would avoid potential losses of recreational value and other associated ecosystem services. However, this would incur income reductions for those farmers. A key objective of this study was to calculate the forgone income of, and hence compensation required by, farmers who avoid a move towards higher input, extensive agriculture and compare this cost to the likely benefits generated by such action.

Terms of the exchange/*Quid pro quo*

The study starts off by considering the drivers of change. In this case, we hold the market drivers constant so prices just track general inflation levels and remain constant in real terms. But we note expected changes in the environment driver (climate change) and simulate this by assuming a 1°C increase in temperature across the region and some shifts in the seasonal pattern of rainfall. Subsequently, we also consider the effectiveness of policy drivers designed to counteract the negative consequences of climate change.

While global climate change will place greater stress on the world agricultural system, within certain temperate countries such as the UK, increases in temperature will actually result in elevated potential for agricultural production and. Specifically, within the case study area, climate change will result in increased suitability for arable production. As this is associated with higher profits than many grassland systems, our analysis suggests that farmers will shift away

from livestock production and towards cropping regimes. This will result in a greater use of the farm inputs associated with arable production; notably fertilizers. This, in turn, will increase the levels of diffuse pollution into waterways and rivers, resulting in elevated nutrient levels within freshwater environments. Therefore, the integrated suite of models employed to analyse this chain of events predicts a decline in the future water and ecological quality in catchment waterways which arises both from the direct effect of the water temperature increasing and from the (larger) indirect effect of the increased run off of nutrients into waterways from the climate induced shift towards arable farming.

This decline in the ecological quality of the river not only reduces associated non-use values, it also generates a potentially major non-market externality in terms of the impact it has upon the recreational value of visiting the river. Both avoiding losses and generating overall improvements in water quality deliver substantial benefits. However, such policies would not be costless. Aside from any direct costs of water quality improvement, avoiding the land-use change induced by climate change would mean that farmers would forgo profits associated with moving to higher value arable production. To assess this we need to analyse the aggregate benefits to recreationalists from water quality improvements and compare these to the overall costs of compensating farmers for profits forgone.

Aggregation shows that the recreational value losses induced by climate change are concentrated in the west of the catchment in those areas which experience the largest decline in water quality. Even though the local population density is considerably lower than in the east, this still generates an aggregate loss of approximately £26million per annum.

Mechanism for transfer of value

Funding for the improvements outlined above could be obtained from general taxation. Here targeted payments to private landowners, such as farmers, could be made under a water stewardship scheme. Alternatively funding could be obtained from private water companies through a mixture of regulation and incentives.

Monitoring and verification

The general mode of monitoring and verification employed in the UK for similar land-use decisions is through occasional on-site inspection. This is usually undertaken by an expert who visits the site to undertake observations and tests which assess the actions taken by the farmers. A problem with this method is that it is relatively expensive and time consuming to implement and other methods exist which could be employed to reduce these expenses. Satellites could be used to verify land-use changes made by farmers. This method would be particularly effective when the changes in land-use are easily observable from satellite pictures e.g. the change from arable to grassland-use. Drone technology might also play a role here. The development of cheaper individual water monitoring mechanisms should also be encouraged so that information about water quality is available to both farmers and monitoring authorities. Products have been

developed to monitor water quality, but a longer term goal would be to develop cheaper digital monitoring equipment which could relay data in real-time to monitoring authorities to help prevent and treat pollution. Such data could also be used to take preventative measures to reduce the costs associated with short term pollution incidents. For example, water abstraction inlets could be closed if prior warnings of major pesticide incidents were received.

Effectiveness

The analysis made use of a simplified climate scenario for illustrative purposes. Future analyses could make use of a wider array of climate change data, as well as including any non-linear effects and uncertainties in the modelling process for both climate and land-use change. It should also account for seasonal variation within the model. In particular levels of rainfall, which vary across the country and throughout the year, directly influence the concentration levels of chlorophyll-a in the water.

Effectiveness analyses are complicated by the timescale of environmental changes. Lags commonly occur between policy decisions, implementation, behavioural consequences and environmental response.

Key lessons learned

While acknowledging that the direct market impacts of climate change on agriculture may be positive within the UK context (although not in many other countries), a central contribution of this research has been to demonstrate that focusing solely on these direct impacts paints a highly incomplete picture of the net impact of climate change. In our case study of the UK's River Aire, several key points have been made:

- It is important to understand and model the various direct and indirect effects that climate change would have on a catchment area. In this case study, three important effects have been considered:
    - Climate change directly causes a decline in the ecological quality of a river because a temperature rise of 1°C causes an increase in water temperature, which in turn has negative impacts on the native flora and fauna of the river.
    - Climate change indirectly causes a decline in the ecological quality of a river through induced land-use change, which causes a shift towards crops raising diffuse pollution of waterways.
    - A decline in the ecological quality of the river Aire would cause a decline in the recreational value of the river.
- A policy to offset the negative indirect effects of agriculture was examined. This found that the benefits of such a scheme significantly outweighed its costs.
- Methods for funding such change include both direct state support and business to business arrangements.

Case 3. Business to business funding of natural capital improvements: Catchment level reverse auctions

Description of the problem

Water quality in rivers is of significant interest to private water companies who spend large amounts of money treating water to conform to legal standards. Stopping pollution at the source by paying farmers to reduce their inputs of pesticides, fertilizers and particulates can dramatically reduce this cost. There are also public benefits to reducing pollution as it results in increased levels of biodiversity, recreational and tourism benefits, fish catch and reduced incidence of siltation and associated costs.

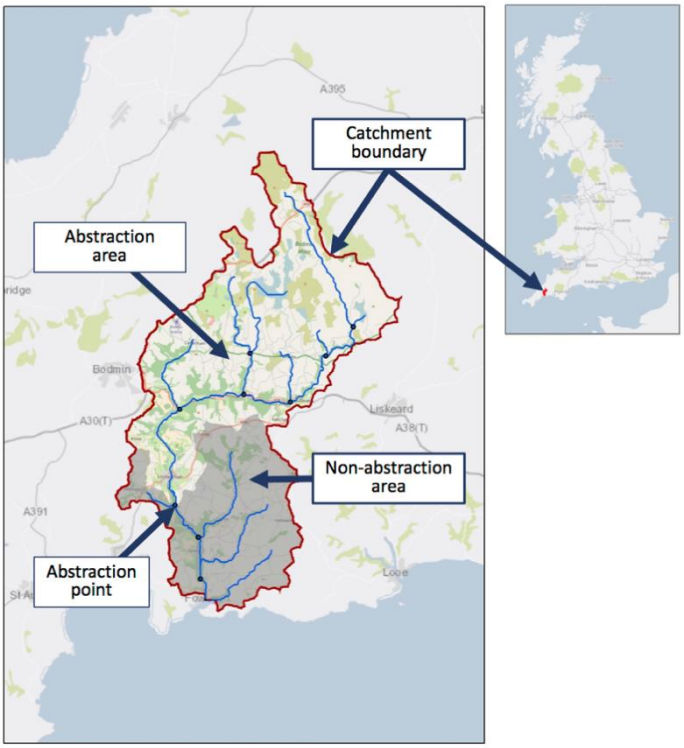

Figure 9.1 The Fowey Catchment Area

Biophysical explanation of the relevant ecosystem services in the specific cases

This case study examines the Fowey Catchment in South West England. Figure 9.1 shows the river Fowey which runs from the top of the catchment boundary approximately 30 miles South through the abstraction area farmland, to the abstraction point, and then out to sea. SWW own

the water extraction point which supplies 95% of Cornwall's drinking water, therefore the river Fowey abstraction area is of great importance to SWW and this was the focus of the reverse auction. Conversely the area downstream of the abstraction point, along with areas outside the catchment, are of little relevance to the quality of Cornwall's water supplies.

Identification of the beneficiaries

Both the water company, SWW, and farmers benefit from the reverse auction scheme. While SWW cuts its costs in cleaning the water, farmers will only enter into the natural capital market if their benefits exceed their costs. Such an outcome is likely to encourage further investment in similar schemes from a private company; indeed, this result can be observed with SWW, who have expanded their UTI investment across 11 catchments in Devon and Cornwall with an expanded budget of £11million.

Moreover, there are positive spill-over effects to the environment and society. The environment benefits from the natural capital market reduces the levels of diffuse pollution in the river. Lower chemical loading in the river increases levels of dissolved oxygen and reduces eutrophication. Consequently, native flora and fauna, such as waterlilies, thrive, giving greater diversity to the ecosystem.

Society also benefits from the reverse auction scheme. The cleaner waterways result in lower water bills for customers of SWW. There are also higher ecosystem service values associated with the aquatic environment including:

- Recreation activities - e.g. angling, boating and swimming etc.
- Informal recreation - e.g. walking, picnicking, tourism and associated employment, associated businesses (pubs, hotels, markets) etc.
- Higher economic activity - e.g. commercial fisheries and shell fisheries. This can potentially be extended to lowering port costs of dredging (clearing the river bed of mud and weeds) if sediment reduction occurs.
- Non-use values – e.g. the improvements in the provision and quality of wild species habitats and associated biodiversity.

Identification of the suppliers

Any landowners who live near the river are potential suppliers of clean water to SWW. The majority of these landowners are farmers who are also the main polluters into the river. Other private land owners, such as small businesses and homeowners, do pollute into waterways but the effect of this is small in comparison.

Terms of the exchange/*Quid pro quo*

This case study examines the Fowey Catchment in South West England. South West Water (SWW) distributed grants to farmers through the Fowey River Improvement Scheme which used the reverse auction market to allocate funds to farmers for capital investments. The scheme sought

to test whether improvements could be made relative to the ALS approach previously used to allocate funds. SWW needed to know:

1. What the change was – SWW funding was provided for capital and operational investments on farmland, e.g. to update slurry storage, watercourse fencing, covered livestock feeding areas and for providing management packages which involved soil tests, waste management and excluding livestock from watercourses. These different capital investments would have different impacts on reducing pollution levels.

2. How it would impact the water quality - The impact of the change depends upon the current state of the area which was being altered; e.g. further updating slurry storage on a farm which had recently replaced its slurry storage might represent poor value for money.

3. Where the change was happening - The closer the change was to the river Fowey, the greater impact it would have on the water quality and the greater value for money it offered to SWW. It also mattered how pollution sensitive the area of change was, given that some land areas are more prone to pollution runoff than others. Factors affecting local sensitivity of an area include soil characteristics and gradient.

4. The likely costs of change – Includes the amount of capital investment required to implement the change by both the farmer and SWW and the cost of monitoring that the change has taken place.

The driver of change in this case study is the market and for a market to work efficiently information has to be available to both the buyer and seller. The information regarding points 1-3 above could be obtained in the ALS, but point 4 could not. This represents a market failure in the ALS because the farmers were in a position where they do not have to reveal their real costs and indeed, can overstate them. This information asymmetry results in overpayments to individual farms which in turn reduces overall impact as less farms can be engaged for a given budget. This in turn further inhibits additional investment by the water company who see the lower value for money of prior spending.

Mechanism for transfer of value

The reverse auction provides farmers with an incentive to reveal their true costs. In summary, this moved the payment arrangement from one where the farmer effectively dictated the price for their participation in a pollution reduction scheme, to a situation where the water company elicited competitive tenders from farmers to supply improved water quality. In essence the market worked as follows:

- Water quality researchers provided information on the best areas across the catchment to locate water improvement activities (e.g. on areas near to waterways or with certain vulnerabilities to pollution). This in effect provided a measure of investment benefits and was kept confidential to the water company;

- ❖ Farmers were then invited to prepare bids for investments from the water company for improvements to water related infrastructure on their farms (e.g. better hard standing, drainage, slurry stores, etc.);
- ❖ All farmers in the catchment were approached, thereby setting up competition for investments across farmers and driving down stated costs;
- ❖ All bids were compared with their expected benefits to allow the water company to derive a value for money score for each potential investment;
- ❖ Those bids delivering the highest value for money were funded.

This process, in which those bids offering the lowest cost per unit of benefit are funded, is known as a 'reverse auction'. To further drive down costs, the market allowed 'practice rounds' of bidding. Here, once bids were received, farmers were informed where their bids would not have attained the necessary value for money for funding and allowed to revise their bids either by reducing costs or altering investments to improve benefits. After two such practice rounds a final 'for real' round was undertaken, contracts were awarded and investments made.

By inviting multiple farmers to submit bids the buyer sets up a competitive market where farmers now have an incentive not to overstate their compensation requirements. The figure below shows the farmers' final bids ordered from left to right by value for money. The minimum value for money line indicates the point at which the available budget was exhausted. As can be seen, the competitive structure of the market ensures that all funded bids offer high value for money. A higher value for money score indicates better value for money (the value of 1 has no special significance and, in particular, it is not related to a 1:1 benefit cost ratio.) Full details of the value for money scoring system are given in the publication.

The figure also shows the somewhat noisy relationship between value for money and the grant level requested. While a number of low value bids are ones which requests high levels of funding, and it is clear that some farms asking for lower grants (i.e. lower costs) deliver high value for money, nevertheless we can see that at almost any grant (cost) level there are some farms offering good value for money.

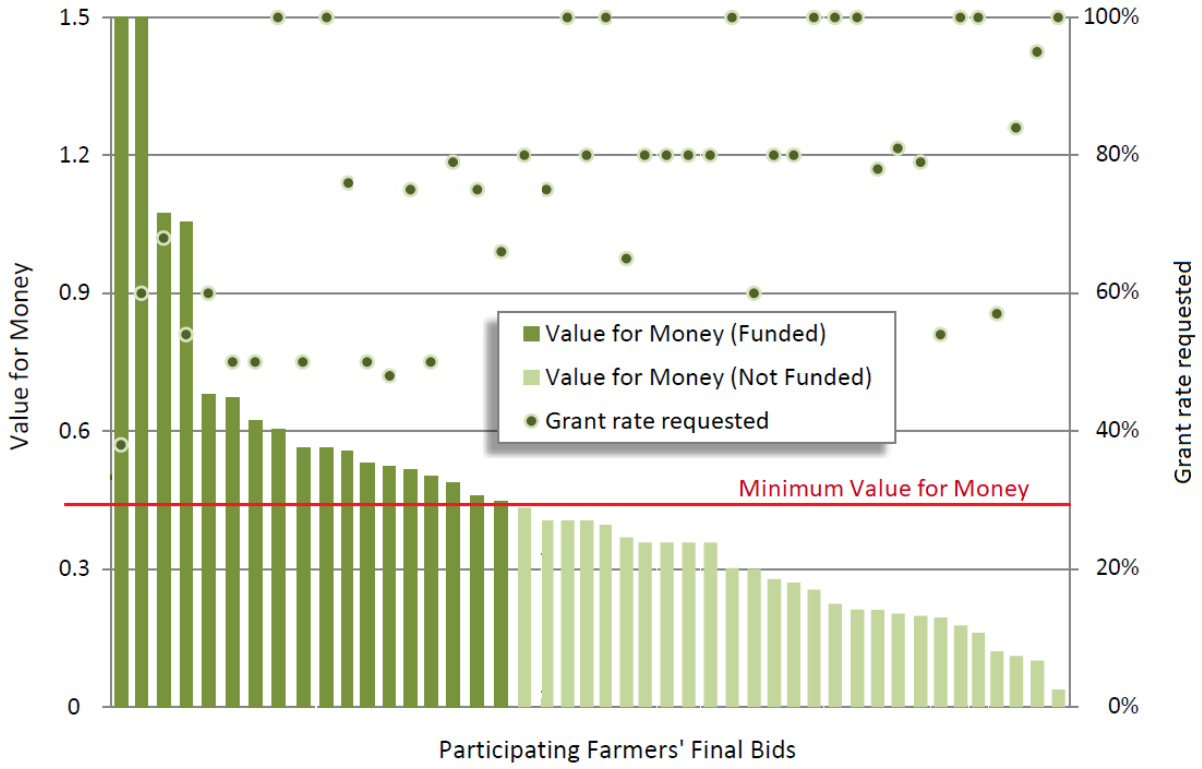

Figure 9.2 Comparison of Participating Farmers' Final Bids: Value for money and grant rate requested

Cash payments were made directly from SWW to funded farmers so that the capital investments could proceed promptly. These payments were made on the condition that the farmers signed and fulfilled a contract whose conditions and duration were determined by the nature of the capital works. Contracts typically lasted 25 years for more substantial, longer-lived investments (e.g. slurry storage and roofing) and 10 years for shorter-lived capital items (e.g. fencing and concreting). The contracts stipulated that the capital items in question would have to be used for the agreed purpose, be properly maintained and insured against any damage.

Monitoring and verification

All of the capital investments were easy to monitor and verify because payments were issued on the actions taken by farmers. Visible confirmation of a build or management changes was all that was needed.

Effectiveness

The reverse auction case study discussed here was a relatively low budget proof of concept exercise which proved very successful and provides positive prospects for similar schemes to be run in the future. SWW had £360,000 of funds to distribute but was considerably oversubscribed, receiving bids for £776,000 worth of investment. The reverse auction approach to investment decisions was also 20-40% more cost-effective than the advisor led approach.

The limitations of this scheme centred around the difficulty of assessing the impacts the capital investments had on water quality. Firstly, it was hard to know whether the investments made were ones which would deliver the best water quality improvements on the farm. All of the investments were reviewed by an advisor and deemed to be ones that would deliver environmental improvements, but they also noted that the farmers only identified 54% of the projects on their farm which could deliver such improvements. A drawback of the reverse auction is that the farmers may well not have the knowledge that the farm advisors do with respect to environmental investments. However, it is worth noting that this was the first time that farmers had to make such decisions and we expect that the knowledge of such investments would increase if further auctions took place. A future modification could be to produce a hybrid scheme where an advisor visited the farms and scored the investments and this score, in turn, would contribute to the value for money score used to assess the bids. Alternatively, there is the opportunity to offer training courses to farmers to help close the knowledge gap.

Secondly, it was important to determine whether the capital investments made were ones which the farmers would have made without the grants. If the farmers were going to carry out these capital investments regardless of the grants, then clearly funding these investments is not an efficient use of resources from SWW's point of view. Surveys taken after the auction showed that 62% of farmers stated they "would have undertaken investments irrespective of whether they received funding from SWW". However, almost all respondents caveated this statement with responses like "only when, and if, alternative finance became available to fund it", "not now and probably a number of years in the future" and "to a lower standard than proposed in the bid". At the very least, these grants pushed forward the priority of capital investments which benefit the environment.

Future schemes could make use of the potential benefit to getting multiple purchasers involved. Sharing the cost of the scheme reduces the burden and risk on any one investor, making it more likely that the scheme would continue into the future. Increased financing can occur, allowing for an expansion of the scheme which can increase the impact it has on the environment. It can also broaden the range of investment goals within the scheme, e.g. reducing sedimentation levels, which can have a greater positive impact on the environment and recreation.

An improvement might be made in the way water quality enhancements were verified in the reverse auction scenario by shifting from payments for action to payments for outcome. The problem with payments for action is that there is no guarantee the water quality in the river will increase from the changes to capital made on the farms. Without measuring the outcome of the changes, it is also impossible to know how much effect each capital investment had. In principle, monitoring water quality in the catchment or at each farm in real time would help decrease the costs associated with farm visits and determine the effect of the capital investments. Moreover, real time monitoring of pollutant levels can help prevent any major decreases in water quality arising from major events, such as storms, by acting as an early warning system. While ongoing improvements in monitoring technology will help greatly here, in practice it is likely that a mixture of payments for action and outcomes will persist, in part to defray the risks to farmers inhibiting participation.

Key lessons learned

The Fowey reverse auction natural capital market proved a success and helped eliminate some of the problems associated with more traditional PES mechanisms. Several key lessons have been learned by this case study, including:

- Business to business investments can produce win-win outcomes. Specifically, benefitting:
  - The firm – engages more farmers, increases the value for money of investments and increased water quality extracted from the river.
  - The farms – rewards to the average farmer are increased.
  - The environment – increased water quality results in increased biodiversity.
  - Society – lower water bills and increased service values from the aquatic environment.
- Increasing the information available to the investor increases the value those investments have to society.
- A reverse auction can be used to encourage the providers of environmental goods to reveal their costs to the investors.
- Valuing bids on a value for money basis helps ensure the best investments are made.
- Reverse auctions can be cheaper and more time efficient than pure ALS approaches for large scale investments.

Recommended key references

Bateman, I. J., Harwood, A. R., Mace, G. M., Watson, R. T., Abson, D. J., Andrews, B., Andrews, B., Binner, A., Crowe, A., Day, B. H., Dugdale, S., Fezzi, C., Foden, J., Hadley, D., Haines-Young, R., Hulme, M., Kontoleon, A., Lovett, A. A., Munday, P., Pascual, U., Paterson, J., Perino, G., Sen, A., Siriwardena, G., van Soest, D., Termansen, M. (2013) Bringing ecosystem services into economic decision-making: land use in the United Kingdom. *Science*, *341*(6141), 45-50.

Bateman, I.J., Abson, D., Andrews, B., Crowe, A., Darnell, A., Dugdale, S., Fezzi, C., Foden, J., Haines-Young, R., Hulme, M., Munday, P., Pascual, U., Paterson, J., Perino, G., Sen, A., Siriwardena, G. and Termansen, M. (2011a) Valuing Changes in Ecosystem Services: Scenario Analyses, in *The UK National Ecosystem Assessment Technical Report,* UK National Ecosystem Assessment, UNEP-WCMC, Cambridge, also available from http://uknea.unep-wcmc.org/.

Bateman, I. J., Harwood, A. R., Mace, G. M., Watson, R. T., Abson, D. J., Andrews, B., Andrews, B., Binner, A., Crowe, A., Day, B. H., Dugdale, S., Fezzi, C., Foden, J., Hadley, D., Haines-Young, R., Hulme, M., Kontoleon, A., Lovett, A. A., Munday, P., Pascual, U., Paterson, J., Perino, G., Sen, A., Siriwardena, G., van Soest, D., Termansen, M. (2013) Bringing ecosystem services into economic decision-making: land use in the United Kingdom. *Science*, *341*(6141), 45-50.

Day, B., Bateman, I., and Lake, I. (2007) Beyond implicit prices: recovering theoretically consistent and transferable values for noise avoidance from a hedonic property price model, *Environmental and Resource Economics*, *37*(1), 211-232.

Day, B., Couldrick, L., Welters, R., Inman, A. and Rickard, G. (2013) Payment for Ecosystem Services Pilot Project: The Fowey River Improvement Auction, Final Report to the Department for Environment, Food and Rural Affairs, LEEP (University of Exeter) and Westcountry Rivers Trust.

H.M. Government (2011) *The Natural Choice: Securing the value of nature.* Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/228842/8082.pdf

House of Commons (2012) Natural Environment White Paper, *HC 492*, House of Commons Environment, Food and Rural Affairs Committee, The Stationery Office Limited, London.

NCC (2013*) The state of natural capital: towards a framework for measurement and valuation*, Natural Capital Committee, Department for Environment, Food and Rural Affairs (Defra), London, available at: https://www.gov.uk/government/publications/natural-capital-committees-first-state-of-natural-capital-report

NCC (2017b). *How to do it: a Natural Capital Workbook,* Natural Capital Committee, Department for Environment, Food and Rural Affairs (Defra), London, available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/608852/ncc-natural-capital-workbook.pdf

NCC (2017c). *Natural Capital Valuation,* Natural Capital Committee, Department for Environment, Food and Rural Affairs (Defra), London, available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/608850/ncc-natural-capital-valuation.pdf

10. BLENDED MECHANISMS: THE CASE OF DEVELOPMENT PLANNING AND INVESTMENT

Katie Arkema, Nicola Virgill-Rolle

Introduction

In many countries around the world, major development projects are underway. An estimated $57 trillion in global infrastructure development is anticipated by 2030 and the road network length is projected to increase 60% by 2050. As awareness grows about the role ecosystems play in supporting livelihoods and human well-being, national governments are pursuing development planning that accounts for the long-term health of people and the environment as well as near-term economic goals.

Information about where and how ecosystems maintain water quality, sequester carbon, provide sources of sustenance, support tourism, agriculture, fisheries, and other sectors, and reduce the risk of communities to natural hazards can inform where to target investments in infrastructure and conservation. For example, assessments of natural capital can inform the finance mechanisms discussed in previous chapters by demonstrating where and how much restoration or conservation is needed to ensure the delivery of ecosystem services into the future.

Accounting for natural capital also helps to site development projects to leverage the benefits nature provides (and to avoid unnecessary losses of services). For example, considering the role that coastal and hillside forests play in preventing erosion and the importance of access to natural areas for tourism can help determine where new roads should be built and degraded roads maintained.

In this chapter we introduce two case studies from the Caribbean in which sustainable development planning was informed by an ecosystem services assessment. In particular, we explore how incorporating natural capital information in the planning phase helped to facilitate project financing during the implementation phase. In Belize, ecosystem services information was used to site ocean and coastal activities (e.g., dredging, fishing, oil exploration, ocean transportation etc.) and to design the country's first Integrated Coastal Zone Management (ICZM) Plan. The plan has been used to inform investments in sustainable tourism development and

nature-based coastal resilience projects. In The Bahamas, an ecosystem services approach to sustainable development planning is helping to pave the way for a loan from the Inter-American Development Bank to the Government of The Bahamas to restore mangrove forests for coastal resilience in the wake of two major hurricanes.

While Belize and The Bahamas are small Caribbean countries, the issues they face are relevant to countries around the world – even much larger countries like the US and China which have far larger coastal zones and more people living in harm's way. Globally, more than a third of the human population lies within 100 km of the ocean. The Bahamas and Belize highlight the role that coastal and marine ecosystems play in supporting economic development while enhancing coastal resilience from natural hazards in the face of global climate change.

Case 1: Integrated Coastal Zone Management and investments in development, conservation and restoration in Belize

Description of the problem

Located along the eastern coast of Central America, Belize is known for its unique coastal and marine ecosystems. The highly productive coastal zone of Belize is home to a diversity of species, including endangered manatees and sea turtles, as well as 35% of the human population of Belize. Many shoreline communities rely on fishing for sustenance and livelihoods. World-renowned snorkeling and diving draw more than 800,000 tourists annually. In addition to attracting fishers and tourists, coral reefs, mangrove forests and seagrass beds shield coastal communities from flooding and erosion. Despite the importance of Belize's marine environments, economic development of ocean and coastal sectors, including tourism, aquaculture, oil and gas, and marine transportation, threaten the very ecosystems that underlie the national economy and support human wellbeing.

To address the unstructured nature of economic activities in the coastal zone and to ensure sustainable ecosystems for generations to come, The Government of Belize embarked upon a massive effort to design the nation's first Integrated Coastal Zone Management (ICZM) Plan. The 2000 Coastal Zone Management Act called for a plan based on both science and local knowledge, that would be national in scope but emphasize regional differences, and provide spatially explicit guidance about where and how to engage in ocean and coastal activities to achieve both conservation and development goals. The Belize Coastal Zone Management Authority and Institute (CZMAI) partnered with the Natural Capital Project (NatCap) in 2010 to use ecosystem service models to assess tourism, fisheries, and coastal protection objectives under several future scenarios for zoning ocean and coastal activities. The highly iterative and participatory process of stakeholder engagement and ecosystem modeling ultimately yielded a preferred zoning scheme for the ICZM plan that in turn helped to facilitate financing for investments in restoration and conservation of coastal and marine ecosystems. The plan was approved in 2016.

Biophysical explanation of the relevant ecosystem services

Coastal and marine ecosystems, such as coral reefs, mangrove forests, and seagrass beds, provide numerous ecosystem services to the Belizean people and visitors worldwide. Tourism is the single largest contributor to the country's economic growth, generating $264.4 million USD in 2008 and more than a million visitors in 2014. The marine environment is a large part of what draws visitors. For example, tourists come to the country to experience the Belize Barrier Reef Reserve System and the Great Blue Hole, both of which are within a UNESCO world heritage site. In turn, their expenditures for recreational activities (e.g., snorkeling, SCUBA diving), food, lodging, entertainment, and other amenities support local economies.

Fishing is another benefit supported by coastal and marine ecosystems in Belize. In addition to the fin fish, lobster, conch, and other harvested species, coral reefs, mangroves, and seagrasses provide important nursery and adult habitat for ecologically and economically important species. For example, the spiny lobster, which make up the largest share of the export fishery in Belize, recruit to mangroves and seagrasses from the open ocean. In the coastal vegetation the lobsters grow to a juvenile life stage, eventually migrating offshore to seagrasses and coral reefs where they live and are caught as adults.

Coral reefs, mangrove forests, and seagrass beds also provide coastal protection from sea-level rise and storms. Through changes in depth caused by the barrier reef and the frictional effects of coral and vegetation, ecosystems extract wave energy, attenuate water flow, and trap sediments. Their effects on nearshore hydrodynamics and sediment transport can in turn reduce the impact of coastal erosion and flooding on shoreline communities. When coastal and marine ecosystems are degraded, through pollution, dredging, storm damage, and other stressors, their ability to provide fisheries, tourism, and coastal protection services suffers, as do the Belizeans and visitors relying on these services.

Identification of the beneficiaries

Coastal property owners – both single family homes and hotels and lodges – benefit from the ability of coral reefs, mangroves, and seagrass to reduce coastal flooding and stabilize shorelines. More than a third of the Belizean population living in the coastal zone benefits from risk reduction provided by ecosystems for public infrastructure and services (e.g., hospitals, schools etc.). People involved in small scale artisanal and subsistence fisheries and commercial fishing operators benefit from harvested species, such as spiny lobster and conch, as do other components of the fishing sector, including the processors, exporters and their employees. Beneficiaries of healthy coastal ecosystems for tourism are numerous and include owners and employees of small lodges and ecotourism resorts, large resorts and hotels, restaurants, retailers, outdoor adventure operators, and other businesses that tourists frequent.

Identification of the suppliers

Coastal and marine ecosystem services are supplied by both public and private lands along the coast and within nearshore waters. As in many countries, coastal resources and public lands are

managed by multiple agencies. Accounting for the role that ecosystems play in supporting different coastal sectors can enhance coordination among these agencies to ensure achievement of economic, environmental, and social objectives. For example, incorporating nursery habitat into the models for quantifying catch and revenue of spiny lobster highlighted the economic importance of mangroves, which are managed by the Department of Forestry, to lobster, which are managed by the Fisheries Department. In addition to zoning and management of public areas, private land owners also supply ecosystem services. For example, a program in southern Belize was designed to reward waterfront property owners who invested in mangrove restoration and conservation for its multiple coastal resilience, carbon sequestration, and fisheries benefits. As another example, several resorts along the Placencia Peninsula, an area known for its beautiful beaches, have avoided construction of seawalls, which can lead to long-term erosion and changes in coastal geomorphology. Instead, owners would rather rebuild the resorts after a major hurricane than risk losing the primary resource—
the beach—that ultimately supports tourism.

Design of country's first national Integrated Coastal Zone Management (ICZM) Plan

To minimize ecological degradation and better manage conflicting uses of the coastal zone, The Government of Belize embarked on a process to develop the first national ICZM plan for the country. The approach combined stakeholder engagement, scenario development, and quantitative modeling of ecosystem services. The stakeholder engagement process involved scoping objectives, gathering information, and eliciting feedback through coastal advisory committees composed of local representatives from diverse sectors and interests, public consultations, and expert reviews. Scenario development involved synthesizing spatial data for eight ocean and coastal activities (development, transportation, fishing, agricultural run-off, tourism, dredging, aquaculture, oil exploration) to develop one current (2010) and three future (2025) zoning scenarios based on stakeholder input, government reports, and existing and pending legislation. Spatial variation in ecosystem services in the current and future scenarios were quantified in biophysical and economic metrics using the tourism and recreation, coastal protection, and fisheries models in the InVEST software suite.

Through iteration of stakeholder engagement, scenario development, and modeling ecosystem services, the Belize Coastal Zone Management Authority and Institute (CZMAI), in collaboration with the Natural Capital Project, developed a preferred spatial plan for ICZM in Belize. Analysis of ecosystem services suggested that the preferred plan would lead to greater returns from coastal protection and tourism than outcomes from scenarios oriented towards achieving *either* conservation *or* development goals. The plan would also reduce impacts to coastal habitat and increase revenues from lobster fishing relative to current management. By accounting for spatial variation in the impacts of coastal and ocean activities on benefits ecosystems provide to people, the results from modeling ecosystem services allowed stakeholders and policy-makers to make informed decisions about the extent and location of zones of human use in the plan. Including outcomes in terms of ecosystem service supply and

value (e.g., fisheries catch and revenue, coastal land protected from storms and avoided damages, and number of tourists and tourism expenditure) allowed for explicit consideration of multiple benefits from oceans and coasts that typically are evaluated separately in management decisions (Figure 10.1).

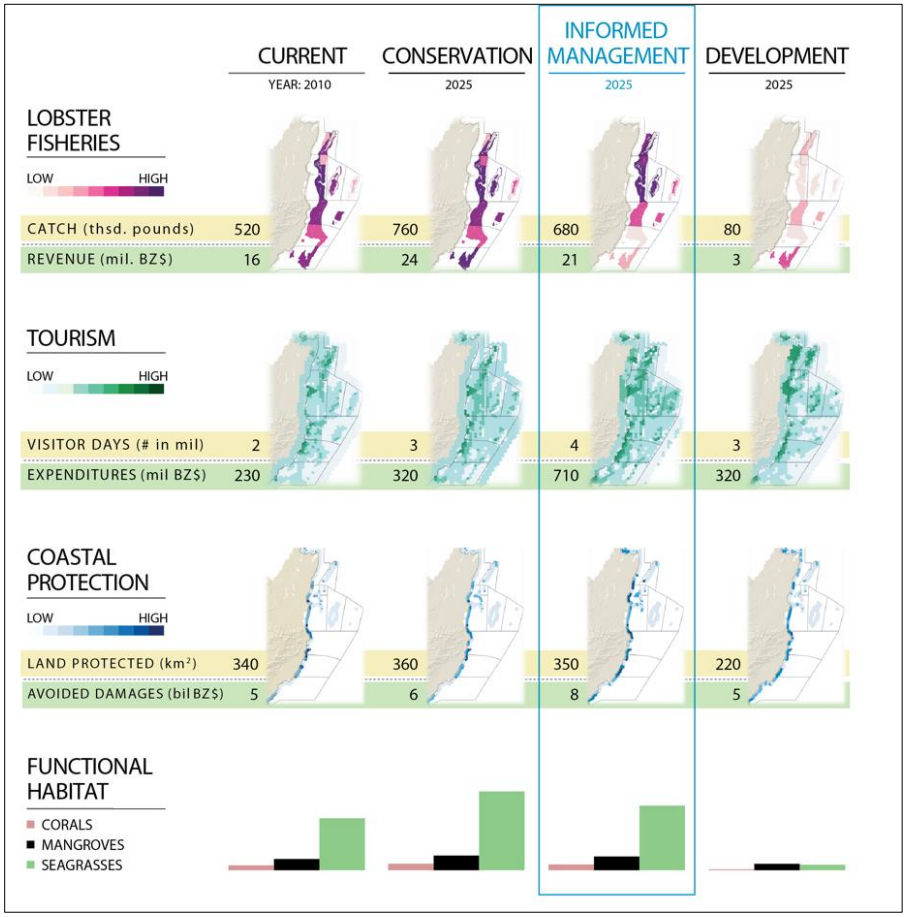

Figure 10.1 Biophysical and economic values for three ecosystem services and the area of habitat capable of providing services under the Current and three future scenarios for the ICZM Plan for Belize. This figure first appeared in the Proceedings of the National Academies of Sciences (Arkema et al. 2015).

How the Belize ICZM Plan is being used to inform permitting and investments

By accounting for ecosystem services, the Belize ICZM plan highlights how the country's coral reefs, mangrove forests, seagrasses and other coastal and marine ecosystems play a critical role in national economic development and coastal resilience from natural disasters. This information about the economic and societal value of ecosystems helped to pave the way for financing conservation and restoration and investments in sustainable development. For example, the Inter-American Development Bank (IDB) is working with the Belize Tourism Board to finance sustainable tourism projects that are consistent with the ICZM Plan. The IDB has also invested in three shoreline stabilization projects in Toledo, Cay Caulker, and Corazal, which have nature-

based project designs. Traditional approaches to coastal protection (e.g., seawall construction) is often under the jurisdiction of agencies responsible for major infrastructure projects. In the three nature-based coastal resilience projects in Belize, a suite of agencies are involved, including CZMAI and the Ministry of Tourism. Because natural and nature-based coastal resilience projects have the potential to meet multiple objectives, they often have the support of a suite of stakeholders and agencies and thus may also benefit from more diverse sources of financing.

Monitoring and verification

Monitoring and verification are underway in Belize for both the ICZM Plan and the tourism and shoreline stabilization projects. The ICZM Plan will be revised over a 4-year time period. To inform adaptive management of the coastal zone, CZMAI has partnered with scientists, NGOs, and students in sustainability science to design a monitoring protocol. CZMAI's Data Centre under the Marine Conservation & Climate Adaptation Project is responsible for managing an inventory of development sites and activities for the coastal areas within the nine planning regions. This inventory will serve to assess ICZM Plan compliance and monitor proper implementation of the development guidelines for each region within the 4-year time period. In addition, NGOs such as Healthy Reefs for Healthy People are engaged in ecological monitoring that can be used to evaluate the ecological outcomes of the ICZM Plan. A regular report card put out every few years synthesizes field data on coral reef cover, fish density and biomass, and algal cover to track health of the reef system over time. The shoreline stabilization projects are also being monitored to track changes in local hydrodynamics and sedimentation processes.

Effectiveness (from biophysical and social perspectives)

With the ICZM plan approved in the middle of 2016 and the implementation of the shoreline stabilization projects still underway, it is too soon to know the efficacy of either the ICZM plan or the investments in nature-based shoreline protection. However, since the formal approval of the ICZM plan by The Government of Belize in the middle of 2016, CZMAI has completed an institutional assessment and identification of strategic actions towards strengthening the institutional structure and legislative framework for improved coastal zone management in Belize. CZMAI has also developed a "Short term Road Map" in support of coordinating the implementation of the Belize ICZM Plan. In addition, CZMAI has improved implementation of broad-based education and stakeholder engagement activities including, but not limited to, Coastal Awareness Week 2017 celebrated in partnership with the IDB under the theme "Business and the Environment: A Foundation for Sustainable Growth."

Key Lessons Learned

- Multiple rounds of stakeholder engagement, modeling of ecosystem services, and scenario development legitimizes the planning process and allows planners to incorporate both societal and scientific knowledge and solutions.

- ❖ Accounting for ecosystem services can inform the design of ICZM plans to enhance delivery of tourism, fisheries, and coastal protection related services beyond that which would have otherwise resulted from stakeholder engagement alone.
- ❖ Including outcomes in terms of ecosystem service supply and value allow for explicit consideration of multiple benefits from oceans and coasts that typically are evaluated separately in management decisions.
- ❖ An ecosystem services framework for coastal planning provides a common language through which multiple agencies can communicate and coordinate to achieve a shared vision.

Case 2: Development planning for Andros Island in The Bahamas

Description of the problem

The Island of Andros lies 40 miles to the west of Nassau, the capital of The Bahamas. Encompassing a land area greater than all other 700 Bahamian islands combined, Andros remains largely undeveloped. Vast mangrove and coppice forests, the third largest coral reef in the world, seagrass beds, sand flats, and a concentrated system of blue holes (unique, roughly circular steep walled carbonate depressions named for their deep blue waters) support the country's commercial and sport-fishing industries, nature-based tourism activities, agriculture, and freshwater resources. While there has been a concerted effort to provide the basic elements of human development to every island of the Bahamian archipelago; many parts of Andros still lack essential infrastructure such as piped water supplies and modern educational and healthcare facilities to support their livelihoods and those of generations to come. The central challenge confronting the Government of The Bahamas is to make investments that support sustainable economic development and promote education while also harnessing the island's wealth of natural assets and without sacrificing the ecosystems that underlie its economy and sustain the wellbeing of its citizens.

To address this challenge, the Office of the Prime Minister (OPM), with support from the Inter-American Development Bank (IDB), engaged in an innovative process to design a Sustainable Development Master Plan for Andros Island. The goal was to identify public and private investment opportunities, policy recommendations, zoning guidelines, and other management actions to guide the sustainable development of the island over the next 25 years. In consultation with Androsians, government agencies, NGOs, and other stakeholders, OPM worked with the Natural Capital Project (NatCap) to design a preferred island-wide future scenario depicting where human activities and a suite of environmental and social objectives could be harmonized. In early 2017 the planning process delivered a community-supported vision within which to embed specific development projects, policies, and investments.

Biophysical explanation of the relevant ecosystem service(s) in the specific case(s)

The ecosystems of The Bahamas deliver a suite of important benefits. As one of the more pristine islands, the environment of Andros is particularly unique. Andros has one of the highest densities of blue holes in the world. In addition to attracting tourists, these blue holes and other fascinating aspects of Andros' geology are research sites for scientists from around the world. The extensive sandflats and freshwater creeks provide critical nursery habitat for bonefish, a lucrative recreational fishery. Land crabs, a local delicacy and source of income generation, also use multiple coastal and marine habitats, with females laying their eggs in the nearshore waters, the early life stages occurring in the ocean, and juveniles and adults living in holes in the floor of the coastal forest.

Like many small island developing states (SIDS), The Bahamas is particularly vulnerable to natural disasters. Indeed, in the last four years several hurricanes have hit The Bahamas. Hurricane Matthew, in 2016, impacted the entire island chain including Andros Island. The results were approximately $600 million USD in damages across the country. Degraded seawalls and coastal structures highlight the challenge of investing in built infrastructure that requires regular maintenance. This challenge is amplified in a country of more than 700 islands with the majority of its financial and human capital concentrated on a single island (New Providence). As an alternative to traditional shoreline stabilization structures, the coral reefs, mangroves, coppice forests, and seagrass beds create three dimensional structure that traps sediments and attenuates waves.

Identification of the beneficiaries

All of the main settlements on Andros are coastal, which means that nearly the entire population of the island benefits to some extent from the coastal resilience provided by the barrier reef, coastal forests of mangrove and coppice, beach grasses, and underwater seagrasses. In particular, coastal hazard analyses conducted with the InVEST Coastal Vulnerability model combined with census data for Andros show that 50% of the population in the most exposed areas benefits from risk reduction provided by coastal and marine ecosystems. Other beneficiaries of sustainable development include the more than 2500 fishermen for spiny lobster, conch, grouper, snapper, and other fish living on the coral reef, across the Great Bahama Bank, and in the nearshore seagrass and sandflats. The bone-fishing sector on Andros is particularly lucrative with sport-fishermen spending several thousand dollars for a week of lodging on Andros and a local guide to take them to the best spots by boat. Finally, with the land crabs selling for $5-8/crab, many an islander spoke of how the local and nearby markets for crab "put my kids through college".

Identification of the suppliers

Much of the land of Andros Island is crown land -- that is owned by the government. In addition, many ecotourism lodges and small resorts dot the east coast of the island which is the most

populated area. Several of the owners have developed eco-conscious businesses both out of personal interests and because of the economic return from guests that are seeking a sustainable tourism experience. For example, Small Hope Bay has engaged in dune restoration for coastal resilience and put up signage explaining the benefits of the dunes to guests. Another resort, Kamalame Cay, caters to a high-end clientele interested in conservation, its cottages open to the sea, taking advantage of the ocean breeze in place of air-conditioning. The owner of this resort lives nearby in a home he built for his family tucked inside the mangrove forest to protect it from storms.

Design of Sustainable Development Master Plan for Andros Island

To identify public and private investment opportunities, policy recommendations, and zoning guidelines that would improve the livelihoods of Androsians, provide them with training and educational opportunities, improve access to tourists and employment, and enhance coastal resilience, and safeguard ecosystems that underlie human wellbeing, The Government of The Bahamas worked with stakeholders, agencies, NGOs and other stakeholders to design a Sustainable Development Master Plan for Andros Island. The approach was similar to the one used in Belize in that included stakeholder engagement, scenario development, and quantitative modeling of ecosystem services. However, in The Bahamas, because the financial support for the planning process was from a multi-lateral development bank and the central government (the Office of the Prime Minister) led the project, there was an even greater focus on development projects and the importance of ecosystems to human well-being and economic benefits.

Through an extensive stakeholder engagement process, the planning team created spatial data layers reflecting the current situation of human activities and four future development scenarios. The Business as Usual scenario represents a future similar to the current situation with little investment in new infrastructure, educational opportunities, or development. The Conservation scenario gives priority to ecosystem health and protection of habitats and species rather than economic development. For example, this scenario includes the ratification of a National Park for the Andros barrier reef, but no new coastal development. The Sustainable Prosperity scenario blends human development and conservation goals by investing in critical infrastructure and education to achieve a nature-based economy that can be sustained over time. Examples of activities include daily ferries from Nassau, small and mid-sized Bahamian owned businesses (e.g., hotels, processing factories for local goods), community agriculture, and mangrove restoration as both a natural means of shoreline protection from storms and a habitat for lobster. The Intensive Development scenario gives priority to major economic development rather than ecosystem health and protection of habitats and species. Example activities include construction of a cruise ship port in North Andros, large, energy intensive resorts and luxury housing developments, expanded mining activities, and seawalls along the entire east coast of the island.

Through iteration of stakeholder engagement, scenario development, and modeling ecosystem services, the Office of the Prime Minister, in collaboration with Androsians, the

University of The Bahamas, and the Natural Capital Project designed the Sustainable Prosperity scenario as the preferred scenario for sustainable development of Andros Island. A consulting firm then worked with the planning team and stakeholders to identify a suite of priority projects that would realize this scenario over a 5 year, 10 year, and 15 year time frame. Importantly, using an ecosystem services approach and participatory mapping showed that the citizens of Andros were less eager about massive new development projects that could pose severe risk to ecosystems and instead, wanted investments in degraded infrastructure like roads or processing plants for local goods within existing settlements that would allow them to better access – and safeguard -- the wealth of natural resources on the island.

How the Sustainable Development Master Plan is being used to inform investment decisions

Accounting for ecosystem services in the design of the Andros Sustainable Development Master Plan has helped to prioritize the financing of ecosystem restoration and conservation of coastal and marine ecosystems in The Bahamas. From a conservation perspective, the plan has provided the central government with a framework against which to evaluate – at least informally – several development proposals. For example, proposals for extensive mining in and around Andros (esp. related to aragonite) and for cruise ship development have been made. These kinds of activities and investments were included in the Intensive Development scenario for the future which the ecosystem service models suggested would lead to decreases in tourism, fisheries, and coastal protection related benefits and which Androsians rejected in favor of the Sustainable Prosperity scenario. The plan includes an explanation and the results of the ecosystem services assessment across alternative futures. Thus the plan provides quantitative information that stakeholders can point to during the evaluation of proposed infrastructure projects to show the potential costs to the environmental and human wellbeing of the island and to communicate about stakeholder consensus for the future of the island.

Accounting for ecosystem services in the design of the master plan also helped finance ecosystem restoration. In particular, the analysis for the plan highlighted the potentially negative consequences of traditional approaches to shoreline protection (e.g., seawalls) for the long-term health of fisheries, the tourism industry, and shoreline erosion. As a result of this work, the Government of The Bahamas and their development financing partners are considering mechanisms to fund several different coastal management projects across The Bahamas. Additionally, because of the ecosystem service analysis for the Andros Master Plan, the IDB and Government of The Bahamas are interested in using this island as a site to demonstrate the effectiveness of natural infrastructure for shoreline stabilization. The project includes $3 million USD for restoration of ecosystems such as mangroves. In addition to the coastal resilience benefits, the co-benefits (e.g., fisheries, tourism) of natural approaches to shoreline stabilization and flood protection are essential to the economy and livelihoods on Andros.

Monitoring and verification

No formal protocols have been developed for monitoring the Sustainable Development Master Plan for Andros. However, over the past several years The Bahamas has been engaged in a national development planning initiative called Vision2040. As a part of this effort, the Development Planning unit in the Office of the Prime Minster has integrated the United Nation Sustainable Development Goals (SDGs) into the planning framework for Vision 2040, as well as the monitoring and evaluation framework to track progress. There is also potential for applying the SDGs and their corresponding targets at the island scale to monitor master plans. In the case of the Andros Sustainable Development Master Plan, the ecosystem service objectives that the Office of the Prime Minister, NatCap, the IDB, and University of The Bahamas, used to explore the alternative scenarios proposed by stakeholders map nicely onto several of the SDGs. The goals that align well with the Andros plan include Life Below Water (SDG14), No Poverty (SDG1), Zero Hunger (SDG2), Good Health and Wellbeing (SDG3), Climate Action (SDG13), and Sustainable Cities and Communities (SDG11).

Effectiveness (from biophysical and social perspectives)

With the Andros Sustainable Development Master Plan recently approved in 2017 and a new partnership operation for mangrove restoration still in development, it is too early to know the effectiveness of the plan for achieving its long-term ecological, economic, and environmental goals. However, anecdotally the planning process has already been effective as a way for Androsians to identify and communicate what they want for their future. For example, the central government receives major development proposals and inquiries from national and international corporations with interests in Andros (e.g., timber, cruise ship, mining) and the Andros Master Plan provides a basis against which to review these proposals. In any country, but especially in an archipelago, it is often difficult for local communities to communicate with the central government about their priorities. With a road map in hand, such as the Andros Sustainable Development Master Plan, Bahamians are better equipped to say whether proposed projects align with the overarching vision and specific types of investments they desire for the future of their island. In addition, accounting for ecosystem services in development planning changed the conversation around investments in coastal infrastructure for disaster risk reduction. As a result, engineers in the Ministry of Works, Housing, and Urban Development are increasingly considering alternative natural and nature-based approaches such as mangrove restoration for coastal resilience.

Key lessons learned

- Full and repeated engagement among policy-makers, scientists, and stakeholders in building alternative visions of the future focuses and legitimizes the planning process.
- Measuring and comparing changes in the benefits of nature across scenarios helps people identify shared goals and understand trade-offs.

- ❖ Hand-drawn and printed maps reflecting stakeholder recommendations and large posters illustrating changes in ecosystem services can serve as 'boundary objects' during a sustainable development process, around which stakeholders, scientists and policy-makers can come together and share ideas.
- ❖ Ecosystem services can be used to evaluate the impact and benefit of a proposed master plan in economic, environmental, and social metrics, thus encouraging consideration of all three aspects of sustainable development together, throughout a planning process.

Recommended key references

Arkema K., G. Verutes, S. Wood, C. Clarke, M. Canto, S. Rosado, A. Rosenthal, M. Ruckelshaus, G. Guannel, J. Toft, J. Faries, J. M. Silver, R. Griffin, A. D. Guerry. 2015. Improved returns on nature's benefits to people from using ecosystem service models in marine and coastal planning in Belize. *Proceedings of the National Academy of Sciences.* 112 (24):7390–7395, doi: 10.1073/pnas.1406483112

Arkema K.K. and M. Ruckelshaus. 2017. "Transdisciplinary research for conservation and sustainable development planning in the Caribbean." In *Conservation in the Anthropocene Ocean: Interdisciplinary Science in Support of Nature and People*. Levin, P & M. Poe, Eds.:pp. San Diego, CA: Elsevier.

Coastal Zone Management Authority and Institute (CZMAI). 2016. Belize integrated coastal zone management plan. Belize City, Belize. Coastal Zone Management Authority and Institute. 265 p. https://www.coastalzonebelize.org/wp-content/uploads/2015/08/BELIZE-Integrated-Coastal-Zone-Management-Plan.pdf

Dobbs, R., Pohl, H., Lin, D.-Y. *et al.* (2013) *Infrastructure productivity: how to save* $*1 trillion a year*. McKinsey & Company, Seoul.

Dulac, J. 2013. *Global land transport infrastructure requirements*. International Energy Agency, Paris.

Sustainable Development Master Plan for Andros Island. February 2017. https://www.dropbox.com/s/dbkyw0lzvrbd6qk/AMP%20FINAL%20VERSION%20FEB%202017.pdf?dl=0

Verutes, G., K. Akema, C. Clarke-Samuels, S. Wood, A. Rosenthal, S. Rosado, M. Canto, N. Bood, M. Ruckelshaus. Integrated Planning that Safeguards Ecosystems and Balances Multiple Objectives in Coastal Belize. International Journal of Biodiversity Science, Ecosystem Services & Management. 13(3):1-17, http://dx.doi.org/10.1080/21513732.2017.1345979

Glossary

Bathymetry. The measurement of depth of water in oceans, seas, or lakes.

Easement. A right to use someone else's land for a specified purpose, such as for conservation measures (e.g., planting trees or fencing livestock away from open rivers and streams to maintain drinking water quality for downstream consumers).

Full-time-equivalent job-year. A unit of level of employment provided, in terms of the equivalent of one full-time job over one year. For example, four full-time six-month positions would be two full-time-equivalent job years.

In-kind payments. Compensation with a good or service instead of a monetary payment.

In lieu fees. A method of compensatory mitigation in which the permittee (the party responsible for impacts to wetlands or other habitat) provides funds to an in-lieu-fee sponsor (usually a government agency or non-governmental organization), rather than ("in lieu" of) the permittee undertaking mitigation directly or purchasing credits from a mitigation bank. The in-lieu-fee sponsor then uses funds aggregated from multiple projects to undertake mitigation activities.

Indigenous communities. The United Nations provides a working definition of indigenous communities, peoples and nations as "those which, having a historical continuity with pre-invasion and pre-colonial societies that developed on their territories, consider themselves distinct from other sectors of the societies now prevailing on those territories, or parts of them. They form at present non-dominant sectors of society and are determined to preserve, develop and transmit to future generations their ancestral territories, and their ethnic identity, as the basis of their continued existence as peoples, in accordance with their own cultural patterns, social institutions and legal system."

Mitigation ratio. The ratio between the amount of compensation required as compared to the amount of impact, usually measured in terms of area. For example, requiring 4 hectares of mitigation for every 1 hectare of impact to wetlands represents a 4:1 mitigation ratio.

Source water protection. *Actions* in watersheds or groundwater recharge areas to keep pollutants from getting into surface or ground water.

Tax base. The wealth (for example, assets or revenue) on which taxes are imposed.

Water main. A large pipe that supplies water to users in a particular area.

Figure data sources

Figure 2.2

OasisNYC.net, 2016. *Watersheds*. Available online at: http://www.oasisnyc.net/watershed/kmz/Basins_Sub-basins.kmz. Accessed October 2017

Watershed Agriculture Council. 2017. *Croton & Catskill/Delaware Watersheds.* Available online at: http://www.nycwatershed.org/about-us/overview/croton-catskilldelaware-watersheds/

U.S. Geological Survey, Department of the Interior. 2016. *USGS Small-scale Dataset - Global Map: 1:1,000,000-Scale Canals and Aqueducts of the United States 201406 Shapefile.* Available online at: https://catalog.data.gov/dataset/usgs-small-scale-dataset-global-map-1-1000000-scale-canals-and-aqueducts-of-the-united-states-

Figure 2.3-4-5

United States Department of Agriculture, Farm Service Agency, n.d. *CRP Enrollment and Rental Payments by County, 1986-2016.* Available online at*:* https://www.fsa.usda.gov/programs-and-services/conservation-programs/reports-and-statistics/conservation-reserve-program-statistics/index

Figure 2.6

Wannenburgh, A. 2015 *Key Working for Water datasets*. Available online at*:* http://www.arcgis.com/home/item.html?id=227cf316bed84a17be1bdea0d97044eb

Figure 3.1

Location of Water Funds in TNC portfolio courtesy of Emily Chapin, TNC

Figures 4.3-4

US Army Corps of Engineers. RIBITS (Regulatory In-Lieu Fee and Bank Information Tracking System) *Wetland mitigation banks and Conservation banks* Available online at : https://ribits.usace.army.mil/ribits_apex/f?p=107:158:11813919179114::NO::: Accessed October 2017

Figure 4.5

California Air Resources Board. 2017. *ARB Offset Credits Issued*, Available online at : https://www.arb.ca.gov/cc/capandtrade/offsets/issuance/arb_offset_credit_issuance_table.pdf. Accessed October 2017

Figure 5.2

National Conservation Easement Database, 2017. Available online at: https://www.conservationeasement.us/downloads . Accessed October 2017

Figure 5.3

ARPA location data: Courtesy of Michele Daily, WWF-US

Mayorga, E., M.G. Logsdon, M.V.R. Ballester, and J.E. Richey. 2012. LBA-ECO CD-06 Amazon River Basin Land and Stream Drainage Direction Maps. Data set. Available online http://daac.ornl.gov from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A. http://dx.doi.org/10.3334/ORNLDAAC/1086

Figure 6.3

Commonwealth of Australia, Department of the Environment ABN 34 190 894 983. *Murray-Darling Basin Boundary - Water Act 2007*. The boundary was derived from the dataset that is titled "Australia's River Basins 1997" and is dated 30 June 1997.

Figures 7.1-2

Data and base figures: Courtesy of Katie Arkema from:

Arkema, K. K., Guannel, G., Verutes, G., Wood, S. A., Guerry, A., Ruckelshaus, M., ... & Silver, J. M. (2013). Coastal habitats shield people and property from sea-level rise and storms. Nature Climate Change, 3(10), 913-918.

Figure 8.1

Medina, Waldy. 2012 (updated March 2014). *Capas SIG y Mapas del ACG*. Available online at https://www.acguanacaste.ac.cr/biodesarrollo/sistemas-de-informacion-geografica/capas-sig. Accessed November 2017

Figure 10.1

Arkema, K. K., Verutes, G. M., Wood, S. A., Clarke-Samuels, C., Rosado, S., Canto, M., ... & Faries, J. (2015). Embedding ecosystem services in coastal planning leads to better outcomes for people and nature. Proceedings of the National Academy of Sciences, 112(24), 7390-7395.

Acknowledgements

We are grateful to the many people who shared their expertise and provided feedback on these case studies, including Marc Diaz, Lauren Ferstandig and Craig Holland from NatureVest at The Nature Conservancy (TNC); Meg Symington, Hanna Helsingen, Thomas Barano and Emily McKenzie from World Wildlife Fund (WWF); Fredrick Kihara and Colin Apse from TNC Africa program; David Le Maitre and Nadia Sitas from CSIR, South Africa; Mary Ruckelshaus from the Natural Capital Project; Rob Pacheco of Hawaii Forest & Trail; and Sam Ham from University of Idaho; and Gregory Verutes, previously from the Natural Capital Project and currently at the Audubon Society.

We also thank Christa Anderson from Stanford University; Michele Dailey from WWF; Emily Chapin from TNC; and Katie Chang from Land Trust Alliance for generously sharing data for maps and figures.

Finally, we are deeply indebted to Peter and Helen Bing, and to Vicki and Roger Sant, who made the Natural Capital Project possible back when it was just a dream.

Back cover image: A man sets up for fishing along a river in Yangshuo, China.
Photo by Stacie Wolny.