Success Stories in Mainstreaming Ecosystem Services into Macro-economic Policy and Land Use Planning: Evidence from Chile, Trinidad and Tobago, South Africa and Viet Nam

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ProEcoServ
Project for Ecosystem Services

Success Stories in Mainstreaming Ecosystem Services into Macro-economic Policy and Land Use Planning: Evidence from Chile, Trinidad and Tobago, South Africa and Viet Nam

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The Global Synthesis Report of the Project for Ecosystem Services is an output of the four year Project for Ecosystem Services (ProEcoServ), a GEF-funded umbrella project aiming at piloting the bundling of ecosystem services and the integration of ecosystem services approaches into resource management and decision making. This project was implemented by the Ecosystem Services Economics (ESE) Unit of the Division of Environmental Policy Implementation (DEPI), UNEP, in partnership with the Centre for Advanced Studies in Arid Zones (CEAZA) in Chile, the Council for Scientific and Industrial Research (CSIR) in South Africa, the Institute of Strategy, Policy on Natural Resources and Environment (ISPONRE), Ministry of Natural Resources in Viet Nam, and the University of West Indies (UWI) in Trinidad and Tobago. This work has been designed and implemented under the overall direction of Pushpam Kumar, Chief, ESE Unit, DEPI, UNEP.

We regret any errors or omissions that may have been unwittingly made. Any comments or corrections can be sent to publications@unep.org.

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FOREWORD

Environmental, social and economic dimensions of human development need to be integrated through scientifically credible pathways, taking advantage of new knowledge and accumulated wisdom of the local people. The Global Environmental Facility (GEF) supported Project for Ecosystem Services (ProEcoServ) implemented in four pilot countries – Chile, South Africa, Trinidad and Tobago, and Viet Nam – from 2011 to 2015, has successfully demonstrated the application of tools and approaches for mainstreaming ecosystem services (ESs) into macro-economic policy. At national and sub-national level, the findings were scientifically robust. Bio-physical assessments and economic valuation estimation results were used for: (1) sustainable development planning; (2) poverty reduction strategies; (3) development of indicators like gross domestic product (GDP); and (4) application of innovative policy tools like Payment for Ecosystem Services (PES) in the pilot countries.

The GEF recognizes the success of ProEcoServ as it has shown empirical evidence on how ecosystem services impact welfare and economies, and influenced some key policy processes in pilot countries. For example, in South Africa, insurance companies seek information on the value of ESs in the mitigation of natural disaster risk, leading to the creation of public private partnerships (PPPs) in this area. In addition, the National Water Resource Strategy and National Development Planning recognize the role of ecosystem services as forming an integral part of ecological infrastructure. In Viet Nam, the National Green Growth Strategy to 2020 captures the findings from Ca Mau region, while in Trinidad and Tobago the Green Fund uses payment for ecosystem services such as shore protection; carbon sequestration has also been facilitated by the values attributed to forest and coastal ecosystems. In Chile the first ever Tourism Development Plan for the Municipality de San Pedro de Atacama recognizes the need for sustainable land and tourism management in one of the driest landscape in the world.

ProEcoServ has therefore been successful in demonstrating the key role of the science–policy interface and highlights the continued need for the use of interdisciplinary science for greater social credibility and acceptability. Its importance in local/national development planning is a leap forward towards the goal of mainstreaming natural capital for human wellbeing. This, in turn, contributes towards the achievement of an inclusive green economy and sustainable development goals.

Achim Steiner

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EXECUTIVE SUMMARY

The Project for Ecosystem Services (ProEcoServ) is UNEP's flagship project focused on the valuation and mainstreaming of ecosystem services into policy design within the larger ambit of sustainable development. It builds on the Millennium Ecosystem Assessment (MA), its sub-global assessments, and the ongoing MA follow-up process. The project had pilots in four countries: South Africa, Trinidad and Tobago, Chile, and Viet Nam. During the four years of the project, ProEcoServ facilitated policymakers in pilot countries to access scientific information on how ecosystem services impact human welfare and economies. More importantly, ProEcoServ successfully demonstrated the processes for the uptake of ecosystem assessment policy tools by decision makers. This was achieved by developing tools and products to be used by policymakers, using ProEcoServ information to support key sector investment decisions and macro-economic models. Ultimately, ProEcoServ left a lasting legacy in the pilot countries in their spheres of governance, ranging from local, provincial, national and regional levels.

The project was developed over a period of four years, 2011 to 2015, and implemented in four pilot countries, including South Africa, Trinidad and Tobago, Chile and Viet Nam.

ProEcoServ – South Africa

In South Africa, ProEcoServ adopted a multi-scale valuation approach including case studies of local-scale decision making, planning and approaches for mainstreaming ecosystems services for national-scale policy awareness and engagement. Particularly at the national level, ProEcoServ produced national ecosystem service maps, delivered a solid outreach and communications strategy, promoted public-private cooperation, and established a framework for investment in ecological infrastructure that in turn has been adopted in national policy and planning. At the sub-national level, ProEcoServ explored the use of two pilots, one in the Eden District Municipality and another in the Olifants Grassland Catchment, where it explored ecosystem services-based strategies for disaster management and sustainable water resource management, respectively. A final case study focused on transboundary ecosystem service management between South Africa and Lesotho. The team was particularly successful in bringing forward – and demonstrating – the relevance of ecological infrastructure, the nature-based equivalent of built infrastructure, as a crucial factor for social and economic development. Stakeholders were brought together to co-develop a framework for guiding new investments in ecological infrastructure, and to communicate the framework widely across their networks. The framework provides some key principles for investing in ecological infrastructure, while considering the scope for resource mobilization, and key research needs for supporting investment in ecological infrastructure. Moreover, policy instruments such as the National Development Plan and the National Infrastructure Development Plan, two of the most powerful planning processes in South Africa, adopted this concept in their narratives with particular focus on freshwater management decisions. In particular, ProEcoServ developed maps of strategic water source areas, which cover only 8 per cent of the country but contribute to more than 60 per cent of the national economy and support half of the total population. This information was also incorporated into the National Water Resources Strategy, and the development of a network of government agencies to support the effective use of freshwater maps in the classification of water resources. ProEcoServ also focused on understanding the causes of extreme weather events (flood, drought, wildfire and storm-waves) and disseminated new ways of building resistance and resilience using an ecosystem service-based approach. This included collaborating with the insurance sector in the Eden District Municipality. In the 2014 January floods, damages and losses in this area alone amounted to 66 million USD – double the amount of the annual financial budget of the District Municipality. In this context, cooperative efforts by the insurance sector evolved to understand the drivers of disaster risk in the District Municipality and to identify and implement appropriate response strategies for disaster risk management. The findings highlighted that land-use management that is cognizant of the role of ecosystems in regulating natural hazards can reduce the risk of disasters, in some cases, substantially. To address this, Santam – South Africa's largest short-term insurer – is engaging with the South African Insurance Association in an effort to mobilise the industry as a whole to get involved. If these efforts are successful, this leads to industry-wide changes in the way risk is understood and tackled, including the recognition of socio-ecological systems for reduced disaster risk (i.e. managing for improved buffering capacity, increased natural hazard regulation, and reduced vulnerability). At national scales, the work supported inputs into disaster management legislation and budgeting processes to allow for pro-active ecosystem-based management for extreme events. ProEcoServ provided inputs into the national Disaster Management Amendment Bill, National

Disaster Management Centre and National Treasury processes to create opportunities for ecosystem-based interventions in the disaster risk management cycle.

ProEcoServ – Trinidad and Tobago

As a small island developing state, Trinidad and Tobago's national economic activity, environmental security, and human health crucially depend on biodiversity and ecosystem services. On both islands of the country, biodiversity and ecosystem services play a major role in supporting activities such as tourism and agriculture; in providing a dependable supply of drinking water; in creating opportunities for subsistence livelihoods; and in protecting the population against natural hazards and the adverse impacts of climate change. In this context, ProEcoServ focused on three main areas with the common objective of mainstreaming biodiversity and ecosystem services into development policies. The first area of work referred to the integration of biodiversity and ecosystem services considerations into land use/spatial planning. ProEcoServ partnered with the Ministry of Planning and Sustainable Development, with the project team building strong and lasting relationships with the Minister and the technical staff. Geographic Information System (GIS)-based maps for spatial planning have also been made available to the Ministry for their use – these include (1) pollination maps for the Nariva Swamp – Ramsar site – and other selected agricultural sites in Trinidad; (2) maps on sediment retention and water purification for the Northern Range in Trinidad; and (3) coastal vulnerability maps for southwest Tobago. In addition to this, the Town and Country Planning Division of the Ministry of Planning and Sustainable Development requested training from ProEcoServ in decision support tools used in biodiversity management in the context of land use planning. Training sessions were successfully delivered. More importantly, ProEcoServ played a key role in bringing forward biodiversity and ecosystem services considerations to be integrated into the National Spatial Development Strategy. Furthermore, ProEcoServ was explicitly cited for this role in one of the Government's overarching policy documents (titled Working for Sustainable Development in Trinidad and Tobago). The second focal area of ProEcoServ was the introduction of Natural Capital Accounting into the national fiscal planning regime in Trinidad and Tobago. With the help of international experts a methodology was developed and adapted for Trinidad and Tobago, and on the basis of this, demonstration accounts have been produced for water, carbon, biodiversity and land. Following completion of the demonstration exercise, a gap analysis was performed resulting in the production of a scoping paper for the introduction of ecosystem services accounts in Trinidad and Tobago. These findings, including their application and implications, are currently being discussed with the Ministry of Finance and the Economy and the Central Statistical Office in Trinidad and Tobago. To support these efforts, Trinidad and Tobago nominated two government representatives to attend the United Nations Statistical Division training on natural capital accounting for Latin America and the Caribbean. The third area of work of ProEcoServ refers to the exploration of the potential for developing a payment for ecosystem services (PES) pilot. With the help of consultants, a roadmap has been put together and is ready for piloting. ProEcoServ invested significant amount of effort into capacity-building and raising awareness around PES, and the project team is working with the Ministry of the Environment and Water Resources to sort out the legal and administrative details for implementing PES.

ProEcoServ – Chile

In Chile, the project developed a "Water Balance Model" that was used to simulate the hydrological balance in the Atacama plateau and the underlying inter-connections between ecotourism, recreation, the condition of this desert area and its potential for water provisioning. In the region, management of water provisioning is important not only to recreationists and the local population but also important in supporting local biodiversity, including birds such as the flamingo, which are touristic attractions. This model is at the core of a decision support system that is not only used for municipality land use management policy but has also been mainstreamed into regional biodiversity conservation. In addition, ProEcoServ compiled data measurements on water demand, tourism flows and biodiversity indicators in a systematic way and brought this together in a user-friendly software platform that made the data available for the community. Finally, ProEcoServ strengthened the relationships across the different local stakeholders as well as trust-building between the project and local communities and organizations. This trust-building capital also contributed to improving the communication between regional and national authorities. These processes facilitated the mainstreaming, scaling-up, and applicability of ProEcoServ ecotourism/water/biodiversity tools to other areas in Chile. As an outcome of the successful work, the ProEcoServ team has been invited by the regional government to expand the work to other areas in Chile in collaboration with several institutions namely the Corporación Nacional Forestal, Servicio Nacional de Turismo, Seremi Medio Ambiente and Dirección General de Aguas.

ProEcoServ – Viet Nam

ProEcoServ's initiative in Viet Nam focused on the Cape Ca Mau National Park/Biosphere Reserve and the surrounding Mekong Delta, in the Ca Mau Province – covering 12 per cent of the country and comprising one of the largest remaining contiguous mangrove forests in the country. The objective of ProEcoServ was to support Ca Mau Division of Natural Resources and Environment and the Ca Mau National Park management to integrate ecosystem services into land use planning. In particular, ProEcoServ created ecosystem service models to assess carbon storage and coastal vulnerability of Ca Mau ecosystems. The project developed coastal vulnerability and carbon sequestration maps and carried out a valuation study on ecosystem services of mangroves. The study highlighted that the economic value of the coastal protection service provided by mangroves in Ca Mau averages USD 2,600 per hectare per year, which is 25 times more than timber market value of mangroves. In addition, the national team provided technical support and input to mainstream ecosystem services for two important national strategies (1) National Strategy on Green Growth and (2) National Strategy on Environment Protection to 2020. These efforts were led by Ministry of Planning and Investment and Ministry of Natural Resources and Environment. The Strategy's specific objectives include the environmental remediation and rehabilitation of degraded areas and a reduction in natural resource degradation and depletion levels. Finally, ProEcoServ established partnerships with different initiatives and communities of practice, enhancing awareness of national and provincial decision makers on the value of ecosystem services for human well-being. Moreover, the ProEcoServ team took the lead in making "Increasing Investments in Natural Capital in the Greater Mekong Sub-region" the theme of the Fourth Greater Mekong Sub region Environment Ministers' Meeting held in 2015. One of the objectives of the high level session was mainstreaming natural capital considerations into socio-economic planning and investment decision making processes. The Viet Namese officials presented ProEcoServ – Viet Nam as a "best practice" initiative in the mainstreaming session.

1. INTRODUCTION

1.1. Background and context

The Global Environmental Facility (GEF)[1] supported Millennium Ecosystem Assessment (MA) concluded that more than 60% of the world's ecosystem services are either degraded or used unsustainably. There is increasing evidence that many changes inflicted by human activities are potentially irreversible, particularly with regard to biodiversity, with likely negative impacts on development and human wellbeing that are disproportionately borne by disenfranchised people at local levels. Particularly affected are regulating ecosystem services, such as air quality regulation, climate regulation at regional and local levels, erosion regulation, water purification and waste absorption, as well as natural hazard regulation. This degradation constitutes a significant barrier to achieving the Millennium Development Goals, if it is not reversed through a set of changes in policies, institutions and practices to conserve or enhance ecosystem services that avoid negative trade-offs and instead provide positive synergies among ecosystem services.

Independent evaluations attest the MA's emphasis on ecosystem services to having clarified the environment-development nexus and the linkages between biodiversity conservation and poverty alleviation in particular. The MA is also widely regarded as having been an innovative and technically sound assessment with high probability of impacting future applied research. The evaluations also concluded, however, that the MA's main strength as a scientific assessment compounded its main weakness: there is little evidence so far that the MA has made a significant direct impact on policy formulation and decision making, especially in developing countries. This has been linked to:

- A generally rather weak focus on sub-global assessments (SGA) within the MA
- A very limited involvement of national and local stakeholders that ultimately make decisions affecting biodiversity and ecosystem management and act upon these
- The lack of tools, models and methods palatable to decision making that can also be readily applied at implementation levels

There is a range of programmes and projects that have begun to address these weaknesses of the MA outcome, not least many funded through the GEF — e.g. on institutionalising payments for ecosystem services (PES). Many sub-global assessments (SGAs) have also been undertaken in the wake of the MA, particularly at sub-national but also at regional levels. A 2008 survey of SGAs for the Convention on Biodiversity Conservation (CBD) Secretariat asserts an increased involvement of and impact on decision makers through ongoing SGAs[2]. However, among the remaining challenges were:

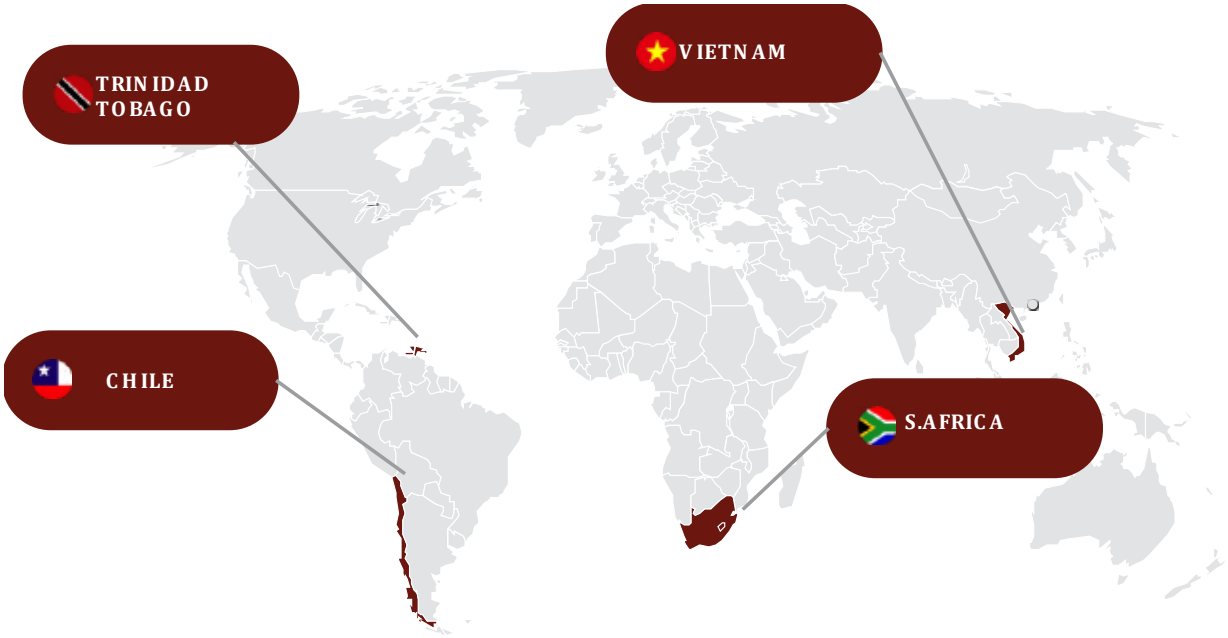
- Lack of data to establish baselines, and to develop tools, models, valuation of ecosystem services or indicators
- Capacity at local levels to carry out assessments of ecosystem services
- Weak institutional and governance arrangements to take up the assessment results and recommendations in policymaking
- Weak market incentives and regulations to support establishment and scaling up of payments for environmental services

ProEcoServ, a GEF-funded umbrella project, aims to address these challenges through a multi-scale approach across four pilot countries, including Chile, South Africa, Trinidad and Tobago, and Viet Nam. The overall developmental goal of the project is to utilise ecosystem assessment and economic valuation to better integrate ecosystem services into poverty reduction and sustainable development planning. ProEcoServ took place in four pilot countries, which were South Africa, Trinidad and Tobago, Chile, and Viet Nam between 2010 and 2015 – see Figure 1.1

1 Global Environment Facility is a partnership for international cooperation where 183 countries work together with international institutions, civil society organizations and the private sector, to address global environmental issues. As a financial mechanism, it seeks to provide funds and deliver on projects related to conventions that include the Convention on Biological Diversity and the United Nations Framework Convention on Climate Change (UNFCCC), among others.

2 See UNEP/CBD/COP/9/INF/30.

Figure 1.1: ProEcoServ pilot countries



ProEcoServ builds on the legacy of the Millennium Ecosystem Assessment (MA, 2005), which provided a comprehensive framework and assessed the consequences of ecosystem changes for human well-being, while promoting the scientific basis for action in the conservation and sustainable use of such systems. With a focus on site-specific assessments, close engagement of local and national stakeholders, knowledge transfer of appropriate tools, methodologies and strategies, the project sought to better incorporate or 'mainstream' ecosystem management into national policy planning and decision making.

1.2 Pilot countries

1.2.1 Chile

Chile extends along the western shore of South America, bordered by the Pacific Ocean and separated for millions of years from the rest of the continent by the Andes, the Patagonian Steppe, and the Atacama Desert. With a length of 4,300 km, Chile stretches 36 latitudinal degrees. These conditions, combined with the altitude ranges from sea level up to 5,000 m, have produced an extraordinary diversity of climates, ecosystems and habitats. In the north of the country, this rich biodiversity meets with the Earth's driest desert, the Atacama Desert. The current project is located in the unique landscape of the Antofagasta Region of Chile, where the biodiversity of these drylands is of particular significance because it includes many unique ecosystems. In particular, many species living in dryland habitats have developed unique adaptations to the potentially harsh conditions.

Between 2004 and 2005, a sub-global assessment (SGA) was conducted in the San Pedro De Atacama (SPA) Municipality, located in the Al Loa Province of Chile's second region. The SGA focussed on water, tourism, biodiversity, mining and astronomy, and provided a comprehensive set of recommendations for the management of the ecosystem services associated with these elements. San Pedro De Atacama is characterised by multiple users of ecosystem services in an adverse physical environment. Increasing conflicts amongst these various users of ecosystem services in the area often relate directly to access and decision making authority over water, and to the desired future direction of tourism. These conflicts have been augmented by various factors since the 1980s, including a mining boom in the 1980s and the explosion of tourism since the 1990s. As a result, local employment has experienced a gradual, but constant transformation. SPA has shifted from being a municipality where the main activities were agriculture and livestock, to one where most of the labour force work in construction, mining and tourism. The new economic activities and significant public investment have helped alleviate poverty in SPA to the extent that in 1996 it was removed from the list of 20 most poverty-stricken municipalities in Chile.

Throughout the Antofagasta Region, the primary economic activities relate to the extraction and transformation of metallic and non-metallic minerals, which constitutes 60% of the Regional Gross Domestic Product (GDP).

Key minerals in the region include copper, molybdenum, silver, sulphur, and lithium carbonate. Locally in San Pedro however, the burgeoning tourism industry has resulted in a more diverse economic base, with the main activities generating employment in the municipality including: construction (18%), hotels and restaurants (15%), and mining (11%). In 1982 agriculture represented the main income-generating work for about 32% of the economically active population in the municipality; in 1992 this figure only reached 21%. Tourism has been the fastest growing sector in the last decade (10%), with roughly 50,000 tourists visiting the area each year. Amongst the Atacameño people, 9% of the working population are involved in agriculture. Tourism seems to be the preferred development option for both the Atacameño communities and outsiders, both resident and non-resident. This activity experienced sudden and unregulated growth triggered by the arrival of entrepreneurs who set up the first campsites and tourism agencies, followed by hostels and restaurants, and finally diverse categories of hotels and internet cafés. This has led to a marked change in the lifestyles of the Atacameño communities, particularly those living in the settlements of San Pedro de Atacama followed by an increased stress on water resources.

In this context, this project attempts to generate and mainstream the production information on water resources. Data were generated to develop practical decision support tools to guide decision makers on choosing development strategies, notably regarding spatial planning.

Box 1.1: Chile: global significance

The Atacama Salar is a wetland ecosystem, and is considered to be accredited under the RAMSAR Convention on Wetlands, similar to two other salar ecosystems in the Antofagasta region that are already RAMSAR wetlands. High Andean Wetlands constitute a habitat for migratory or stationary species and they are generally a biological diversity reservoir for the entire region. The wetlands provide important environmental services including water quality/quantity maintenance and aquifer recharge. These wetlands are also shelters and breeding zones for a great number of species with conservation problems such as Andean flamingo (*Phoenicoparrus andinus*), James' flamingo (*Phoenicoparrus jamesi*), Chilean flamingo (*Phoenicopterus chilensis*), condor (*Vultur gryphus*), horned coot (*Fulica gigantean*), rufous-bellied seedsniper (*Attagis gay*i), least seedsnipe *(Thinocorus rumicivorus*) and American kestrel (*Falco sparverius*). In addition, they are a fundamental component of the habitat for highly economic and ecological important species like the vicuna (*Vicugna vicugn*a) or the vizcacha (*Lagidium viscacia*). These wetlands are strategic stop-overs for a significant number of migratory birds. The three previously mentioned flamingo species that exist in the high Andean wetlands are included in Appendix I of the Convention on International Trade of Endangered Species of Wild Flora and Fauna (CITES) and of the Convention on the Conservation of Migratory Species of Wild Animals (CMS). However, as the Atacama Salar holds over 40% of the world's lithium reserves, and just a single company has a mining concession for over 60% of the salar surface, the salar is currently the focus of controversy due to the impacts on water availability resulting from lithium extraction, and the knock-on effect for the fragile dryland ecosystem.

1.2.2 South Africa

Southern Africa's ecosystems are globally recognised as some of the most biodiverse systems in the world. Humans have long been an integral component of these ecosystems dating back over 50,000 years. As the "cradle of humankind", these ecosystems have co-evolved together with their human inhabitants from largely rangeland systems supporting hunter-gathers and later nomadic pastoralists, to today's landscape of increasingly urban and monoculture agricultural systems.

These changes to the region's ecosystems have brought with them significant improvements in many elements of human well-being. However, these improvements have not been felt by all, especially the rural poor and marginalised and have come at a cost to biodiversity, available freshwater and the quality of land, soil and vegetation. Furthermore, it is now clear that these ecosystems are life support systems, providing ecosystem services such as freshwater, food, fuel, fertile soils and recreation and spiritual opportunities (among many other benefits). This life support is of enormous importance to all inhabitants, and especially rural and poor communities. The sub-global Southern African Millennium Ecosystem Assessment (SAfMA) highlighted this importance, as well as the fact that recent changes in ecosystems and biodiversity have compromised the ability of these life support systems to support and enhance the quality of life of all citizens now and in the future. Of key concern are the declines in biodiversity and ecosystem services associated with already limited water resources. SAfMA highlighted how these declines will be further exacerbated by global change, especially in vulnerable communities.

Box 1.2: South Africa: global significance

South Africa is recognised for their high levels of biodiversity, especially of endemic species. Together they house a rich and spectacular array of terrestrial, aquatic and marine ecosystems occupying less than 2% of the land's surface area, but home to more than 10% of the world's plants and more than 7% of the world's mammals, birds and reptiles. They are also the location of three globally recognised biodiversity hotspots: the Cape Floristic Region; the Succulent Karoo (a semi-arid biodiversity hotspot); and the Maputaland-Pondoland Albany hotspot; unique Afrotropical biogeographic ecoregions, and other types of biodiversity priority areas. These biodiversity priority areas are recognised on the basis of their high levels of species diversity, especially of endemic species, as well as the substantial threats that they face from human activities. South Africa and Lesotho are also the location of the grassland biome, one of the most diverse, most threatened and least conserved biomes in the world (White et al 2000; MA 2005). This biome covers more than two-thirds of South Africa and the entire extent of Lesotho, and is the source of most of the region's water, food, medicinal plants and fuel (especially coal for electricity). A final contributor to the global significance of this project is its focus on the links between biodiversity and water management. While the region is richly endowed with an array of natural resources, there is one exception – water. And as water affects every activity and aspiration of human society and sustains all terrestrial and aquatic ecosystems the value of managing and maximising water flows, while minimising any adverse social and ecological impacts, is a key challenge to the future of the country's development. While the traditional approach to this challenge has been an increase in manufactured infrastructure like dams, transfer schemes and groundwater abstraction, this project with its focus on the bundle of regulating services which support and enhance the quality and quantity of available freshwater, will aim to highlight the role that biodiversity (or ecosystem infrastructure) can play in maximising the available water. By establishing the linkages between biodiversity conservation and the valuable water that these ecosystems provide, making the case for integrated ecosystem and catchment management, providing the necessary information and tools for informed decision making and helping to bridge the gap between science and policy we aim to distil lessons and methods relevant to all water stressed regions.

SAfMA succeeded in raising the profile of the need for sustainable biodiversity and ecosystem management in the region. It also helped to lessen the divide between conservation and development, illustrating that social and economic development depends on judicious management of ecosystem services. It played a pivotal role in highlighting the perilous state of the region's water resources and the opportunities and challenges associated with current water governance arrangements. However, in a similar fashion to the global Millennium Ecosystem Assessment, there is currently little evidence that SAfMA has had a direct impact on policy development and decision making in the region.

This gap between science and policy is linked to the fact that policy and decision makers are often uninvolved in and unaware of the research. Furthermore, the knowledge and data produced are often not in a format useful to the country's decision makers who need tools and information that they can apply in their day to day activities (Cowling et al. 2008)[3]. Faced with these realisations it has become clear that if ecosystem research and development is aimed at ensuring the sustainable management of the region's biodiversity and ecosystem services, then it must be embedded in a social process involving policy and decision makers in order to develop information, knowledge and tools to be mainstreamed into decision- and policy-making.

In this context, this project attempts to bridge this gap between science and policy in ecosystem management in Southern Africa, and by so doing distils lessons for use in other parts of the world. The project builds on SAfMA, especially the Gariep Basin Assessment (one of the nested scales of assessment), and focuses on the countries of Lesotho and South Africa in carrying the work of SAfMA forward into decision making and policy implementation.

1.2.3 Trinidad and Tobago

Trinidad and Tobago is the most industrialised country in the Caribbean relative to its size, and industrial development is often in conflict with environmental conservation. Rapid industrial development, which is largely based on development of the petroleum and petrochemical sector in Trinidad, has expanded to the

3 Richard M. Cowling, Benis Egoh, Andrew T. Knight, Patrick J. O'Farrell, Belinda Reyers, Mathieu Rouget, Dirk J. Roux, Adam Welz, and Angelika Wilhelm-Rechman (2008) An operational model for mainstreaming ecosystem services for implementation, PNAS, vol. 105 no. 28, pps 9483–9488.

Box 1.3: Trinidad and Tobago: global significance

As reported by Caribbean Sea Ecosystem Assessment (CARSEA) 'the Caribbean Sea has been critically assessed and ranked by experts as having the highest priority for conservation of a marine eco-region in Latin America and the Caribbean (Sullivan Sealy and Bustamante 1999). The two ecologically distinct small island groups of the region, the Bahamian and the Lesser Antilles (of which Trinidad and Tobago is a part), each have very high percentages of endemic species, many of which are endangered. Also the Caribbean islands as a whole have been classified as a biodiversity hotspot, meriting global priority for conservation purposes (Myers et al., 2000). Although this classification reflects the diversity and vulnerability of land-based flora and fauna, the many interactions between marine life and island habitats make it highly relevant to the global importance of the Caribbean Sea ecosystem. Trinidad and Tobago offer unique island observatories and early warning systems for larger more extensive tropical country ecosystems. Because of its proximity to the Venezuelan coast, the island of Trinidad has much of the plant biodiversity of the South American mainland, but on a scale where small impacts on ecosystems are very noticeable. The high pressures on land due to small land area, and growing population and industrialisation, mean that ecosystems are in constant threat from development. In addition, the limited extent of the ecosystems and the low buffer capacity, mean that changes to ecosystem services are rapidly noticeable and quickly have social and economic impacts that may take much longer on a comparative mainland site. Hence, the islands provide a unique opportunity to study and evaluate complex ecosystem/human interaction, at shorter time scales than larger countries, so that findings can help develop broader global policy before problems occur at larger scales

extent that Trinidad is the largest supplier of Liquefied Natural Gas to the United States and the number one exporter of ammonia in the world. In Tobago, rapid expansion of the tourism sector has led to Tobago becoming a popular tourist destination in the Caribbean especially for visitors from the United States and Europe. Whereas these developments have given the country global recognition and attention, the Government of Trinidad and Tobago's Vision 2020 Operational Plan 2007-2010 and National Environmental Policy 2005 have made clear its intention to find the right balance between economic development and environmental conservation so that the country does not compromise its own future. As noted by Vision 2020 Operational Plan 2007-2010 the twin-island Republic of Trinidad and Tobago 'like other small island developing states has a fragile natural resource base which allows limited room for error in its utilisation and management'.

A Millennium Ecosystem Assessment (MA) sub-global assessment (SGA) of the Northern Range of Trinidad and Tobago (Northern Range Assessment, 2005) assessed the condition and trends of several ecosystem (including regulatory) services and their contribution to human well-being. Another MA SGA of the Caribbean Sea and coastal areas (CARSEA) similarly documented the general decline in ecosystem services and the mismatch between the provision of services and the scale of governance.

At the national level, the Parliament of Trinidad and Tobago approved a National Environmental Policy in 2005 that contains a mandate to "Conserve life-support systems i.e., the ecological systems that cleanse air and water, regulate water flow, recycle essential elements, create and regenerate soil and enable ecosystems to renew themselves." It also identifies other sustainable benefits such as "oxygen production, carbon fixing, aquifer recharge, stabilisation of soils against erosion, prevention of flooding and the provision of animal habitats." The Government of Trinidad and Tobago has provided legal protection to some of the areas that provide these ecosystem services areas under the Forest Act (1980) and the Environmentally Sensitive Areas Rules (2001) but much more needs to be done.

In this context, the proposed project addresses an important scientific gap in the analysis of coupled social-ecological systems identified by the MA and suggested as one of the priorities for new research on ecosystem services beyond the MA. Carpenter et al. (2009)[4] point out that the MA sub-global assessments were replete with examples of complex feedback that could not be represented as simple ecologically-based causal chains. Particularly, this project focuses on identifying and spatially mapping areas, which provide key bundles of ecosystem services in the Caribbean Sea and coastal environment of Tobago along with some case studies.

4 S. R. Carpenter et al. (2009) Science for managing ecosystem services: Beyond the Millennium Ecosystem Assessment. *Proceedings of the National Academy of Sciences of the United States of America* 106(5): 1305-1312.

1.2.4 Viet Nam

In Viet Nam, ecosystems and biological resources are a part of the country's economy and culture. Biodiversity makes a significant contribution to the national economy by ensuring food security, maintaining the gene resources of livestock and plants, and by providing materials for fuel, medicine and construction.

Biodiversity protection in Viet Nam is incorporated in different legislative forms and sectors. The principles and general regulations for biodiversity protection, included in the Law on Environmental Protection (1993 and 2005), are an important foundation for the further development of specific regulations towards comprehensive biodiversity protection. Species and ecosystems are basic components of the environment; legislation on biodiversity protection, therefore, must be an inseparable part of environmental laws. Sectoral legislation specifies regulations for biodiversity protection within the sector, for instance the law on forest protection and development contains regulations for forest-based biodiversity; the decree 109/2003/ND-CP includes regulations for the protection of wetland biodiversity, or ordinances on plant varieties and domestic animals regulate the protection of genetic resources of plants and domestic animals. In addition, some regulatory measures for biodiversity protection are also found in criminal law and administrative law.

Currently, a system of 128 protected areas has been established and developed in all ecoregions nationwide, covering an area of 2.5 million hectares or about 7.6% of the territory of Viet Nam. In late 2008, the Prime Minister approved a system of 45 interior protected wetlands. Another system of 15 marine protected areas is in planning and has been submitted to the Government for approval. Moreover, two World Natural Heritages, four Association of Southeast Asian Nations (ASEAN) Natural Heritages, two Ramsar Wetlands and six Biosphere Reserves are internationally recognised.

The Downstream Mekong River Delta, also commonly known as the Cuu Long Delta, the Mekong Delta or the Delta, is the most southern region of Viet Nam. The Delta of 39,000 km^2 covers 12 provinces, from Long An to Ca Mau, and accounts for 12% of Viet Nam's total land area. The Mekong Delta presents the most typical wetlands in the Mekong Basin because (1) its biodiversity is abundant; (2) it is most strongly influenced, both positively and negatively, by the Mekong River's operation regime; and (3) it is a zone that intensively interacts with the sea. In the Cuu Long Delta, there exist a wide range of ecosystem types, from coastal mangrove to inland *Melaleuca*, from estuarine and aquaculture to agricultural ones. Each type has its own features with regard to species distribution, area, or services it provides. Among the ecosystems in the Delta, the coastal mangrove, the inland *Melaleuca* and the estuarine are of greatest concern in terms of biodiversity, while rice cultivation, shrimp and fish breeding should be noted due to their immense provisioning capacity and economic value.

Box 1.4: Viet Nam: global significance

The Mekong Delta has a total area of approximately 3.9 million hectares, occupying about 12% of the total natural area of Viet Nam, including thirteen provinces and cities. The wetlands of the Mekong Delta are among the richest ecosystems of the basin (tidal floodplains, coastal marshes, peatland marsh, estuaries, etc.) and are important breeding sites for many aquatic species migrating from upper reaches of the Mekong River. Wetlands are of importance for the entire Mekong Basin in general and for the Mekong Delta in particular. They present not only ecological-environmental values but also socio-economic ones. The wetlands in the Mekong Delta encompass areas of valuable biodiversity and fertile areas for cultivation. It is these areas in the Mekong Delta that have long since been the rice granary of Viet Nam, which contribute around 80% of the exported rice quantity of the nation. Viet Nam has been one among the world's leading shrimp exporters for the last decade, and most of Viet Nam's exported shrimp come from this region. The biodiversity of the wetlands of Mekong Delta is very rich, mostly present in Ca Mau's mangrove ecosystem. Ca Mau has 239 flora species belonging to 76 families. The mangrove forest consists of 93 species of 38 families; the remaining 201 species of 74 families are distributed in fresh water swamp and other wetland ecosystems. In Ca Mau, there are about 101 species of 41 families living in the flora in bird grounds. The fauna of Ca Mau is very abundant, particularly aquatic species (fish, crustaceans, molluscs, reptiles and amphibians) and bird species. The mangrove forest of Ca Mau records 44 genera of phytoplankton, 63 fish species, 50 bird species of 15 families, 12 mammal species and 12 reptile species (Mai Dinh Yen, 1996). High value species of Ca Mau include bees, molluscs (hard clam, blood cockle), crustaceans (mud crab), and shrimp (black tiger, white shrimp, greasy-back shrimp, giant prawn). Ca Mau Cape (Mui Ca Mau) was recognised by UNESCO as a World Biosphere Reserve in 2009, being home to more than 100 rare and endangered species of fauna.

Between 2003 and 2005, the "Downstream Mekong River Wetlands Ecosystem Assessment in Viet Nam" was conducted as a Millennium Ecosystem Assessment SGA, covering the conditions of ecosystem services in 12 provinces of the Cuu Long River Delta of Viet Nam, from Long An to Ca Mau and identifying the main drivers for change in ecosystem services in the area. The study focused mainly on provision services and little emphasis was given to regulating and cultural services. In addition, there is little evidence so far that the SGA has made a significant direct impact on policy formulation and decision making in Viet Nam for the following reasons: (1) limited involvement of policymakers and provincial or local stakeholders during and after the SGA; (2) strong scientific focus with a lack of tools, models and methods for decision making that can be readily applied at implementation levels and (3) limited awareness of decision makers on ecosystem services. This project addresses these gaps.

1.3 Understanding the causes of changes in the ecosystem

Understanding the factors that cause changes in ecosystems and ecosystem services and evaluating their impacts is essential to the design of interventions that enhance positive and minimise negative impacts. Each of the four pilot countries used the project preparation phase to review their respective SGAs, to further examine key threats and drivers of ecosystem change, as well as to carefully scrutinise these results through broad stakeholder involvement and feedback. Although the targeted ecosystems and ecosystem services in each pilot differ considerably and range from marine and coastal areas to dryland systems, there are various commonalities with regard to the main direct and indirect threats and drivers of ecosystem change. Direct drivers of change exert direct influence on ecosystem processes and can therefore be identified and measured to differing degrees of accuracy. The two main direct drivers identified in the four countries include: land use and habitat modification, and unsustainable exploitation of natural resources.

1.3.1 Land use and habitat modification

Over the last fifteen years, the natural area of wetlands in **Viet Nam** has been reduced while artificial wetlands have increased. Natural mangrove forests are being converted into aquaculture ponds, tourism facilities and planted forests. Over the past twenty years, 183,724 ha of mangrove forests have been lost while aquaculture areas have increased to 1.1 million ha in 2003.

The transformation of land into shrimp aquaculture in Viet Nam was oftentimes carried out too quickly and at a large scale, without appropriate planning, little invested capital and poor technology. Therefore, water and land environments were altered seriously, including disease outbreaks as well as pollution at a large scale, thus not only endangering the ecosystem but also leaving many shrimp cultivation areas at high risk. Shrimp aquaculture in Ca Mau Province is conducted with different production models, tending to gradually increase capital and technology investment in order to achieve higher economic gains for the producers. However, the more intense the production models, the higher the potential of pollution it creates, and therefore, the worse consequence it has on the environment and ecosystem. In Ca Mau, intensive, industrial shrimp aquaculture has caused the highest levels of pollutants, such as nitrogen, phosphoresce, chemical oxygen demand, suspended solids, organic wastes, or chemical residuals.

In **South Africa** conversion to agriculture, forestry plantations and urban expansion has resulted in the loss of about 20% of the country's natural habitat. The remainder of the land is mostly used for the grazing of domestic livestock and wildlife. South Africa and Lesotho include large (as yet unquantified) tracts of degraded land from overgrazing, frequent burning and fuel wood harvesting, resulting in biodiversity loss, soil erosion, loss of biotic crusts and declines in water quality. In parts of the region high livestock numbers are a consequence of several indirect factors including human population growth, increasing reliance on the natural resource base, and loss of grazing area to other land uses with consequent displacement of people and herds. Interestingly, in Lesotho an increasing proportion of the national herd is owned by business men, who are generating wealth elsewhere (often South Africa) and then increasing their herd sizes significantly. In addition, most rivers in South Africa are extensively modified with high dam densities and substantial flow modifications, with resultant biodiversity and water quality declines. Mining, although limited in extent, has had substantial impacts on biodiversity and ecosystem services through air and water pollution, the clearing of vegetation and soil, and inappropriate mine closures.

In **Trinidad and Tobago,** the need for land for industrial development, ports, and hotels as well as for housing has led to a significant rate of land clearing especially in the coastal zone. For example regular conflicts occur in Trinidad over the trade-off of mangrove wetlands in favour of industrial development and port facilities.

1.3.2 Unsustainable exploitation of natural resources

Threats to the water cycle in **Chile**'s San Pedro De Atacama municipality are related to additional water demands as a result of mining and tourism. Within the hydrological basin of the Salar de Atacama 162 water rights have been granted for a total of 6,223 l/s, distributed between 2,234 l/s of surface water (73 rights) and 3,989 l/s of underground water (89 rights). Surface water rights are mainly held in the north of the Salar, around San Pedro de Atacama, and in the east, whilst most of the underground water rights are in the southeast of the basin. In the *Altiplano* of the municipality of San Pedro de Atacama, i.e. the basins lying to the east of the Salar Basin, there are a further twenty surface water rights, for a total of 2.7 m^3/s. By comparing the rights granted (6.2 m^3/s) with the water recharge rate of the Basin (about 5 m^3/s) it can be seen that the volume that could be extracted is on average greater than that coming into the system. However, it should be pointed out that extraction rates are only higher than calculated recharge rates in the southeast of the Basin. This situation has been regulated by means of a special agreement between users and the General Water Department (with an early warning plan) and a restriction of water flow. In spite of this, the system is very complex and the comparison between offer (recharge) and demand (use) is not that simple. It should be noted that no water rights are required for brine extraction from the nucleus of the Salar, since this extraction falls under the Mining Code.

It is evident from current recharge figures that water availability is stretched in the municipality. There is however not enough available information to understand the potential threat to water supply with any degree of certainty. There are certain inconsistencies between the information on water rights for the settlements and the available records on effective water use. Accurate information on drinking water consumption and resource availability is required in order to estimate how many people can effectively be supplied with potable water.

1.4 Structure of the report

The report is structured to emphasise the activities that took place in the four pilot countries during the duration of the project and the extent to which this brought about community and other stakeholder engagement, solid outputs, and lasting policy impact.

As such, the second section of the report discusses the ProEcoServ activities in South Africa by providing a synthesis of the work plan, the approach, and the findings and policy outcomes of each intervention. The interventions ranged from local level disaster resilience management, regional level ecosystem and natural resource management to trans-national level ecosystem management and restoration efforts. After providing a summary of the activities, outputs, and impact of the three case studies, the report provides an overall analysis of mainstreaming strategies. The section concludes with key insights for policy impact.

The third section reports on ProEcoServ's work in Trinidad and Tobago, which involved introducing ecosystem value maps as a decision support tool, developing natural capital accounting into the national accounts, and proposing a pilot eco-financing scheme, namely the payment for ecosystem services (PES) model. After providing a short summary on each component, there is an analysis of the policy uptake and long-term policy impacts of such interventions.

The forth section discusses ProEcoServ's work in Chile. The work is developed across four main activities, namely the modelling of water provision and ecotourism, developing a decision support tool, building a participatory, inclusive decision making process and overall strategies for mainstreaming ecosystem services. After providing a summary of these interventions, the report provides an assessment & evaluation of these interventions and the role of participatory processes in the success of such efforts. The section then analyses the policy impact, in particular, the engagement with regional and national development planning entities, and provides overall lessons and recommendations.

The final section of the report presents ProEcoServ's activities in Viet Nam, which involved developing valuation tools to capture the true economic value of mangroves and raising the awareness of national and provincial decision makers as well as of local communities and the private sector on biodiversity and ecosystem services. A pilot valuation study of mangroves was conducted and a comprehensive communication strategy was organised that aimed to support the integration of ecosystem services into planning processes and national policymaking.

2. SOUTH AFRICA

2.1 Introduction

The work carried out in ProEcoServ-South Africa (ProEcoServ-SA) was a collaborative effort led by the Council for Scientific and Industrial Research (CSIR) in partnership with the South African National Biodiversity Institute (SANBI). The Institute for Natural Resources (INR) partnered with ProEcoServ-SA in developing the transboundary component with Lesotho. This multidisciplinary team was comprised of researchers and practitioners with multiple years of experience working in the science, practice, and policy arenas of biodiversity and ecosystem services. And thus, this section provides a synthesis of the ProEcoServ efforts in South Africa.

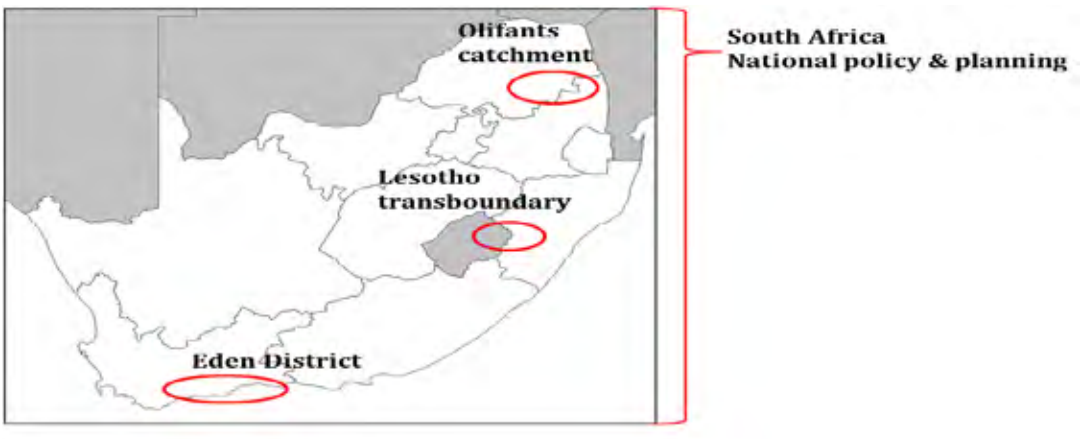
The main objective of ProEcoServ-SA was to better integrate ecosystem assessment, scenario development and economic valuation of ecosystem services into national sustainable development planning in South Africa. More specifically, ProEcoServ-SA built on the Southern African Millennium Ecosystem Assessment (SAfMA), which took place between 2001 and 2004, and included local community assessments, assessments of large basins or catchments, and a regional scale assessment, which included all countries south of the Equator.[5] SAfMA developed large databases and publications; increased capacity in ecosystem service science, awareness in policy circles and more broadly, generated a wider interest in the topic of ecosystem services. The effort and growth in ecosystem assessments catalysed by SAfMA witnessed some early signs of uptake of the ecosystem-service concept evident in the water, biodiversity, and disaster management sectors. By building on this foundation in a more concerted way, ProEcoServ was able to build partnerships with various stakeholders, including government, private sector, and civil society, with an aim of having a lasting impact on ecosystem management and its role in multi-scale development planning and decision making.

2.2 Working plan

South Africa has three spheres of government: local, provincial and national, among which some of the decision making and planning functions are concurrent. Therefore, the project adopted an ecosystem-based approach with a multi-scale policy analysis focusing on: (1) **Disaster resilience management planning** (in the local sphere); (2) **Water resources strategic planning** (in the provincial/national spheres); and (3) **Transboundary watershed management in South Africa and Lesotho** (in the inter-nation regional sphere).

At each governmental sphere, specific applications were used to demonstrate how ecosystem services information and data can be incorporated into policy development through a process of joint-knowledge production involving scientists, local experts, stakeholders and decision makers. The applications served as important learning processes for the analysis of policy impact and distilling lessons for broader application – see Figure 2.1

Figure 2.1: Map indicating the different areas of work



5 See further:http://www.millenniumassessment.org/en/SGA.Safma.html

Finally, ProEcoServ-SA (4) **implemented various strategies for mainstreaming ecosystem services** that delivered communication and outreach, co-production of knowledge, supported the integration of ecosystem services into national policy and dialogue, including the production of national ecosystem-service maps, the promotion of public-private cooperation for ecosystem management, the development of ecosystem-service models to inform investments, and established a framework for investment in ecological infrastructure that in turn has been adopted in national policy and planning.

2.3 Disaster resilience management

2.3.1 Pilot Study: Eden District

Globally, natural disasters have been responsible for the loss of at least a million lives over the last decade, with recovery often taking years and financial losses estimated to be in the trillions of US dollars.[6] South Africa is no exception and is in fact, highly vulnerable to the onslaught and unpredictability of natural disasters. Eden District – a mountainous, biodiversity-rich area in the southern most Western Cape Province is particularly susceptible to natural disasters and extreme events, including floods, droughts, wildfire, and storm-waves. And for this reason, the Eden District was chosen as a pilot study in the local government sphere – see Figure 2.2 and Box 2.1 for more details on the study area.

The current impacts of these extreme weather events are already evident in the large public and private sector losses in the region. Between 2003 and 2008, the Western Cape incurred direct damages of 205 million USD in severe weather events. During this time, the Eden District accounted for 70% of the provincial government's reparations costs provided for direct disaster damage –160 USD million – excluding damages incurred by the private sector, indicating the area's high vulnerability. For example, natural disasters claims incurred by just one short-term insurer in the Eden District over the last 15 years amounted to an estimated 5.5 million USD, with more than 78% of these claims made after 2006. Furthermore, damage per capita in rural areas was 3.5 times more than annual household income in some instances. In this context, this region presents a high potential for the reduction of risk disaster through ecosystem-based management – see Figure 2.2

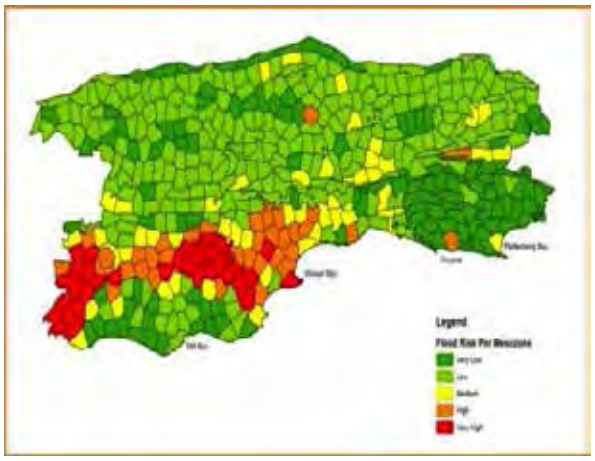
Box 2.1: Eden District Pilot

The Eden District is located in the Western Cape Province, which is the southernmost area of South Africa, covering an area of 23,331 km^2. Considered to have had one of the fastest growth rates in the past decade, the Eden District has the second largest of the district economies in the Western Cape outside of the Cape Metro (which produces 73% of the Western Cape regional GDP). Tourism-related retail, wholesale, catering and accommodation sector contribute to 18 per cent of the regional GDP, with agriculture, forestry & fishing contributing to 5.5 per cent. Of the total area, 99 per cent is rural and only 1 per cent is urban, having strong agriculture and tourism sectors. On the other hand, the region receives rainfall throughout the year, with peaks in March and October, often associated with cut-off low events in southern Africa. The area's rainfall pattern and mountainous nature make it prone to flash floods followed by droughts. Large storm-waves often occur with high rainfall events resulting in severe coastal flooding. At the same time, the region is located within the Fynbos Biome, a fire-prone vegetation type, which makes it further vulnerable to large wildfires that are exacerbated by dense infestations of non-native invasive shrubs and trees that increase frequency and intensity of wildfires. Since agriculture and tourism comprise crucial sectors in the Eden District, socio-economic challenges or lack of diversification make the population more vulnerable to damages incurred by disaster events, including floods, storms, wildfires and droughts. This issue is further compounded by the fact that agriculture is the biggest employer in the district and future increases in extreme events are predicted in the Eden District linked to predicted climate change including: (1) a 2°C increase in temperature by 2100, (2) drier winters, (3) increases in extreme rainfall events during spring and summer, (4) higher sea levels and wind speeds and (5) changes in sediment fluxes from rivers and along the coast.

Source: 'Eden, A Future Empowered Through Excellence'. Eden District Municipality – Integrated Development Plan Report 2014/2015

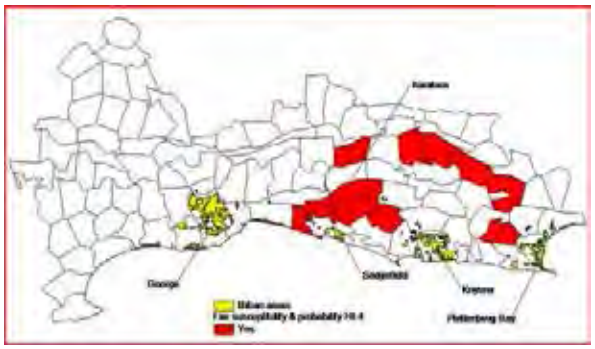
6 For more information please consult the Global Assessment Report on Disaster Risk Reduction, which is available at www.preventionweb.net/english/hyogo/gar/2013/en/home/index.html.

Figure 2.2: Reduction of fire, flood and sea-storm risk through ecosystem-based management



Flood risk

- Revegetating/rehabilitating areas cleared of commercial plantations or invasive alien trees
- Cutting the link between extreme fires (resulting in changed soil conditions) and increased flood risk by reducing fuel load after plant clearing
- Managing the estuary
- Limiting housing and developments on flood plains
- Promoting infiltration by increasing natural "sponges" or areas of natural vegetation in the landscape



Fire risk

- Limiting the further spread of invasive alien trees
- Reducing alien invasive woody biomass (standing biomass and slash)
- Limiting the potential spread of fires by establishing firebreaks (discontinuity of flammable vegetation)

Sea storm risk

- Managing foredunes (e.g. improving vegetation cover and increase sand volume)
- Avoiding hardening the coastline (through the use of engineering solutions such as sea walls, embankments etc.) but rather use environmentally-friendly coastline management options such as sand replenishment
- Limiting housing and development along the coast
- Managing estuary mouths using science-based methods

Saving up to 160 million USD in the public budget for Eden

Box 2.2: Ecosystem Services-based Approach: Actions for Disaster Resilience Management

Several actions to build disaster resilience were identified for each type of natural disaster, together with clear outcomes and agencies able to champion their implementation. These included the development of decision-support systems, products for local planning, and the clearing and restoration of areas invaded by non-native trees or degraded by land-use practices. A restoration project to clear invasive non-native trees on hops farms in the Eden District has been initiated, which will see the investment of almost 4 million USD in the area by the beverage sector, farmers, and government funding for poverty alleviation. Apart from averting the loss of water, this restoration project will reduce the risk of wildfire, and create an estimated 200,000 employment days, or around 100 full-time jobs per year. This will benefit close to 900 people, a substantial contribution to the nearby rural town. Similarly, a multi-million dollar investment by South Africa's National Parks was initiated to clear non-native invasive plants in and around the Garden Route National Park, a protected area embedded in the urban matrix of the Southern Cape region. The local Fire Protection Agency also responded by mobilising members from public and private sector agencies to establish and manage strategic fire belts and fuel-reduction strategies. In addition, foredune restoration projects to reduce storm-wave risk and a process to decentralize insurance underwriters to build partnerships with local authorities were initiated. Furthermore, the concept of 'risk' was used as a defining concept in order to bring together a diverse range of stakeholders to better understand the value of incorporating ecosystem-based management strategies into decision making, and co-design response strategies that would enhance the buffering capacity of ecosystems to mitigate the impacts of natural hazards.

Source: ProEcoServ South Africa

2.3.2 The approach: ecosystem-based management using land-cover scenarios

The Eden pilot focused on understanding the causes of natural disasters and extreme events and learnt new ways of building resistance and resilience using an ecosystem-service based approach. In this context, it involved research institutions, private sector partners from the insurance and beverage sectors, NGOs, together with local and provincial government agencies. Together, the partners sought to understand the drivers of disaster risk in the Eden District Municipality and identify and implement new ways of building resilience against disasters by exploring the role of ecosystem-based management approaches in reducing the risk of flood, drought, wildfire and storm-waves in the region. In other words, the aim was to reduce Eden District's vulnerability to natural disasters by building more resilient landscapes. The spread of non-native invasive trees was identified as a major driver for increasing the risk of flood, wildfire and drought. This lead to a number of targeted actions in priority areas and the clearing of non-native trees, in partnership with the private sector and government agencies – see Box 2.2.

Simulating various scenarios in land cover indicated that the spread of non-native invasive trees halved the monthly river flows experienced during drought and doubled fire intensities to orders of magnitude beyond the limit for effective fire control. Scenarios of plantation forestry clearing practices reduced the return time between large flood events by nearly 20%. Under scenarios of moderate human-induced coastal hardening, predominantly from removal of coastal foredunes and coastal infrastructure development, severe 1:100 year storm-waves were predicted to occur on an annual basis. The findings highlighted that land-use management that is cognisant of the role of ecosystems in regulating natural hazards can reduce the risk of disasters, in some cases, substantially. This information was fed into the co-design of responses and actions for stakeholders.

2.3.3 Findings and the policy impact: public-private partnerships in fostering disaster resilience

The findings were used to mainstream ecosystem-based management approaches into disaster management through a number of products co-developed with stakeholders. Mainstreaming activities and products were guided by a systemic risk management strategy for the Eden District, which linked each natural hazard to the land-cover change drivers disrupting the regulation of that hazard – see Figure 2.3. This in turn helped identify the necessary interventions and institutions or communities responsible for, or with influence over, these land-cover changes. As is often the case, the lack of capacity and resources within responsible institutions, as well as their fragmented nature across sectors often undermine the success of interventions. Therefore, the strategy went beyond identifying who is mandated (but often unable) to manage the drivers, to design interventions needed to build additional capacity, support and connections for the responsible institutions, and identify potential partners with resources and knowledge to implement these interventions.

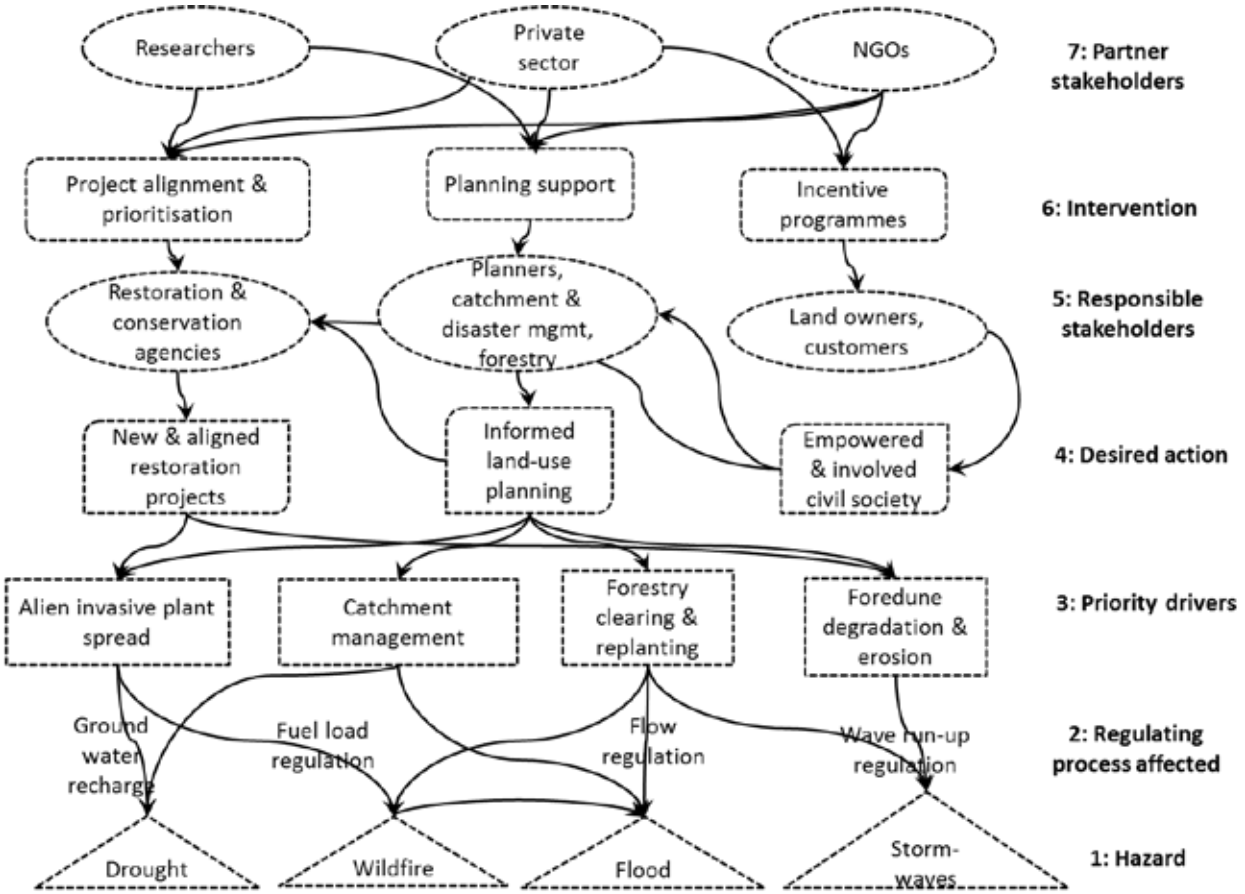
At a local level, the Eden case-study also supported the 'Business-Adopt-A-Municipality' (BAAM) forum set up by the insurance sector for businesses to support local authorities in managing disaster risk and infrastructure. The BAAM is being piloted in the Eden District with the aim of rolling it out to other high-risk municipalities over time. It is supported by the South African Local Government Association, which is representative of local government and interfaces with parliament.

Furthermore, communication, training and decision-support products such as brochures, toolkits, maps and annotated slide shows, were developed and distributed. New networks were established to collaborate, build capacity and coordinate activities in the region. The Eden Disaster Resilience Learning Network now coordinates ecosystem-based management interventions in the area and is chaired by the provincial Department of Environmental Affairs and Development Planning.

The network comprises provincial, district and local authorities from environment and disaster risk reduction, national and provincial conservation authorities, non-governmental organizations, scientists, and corporate partners in the insurance and beverage sectors. Its activities focus on co-developing and co-implementing risk management projects in the Eden District in order to build the resilience of this area to climate change. The Eden Disaster Resilience Learning Network is currently establishing a data portal, on South Africa's Risk and Vulnerability Atlas website, for sharing data and information with local authorities, businesses, and beyond.

At national scales, the Eden Pilot work supported inputs into disaster management legislation and budgeting processes to allow for pro-active ecosystem-based management for extreme events. ProEcoServ-SA provided inputs into the National Disaster Management Amendment Bill, National Disaster Management Centre and National Treasury processes to create opportunities for ecosystem-based interventions in the disaster risk management cycle.

Figure 2.3: Systemic risk management strategy for Eden District of identified interventions and responsible stakeholders and actions to manage drivers of risk



2.4 Water resources strategic planning

2.4.1 Pilot Study: Olifants Grassland Catchment

The Grasslands Biome is the largest of South Africa's nine biomes, covering nearly a third of the country. The grasslands are critical water production landscapes, containing nearly half of the country's strategic water source areas. These biodiversity-rich ecosystems and their supply of ecosystem services are under tremendous pressure from booming urban development, commercial agriculture, plantation forestry and mining. The Olifants Grassland Catchment exemplifies the pressures on this Biome – see also Box 2.3.

First, six of the world's largest coal-fired power stations are located in the Upper Olifants Catchment Area, providing 48% of the country's total power generating capacity for export and domestic consumption. Given that 77% of South Africa's primary energy needs are provided by coal, the catchment supports extensive mining and coal-fired power production. Second, this catchment area includes major urban centres and steel manufacturing industries, and supplies water to the second largest irrigation scheme in the country. Third, the middle regions of the catchment are dominated by dense rural settlements, subsistence agriculture and some isolated commercial agriculture. Finally, this catchment grassland is characterized by unique landscapes and is home to South Africa's flagship protected area: the Kruger National Park. In this context, sustainable water resource management that seeks an equitable balance between these multiple pressures on water is urgently required. For these reasons, the Olifants Catchment Area was selected as a pilot study at the provincial/national governmental spheres, with the objective of integrating freshwater ecosystems into water resource planning and decision making and, in doing so, promoting the sustainable management of water resources.

Box 2.3: Olifants Grassland Catchment

The Olifants Catchment covers about 54,570 km^2 and the total mean annual runoff is about 2,400 million cubic metres per year. Principal water uses include irrigation, thermal power production (i.e. water cooling) and supply to the urban centres. The Olifants River and some of its tributaries, notably the Klein Olifants River, Elands River, Wilge River and Bronkhorstspruit, rise in the Highveld Grasslands, then travels past the foot of the Strydpoort Mountains and through the Drakensberg, descending over the escarpment. The Steelpoort and Blyde tributaries, and others, join the Olifants River before it enters the Kruger National Park and nearby private game reserves. From the water management perspective the Olifants Catchment is divided into five regions: Upper Olifants River, Upper Middle Olifants River, Mountain Region, Lower Middle Olifants Region and Lower Olifants Region. Crossing the Mozambique border, the Olifants River flows into the Massingire Dam. There are 37 dams in the Catchment classified and registered as major dams (reservoir capacity in excess of 2 Million cubic meter), while 134 dams classified as minor dams (reservoir capacity between 0.1 and 2 Million cubic meter), while the rest are small dams (reservoir capacity less than 0.1 Million cubic meter). However, the numbers vary as some of the minor and small dams are not accounted as they are considered to pose a safety risk and are thus not registered by the Department of Water Affairs and Forestry. Furthermore, the upper reaches of the Olifants River Catchment are characterized by mining, agricultural and conservation activities. Over-grazing and highly erodible soils result in such severe erosion, in parts of the middle section, that after heavy rains the Olifants River has a red-brown colour from all the suspended sediments.

Source: The Olifants River System, Hydrological Review of the Olifants River Catchment, and www.csir.co.za/rhp/state_of_rivers/state_of_crocsabieolif_01/olif_eco.html

2.4.2 The approach: ecological infrastructure and policy-linked national mapping for strategic water resource planning

The concept of ecological infrastructure is used in the Olifants Catchment as a way to position ecosystem service concepts within the national development priorities of South Africa where one of the focus areas is infrastructure. Ecological infrastructure can be seen as the nature-based equivalent of built infrastructure which is crucial for providing services and underpinning social and economic development. In addition, the Olifants Catchment pilot is built on the foundations of the National Freshwater Ecosystem Priority Areas (FEPAs), i.e., it is built on maps that represent national consensus on the numbers, types and location of rivers, wetlands

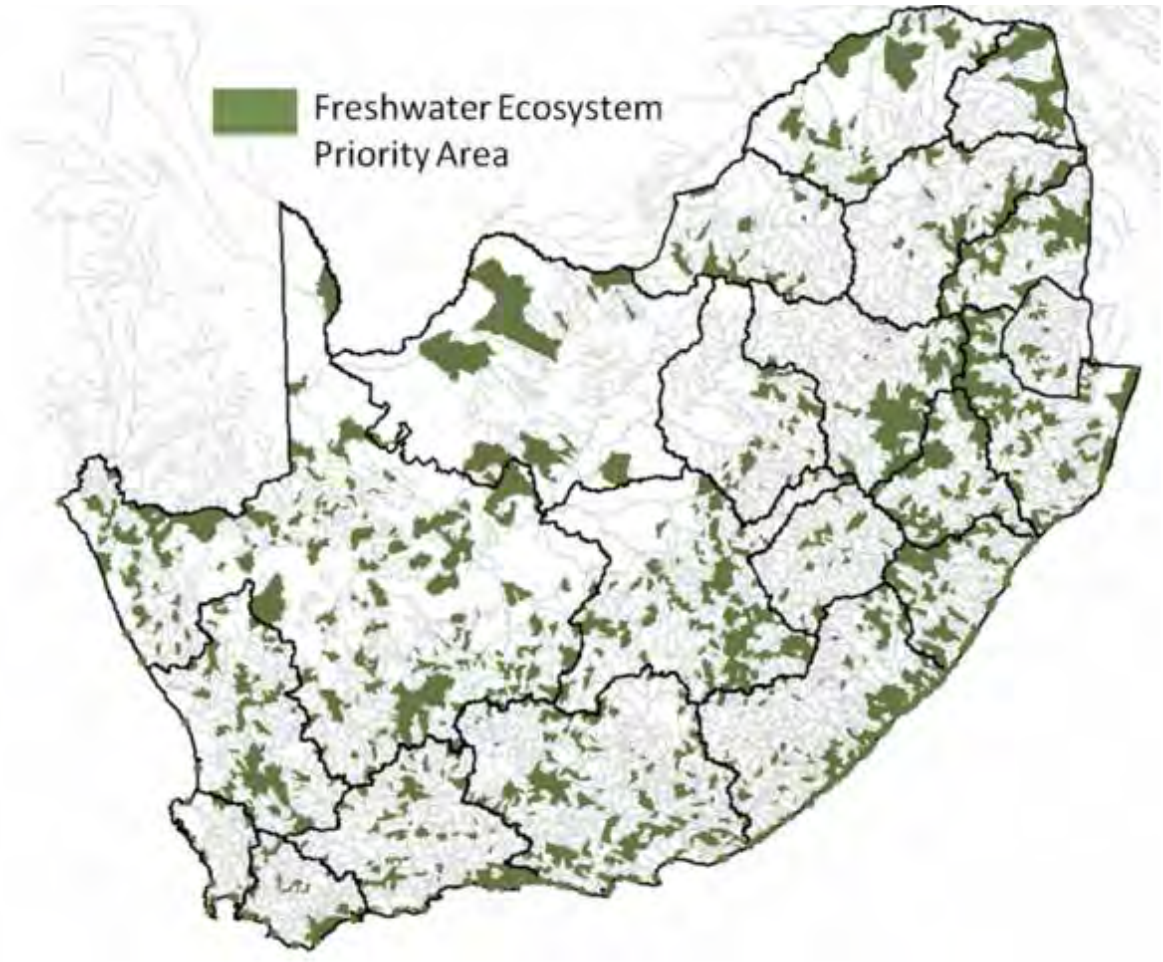
and estuaries, needed to protect representative diversity and ecological functioning of South Africa's water resources.[7] These maps were used in the Olifants Catchment to represent freshwater ecological infrastructure and used to integrate ecosystem services into water management decisions. FEPAs maps highlight 49 priority rivers in the Olifants Catchment, which were incorporated into the scenarios – see Figure 2.4.

During the stakeholder negotiation process, 82% of the National Priority Rivers were selected to be maintained in a natural or near-natural ecological condition. This decision, and the associated map representing the respective freshwater ecological infrastructure, was used to integrate ecosystem services into water management decisions. In particular, these results were presented to the Minister of Environment for consideration and gazetting. The resultant method used the legislated seven-step framework guiding the process, identifying places where FEPAs need to be considered, and suggesting how they can be considered. The approach was presented as a generic framework for policy-linked mapping for strategic water resource planning – see Table 2.1.

From a review of 33 policies, a policy targeting catchment-level water resource planning, known as 'Classification of Water Resources', was identified as the target decision-context for this pilot study – see Box 2.4.

A second policy, the National Water Resource Strategy, was identified as an important enabler for incorporating ecosystem services into catchment-level policy. Officials at the Department of Water Affairs, including the Chief Director, Project Coordinator and their Technical Consultants were identified as key stakeholders for the use case.

Figure 2.4: Freshwater Ecosystem Priority Areas in South Africa - borders demarcate boundaries of 19 Water Management Areas



7 See further: http://bgis.sanbi.org/nfepa/NFEPAmap.asp

Table 2.1: How to include Freshwater Ecosystem Priority Areas in the seven-step process that guides water resource classification in South Africa

Step	Description
1. Delineate the catchment	Integrated units of analysis and significant water resources delineated. Hydrological sub-units and nodes are established as points at which ecological water requirements will be determined or extrapolated. *Allocate river nodes to FEPAs and other ecological infrastructure.*
2. Link economic and social value to ecosystem condition and water use	Develop relationships of conditions in water yield and ecosystem services to social well-being, as well as to sector-specific use and commodity generation.
3. Quantify the ecological water requirements at each node	Specify requirements that are needed to maintain each river node in a condition using environmental flow assessment approaches. *Ensure requirements for maintaining natural conditions for river nodes associated with FEPAs, and any additional areas identified in Step 1.*
4. Set baseline catchment configuration	Using the requirements from Step 3, the catchment configuration with the lowest ecological condition for rivers and estuaries is established. *Explore whether it is possible to 'hard wire' the required ecological condition for river nodes FEPAs.*
5. Construct scenarios and evaluate implications	Explore scenarios including a baseline catchment configuration in Step 4, and configurations that provide for improved levels of ecological condition based on water user needs and economic development strategies. *At least two FEPA scenarios should be considered: achieving recommended ecological categories for FEPAs (a) with all other river nodes achieving the present ecological state and (b) with all other river nodes achieving the recommended ecological category. Apply a penalty to scenarios that do not achieve the recommended categories for FEPAs.*
6. Run a series of stakeholder workshops to evaluate scenarios	Set up iterative process to evaluate the scenario outputs, and refinements of outputs, in Step 5 with quantified implications for regional economic development, social well-being and ecological conditions from Step 5 to assess trade-offs.
7. Select preferred scenario, assign corresponding management classes and the ecological conditions at nodes to achieve these	Management classes are assigned to Integrated Water Management Units established in Step 1 and are legally binding when they are published in the Government Gazette. Nodes, also established in Step 1 representing smaller sub-catchments within the Integrated Water Management Units, are assigned ecological condition.

Note: Italics show methods to include ProEcoServ/ecosystem service considerations

Box 2.4: Classification of Water Resources

The Classification of Water Resources process sets a management class for every significant water resource in a catchment (e.g. stretches of river). The management class stipulates a desired condition of the resource and the extent to which it can be utilised. The class is determined through a scenario planning exercise and is driven by a seven-step, legislated process that provides guidance on stakeholder engagement, environmental flow assessment and scenario development. The Olifants Catchment case study explored ways to include FEPA maps, together with other technical tools such as environmental flow assessment, scenario planning and valuation, into the legislated classification process.

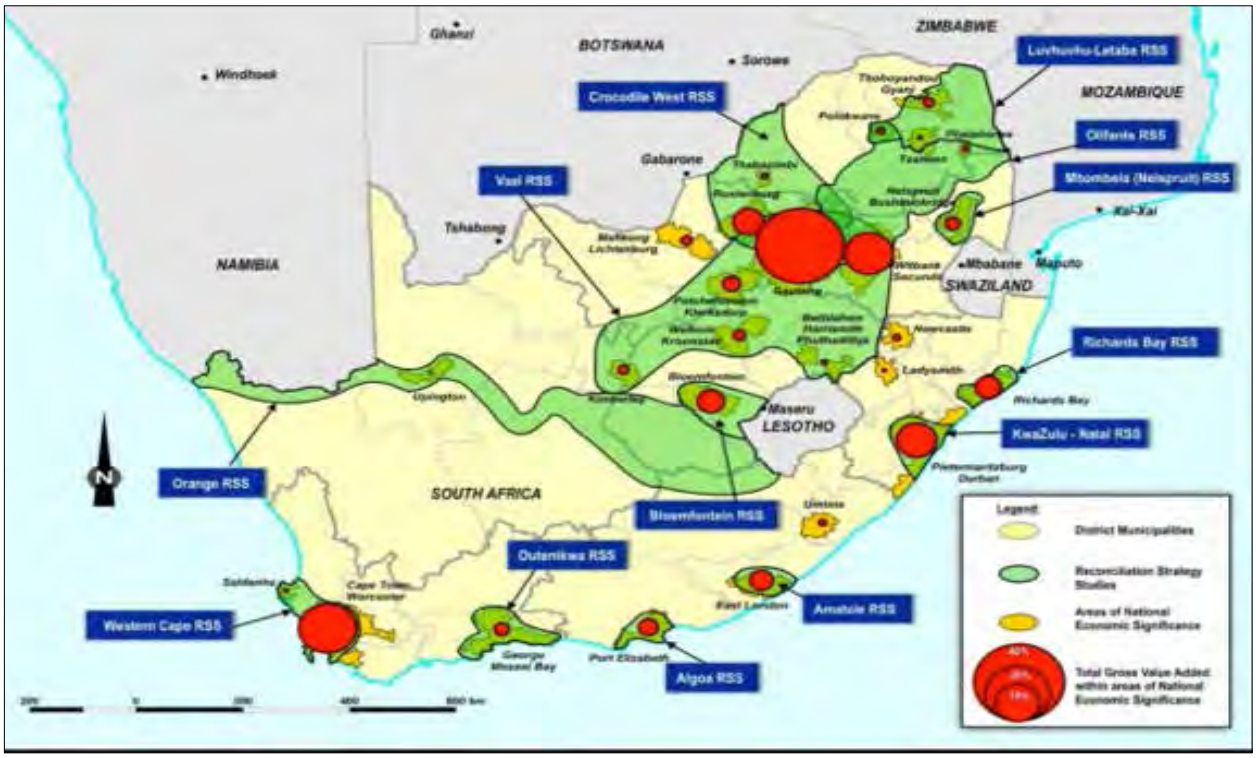
2.4.3 Findings and policy impact: identification of freshwater ecosystem priority areas in the Olifants Catchment

The policy-linked mapping work developed at the Olifants Catchment fed into the development of the map of strategic water source areas of South Africa. According to this map, strategic water source areas make up only 8% of the land area of South Africa, but provide a staggering 50% of the water – see Figure 2.5. These areas collectively support about half of the national population and contribute to more than 60% to the national economy, however, only 16% of their surface area is legally protected. The maps, and their corresponding statistics, provide a very compelling message for national politicians and decision-makers: that managing this small fraction of land is vital to the country's water security, population and economy. This message particularly found traction in two major national development planning processes currently underway: **National Development Planning** and **National Water Resource Management.**

Further, the Olifants Catchment pilot helped to establish a Freshwater Ecosystem Network, with high level endorsement across the Department of Water Affairs and Department of Environmental Affairs, hosted by the South African National Biodiversity Institute. The Network meets on an annual basis and aims to strengthen the technical ability of members to participate effectively in the Classification of Water Resources process, especially in the integration of FEPAs maps and other freshwater ecological infrastructure. It also aims to build links with biodiversity peers who are playing similar roles in different catchments, in order to share experiences, seek advice in dealing with challenges, and support other members based on shared experiences. This case study helped identify and make inputs into the **National Water Resources Strategy**, which was being updated.

In order to inform the process of **national water resource planning**, inputs co-developed with the Department of Water Affairs fed into the updated National Water Resources Strategy, which guides the progressive implementation of South Africa's National Water Act from national to local scale. Based on these inputs, Chapter 5 of the recently published Strategy incorporated both the map of strategic water source areas, and a statement of the intent for government departments to cooperate around their protection. The Department of Water Affairs is currently in the process of developing a cross-sectoral implementation strategy to accompany their National Water Resources Strategy, and ProEcoServ-SA continues to engage in the process of assisting with inputs for the 5- and 20-year objectives for the regulation and protection of the strategic water source areas.

Figure 2.5: Reconciliation Strategy Studies (RSS): linking strategic water source areas and key demand centres



In **National Development Planning**, the message was framed according to the ProEcoServ-SA communications strategy, which targets the audience using the concept of ecological infrastructure. The message made clear that protecting strategic water source areas will protect foundational ecological infrastructure on which a great deal of built infrastructure for water services and water security depends. This message resonated strongly with national decision-makers that are currently developing the Strategic Integrated Projects that guide the coordinated implementation of the National Infrastructure Development Plan.

Beyond national development planning and water resource planning, the map and concept of strategic water source areas has found uptake in other local policy processes. **South African National Parks** (SANParks) have expressed the intention of considering strategic water source areas in decisions regarding the management of individual parks, as well as in the expansion of the national protected areas.

2.5 Transboundary watershed management

2.5.1 Pilot Study: water towers in South Africa and Lesotho

Lesotho is home to one of world's globally recognised water source areas, or 'water towers' – mapped by ProEcoServ-SA as the Maloti-Drakensberg Strategic Water Source Area. Consuming an estimated 98 per cent of the water it treats, semi-arid terrain, limited underground aquifers, and a reliance on water transfers from neighbouring nations, South Africa faces complex challenges in water resource management. Currently ranked as the 30th driest nation in the world[8], recent projections indicate that South Africa's water demands will outpace supply between 2025 and 2030.[9] Meanwhile, Lesotho gains significantly from the sale of water originating in the Maloti-Drakensberg, along with project-related customs dues, comprising almost a third of its government revenue. And thus, water is a key issue in the South Africa-Lesotho policy agenda.

In this context, there is an ongoing collaborative effort in building a series of dams, hydropower stations and tunnels between South Africa and Lesotho[10] – through the Lesotho Highlands Water Project. As Africa's largest water transfer scheme, it ensures that South Africa has a sustained supply of water for its citizens, for industrial and agricultural purposes as Lesotho continues to generate government revenue through royalties. In Lesotho, the project involves the Malibamatso, Matsoku, Senqunyane and Senqu Rivers, whereas in South Africa, the project involves the Vaal River. The project was launched with a funding of 1.2 billion USD with the aim of generating hydro-electric power for Lesotho while increasing the volume of water transferred to South Africa from the current 10 billion cubic metres per year, as a result of Phase 1, to an estimated 15 billion cubic metres per year[11] – see Box 2.5.

However, the massive volume of soil lost to erosion washes downstream and ends up lowering the holding capacity of the dams. This will not only have significant implications for the Lesotho economy, but will also affect the continued supply of clean water to South Africa.

Box 2.5: Lesotho Highlands Water Project

Phase 2 of the Lesotho Highlands Water Project is currently underway and entails the development of the Polihali Dam in the Mokhotlong District, which is located in the north-eastern part of Lesotho, and includes the source of the Orange-Senqu River, a primary watershed of Southern Africa. And thus, the aim of this use case was twofold: (1) to identify likely sediment sources of the Polihali Dam for prioritising protection and restoration efforts. These restoration efforts are intended to provide multiple ecosystem service benefits, by preventing excessive sedimentation of the Polihali Dam while simultaneously improving the agricultural potential of the communities that live in the Polihali Catchment; and, (2) to present the findings of the prioritisation process to the restoration and conservation ministries and departments in Lesotho to ascertain how the identified priority areas could be aligned with current or proposed restoration efforts.

Source: http://www.lhda.org.ls

8 http://www.bloomberg.com/news/articles/2014-03-27/south-africa-to-boost-water-supply-50-from-mountainous-lesotho
9 http://www.mckinsey.com/insights/sustainability/confronting_south_africas_water_challenge
10 http://www.southafrica.info/business/economy/infrastructure/lesotho-water-280314.htm#.VX__jIK42Dk
11 http://www.southafrica.info/business/economy/infrastructure/lesotho-water-280314.htm#.VX__jIK42Dk

2.5.2 The approach: tracking sediment erosion for sustainable management and restoration of ecosystems

A framework for identifying important sediment yield areas which affect the sediment inflow to the Polihali Dam was developed, which modelled the potential of two factors in sub-catchments upstream of the Polihali Dam: (1) the potential for sediment to be eroded or lost from a specific area upstream of the dam; and (2) the potential for sediment to be transported or delivered to the Polihali Dam. The latter component included both land surface interactions and in channel processes. Erosion potential was modelled using data on soil type, slope and land use/cover. Sediment transport potential was modelled using spatial data on basin shape, drainage density and relief ratio at a micro-catchment scale. This produced two separate data layers – one for erosion potential and one for sediment potential, which were combined multiplicatively to produce a map of potential sediment yield for all areas upstream of the Polihali Dam. Priorities for restoration were identified by extracting sub-catchments where the density of high potential sediment yielding areas was more than 95% of its area. These priority areas for prevention of dam sedimentation were then further prioritised to identify those best suited to preventing landscape erosion necessary for crop production and grazing. The final map identified the priority restoration areas for ecosystem services that would secure water quantity and quality issues in the Polihali Dam and provide community livelihood benefits.

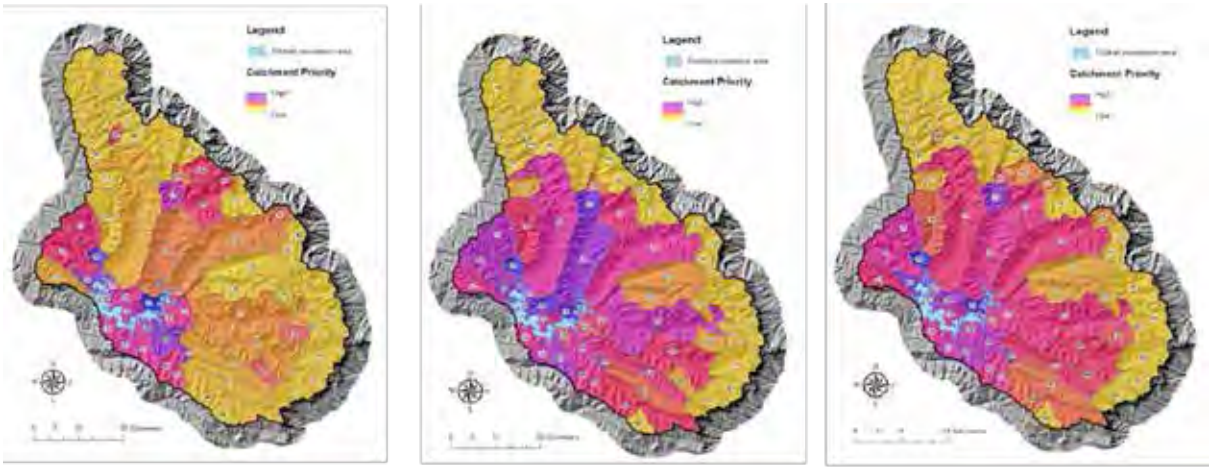
The geomorphology and sediment dynamics baseline study of the Polihali environmental flow assessment was underway at the time of initiating ProEcoServ-SA. ProEcoServ-SA co-developed methods for estimating potential sediment yield with the technical consultant responsible for undertaking the baseline study, and the same methods will now be applied in the baseline study. Results of this undertaking are discussed in the next section.

2.5.3 Findings and policy impact: maps for building the dam

Spatial analysis of sediment erosion and delivery potential indicated that sub-catchments with the highest threat to water security in the Polihali Dam were mainly located immediately upstream of the dam location, although there were a few also located in the headwater tributaries – see Figure 2.6a. Sub-catchment restoration for delivering the highest benefits to livelihoods, in terms of crop production and grazing, were also located immediately above the dam, but were more widespread – see Figure 2.6b. A combination of these priorities provided a map of priority catchments for restoration that achieves both water security in the Polihali Dam and improved livelihoods – see Figure 2.6c. The maps provide a decision-support tool, which can be used to inform policy and development planning at both a national and transboundary level.

In this process, key stakeholders from the Lesotho government were engaged during the course of the study and a request for maps on the priority areas and associated report was made by the Ministry of Forestry and Land Reclamation - Soil and Water Conservation. A promising development came out of the engagement with the environmental flow assessment being conducted as a requirement for the building of the Polihali Dam as part of the Lesotho Highlands Water Project. This environmental flow assessment is intended to ultimately guide management systems and operational procedures of the dam. The rationale behind environmental flow assessments around the world is to sustain the water ecosystems that support the operation of reservoirs in delivering their water supply, and to mitigate the impacts experienced by communities living in the catchments where the reservoir is built. Worldwide, it has been shown that on average the cost of undertaking an environmental assessment is a small fraction of the cost of the dam, but that an environmental flow assessment may save a lot on costs later from unintended consequences of poor social and ecological design. For this reason – and as is the case in the Polihali Catchment – environmental flow assessments are often a requirement for building a large dam.

Figure 2.6: Priorities for restoration that achieves (a) water security in the Polihali Dam, (b) improved grazing and agriculture potential for communities living in the catchment, and (c) a combination of (a) and (b)



(a) Priority: Dam security (b) Priority: Livelihoods (c) Overall priority

Finally, the outcomes of the prioritisation process were presented to the government ministries and departments involved in restoration and conservation programmes in Lesotho, and used as a basis for discussion on how their programmes could be aligned and synergies achieved, potentially through the use of these maps. Key stakeholders targeted included Lesotho's Ministry of Forestry and Land Reclamation, the Ministry of Agriculture and Food Security, the Ministry of Tourism, Environment and Culture, and the Lesotho Highlands Development Authority.

2.6 Mainstreaming strategies

Mainstreaming can be seen as the process of embedding biodiversity and ecosystem service considerations into policies, strategies and practices of key public and private actors that have an impact or rely on biodiversity and ecosystem services, so that biodiversity and ecosystem services are conserved, and sustainably used, both locally and globally.[12] In this context, ProEcoServ-SA aimed to mainstream ecosystem services into policymaking through targeted action in the form of thematic strategies focused on communications and outreach, co-production of knowledge, co-development of national policy instruments, bridging the gap between data modelling and information for better investment and policy decisions, guiding investments in ecosystem services, and building on public-partnerships for consolidated ecosystem management. This section discusses these strategies.

#1: Developing communication tools and providing outreach for ecosystem services

An important component of mainstreaming ecosystem services considerations into policymaking was the use of a consolidated communication strategy and tools. The aim was to develop a communications strategy and toolkit for use by the biodiversity sector with a new language and set of communication tools with which to 'make the case' for biodiversity and ecosystem services. One of the key purposes was to use the concept of ecological infrastructure in alignment with the **National Infrastructure Development Plan**, one of the most powerful planning processes in South Africa directing substantial investment in infrastructure over the next 15 years.

As part of the outreach, ProEcoServ-SA was involved at the two-day Ecological Infrastructure Dialogue in November 2012, which brought together policy-makers, natural resource managers, business and civil society to share information and the current state of knowledge. A follow up Dialogue was held a year later in November 2013, emblematically at the mouth of the uMngeni Estuary in Durban. This Dialogue specifically served to launch the **uMngeni Ecological Infrastructure Partnership** (UEIP), with a memorandum of understanding signed by 17 partners. The initial signatories to the UEIP include representatives from both the public and private sector and are outlined in Box 2.6.

12 Huntley, B.J. and Redford, K.H. (2014). 'Mainstreaming biodiversity in Practice: a STAP advisory document'. Global Environment Facility, Washington, DC.

Box 2.6: Initial Signatories of the UEIP

- NGOs: WWF-SA; Endangered Wildlife Trust (EWT); Duzi uMngeni Conservation Trust (DUCT); WESSA; Wildlands
- Local Government: eThekwini
- Municipalities: uMgungundlovu District Municipality; Msunduzi Local Municipality
- Private Companies: SAPPI; MONDI; Msinsi Holdings
- Statutory Bodies & Research Institutions: KZN-Wildlife; SANBI; Umgeni Water; University of Kwazulu-Natal (UKZN); Water Research Council (WRC)
- Government Departments: KwaZulu-Natal Department of Agriculture and Environmental Affairs

Moreover, a series of case studies that tell a range of stories about the importance of ecological infrastructure were developed and widely distributed – see Box 2.7. In addition, a 'case study toolkit' was developed, which provides guidance for scientists and other practitioners to communicate the key findings of their research or project experience in a compelling manner based on existing 'real-world' examples.

Box 2.7: Case Studies

- "A Stream Ran through It" – Highlights the importance of keeping municipal waste water infrastructure—like sewerage systems and storm water drains—properly maintained in order to support healthy rivers and wetlands, and improve water quality for enhanced human health.
- "Water Thieves" – Outlines the importance of managing invasive non-native plants in catchments and wetlands, which coupled with restoration of vegetation, will stabilise soils, restore river flow and replenish grasslands for grazing.
- "The Dam Busters" – Illustrates that restoring degraded watersheds and improving farming practices can reduce soil erosion and thus prevent sediment from filling up dams, minimising the damage of costly reticulation infrastructure.
- "Washed Away" – Presents a strong case that careful farming practices, infrastructure planning and development should dovetail with keeping watersheds healthy in order to avoid costly damage caused by flooding.
- "Scrubbing Our Water Clean" – Highlights that by restoring degraded wetlands, their important purification function can be restored and they can be the final polishing process as we clean up polluted water.
- "Before and After: Cleaning up the Zaalklaspruit" – Outlines that the restoration of degraded wetlands enables them to act like kidneys in the landscape, thus assisting with the cleaning water polluted by mining, industry, municipal sewerage works and agriculture.
- "A Flower in the Heart of Eden" – Illustrates that working together to co-manage watersheds means that everyone can benefit from greater water yields and protection from flood risk.
- "A Cup of Tea" – Presents the argument that natural ecosystems and the plants and animals that live in them, are critical to sustaining our lives and economies, and thus warrant protection.
- "The Buzz Factor" – Highlights that by conserving natural veld, growing bee-friendly plants and encouraging good farming practices, honeybee populations can be kept strong, thus ensuring that honeybees continue to work on fields and provide "free" pollination services.
- "Push-pull Pest Control for Sugar Farmers" – Introduces how critical it is to control important agricultural pests by combining wetland restoration and conservation, with good farming practices.

Source: www.sanbi.org/news/ten-compelling-case-studies-making-case-biodiversity

The case study toolkit is intended to support an on-going communications campaign and includes user-friendly segments such as how to plan for effective communication and how to gather and present information, as well as provides worksheets for users to populate in order to guide case study compilation. The mainstreaming strategy to provide communications tools for ecosystem services had a far-reaching impact. A survey was conducted to assess effectiveness of the communications strategy and products, by conducting baseline and follow-up surveys of 30 individuals from outside of the biodiversity sector, including government officials and individuals from the private sector. The surveys included respondents exposed to the communications campaign, who were also present at the Ecological Infrastructure Dialogue. A year after the baseline survey, the respondents were asked to complete a similar questionnaire to assess improvement in understanding and awareness.

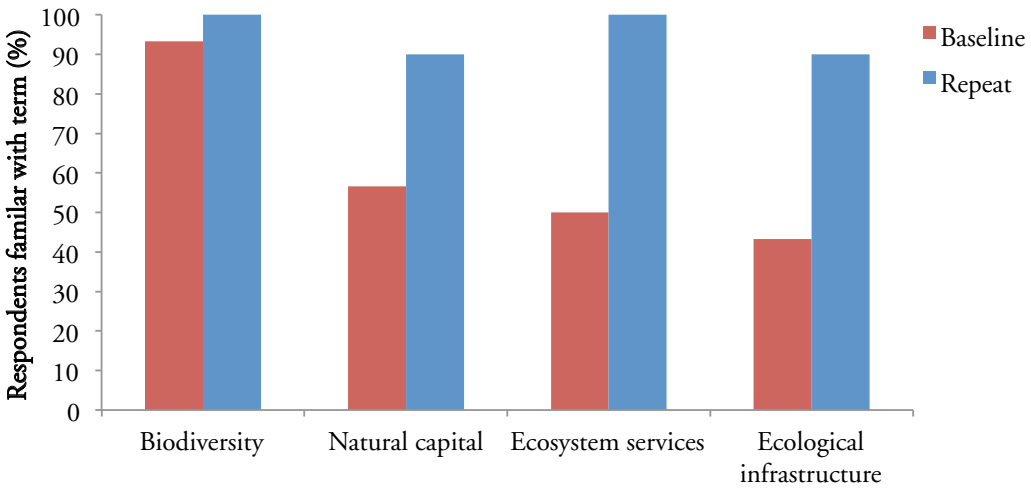
As seen in Figure 2.7, there was an improvement in the awareness and understanding of the concepts of natural capital, ecosystems services and ecological infrastructure. The term biodiversity was found to be well understood from the start of the communications campaign with respondents using the term 'biodiversity' often during the course of their work (100% had used it in the last 3 months). Newer terms such as 'ecosystem services', 'natural capital' and 'ecological infrastructure' showed large improvements with nearly all respondents understanding all terms after the campaign. The use of this terminology was found to have widely increased across government departments and the private sector.

Other measures of impact include increasing media focus, with several media articles profiling ecological infrastructure and ecosystem services. The articles were published in major national media, helping to broaden awareness outside of the biodiversity sector around the role of natural ecosystems in supporting service delivery. The strategy and its outputs were effective in mobilising funding, interest and policy engagement on the topic of ecosystem services and their role in development. Strong interactions between the communications strategy, mainstreaming Strategy #2 on water security and mainstreaming Strategy #3 on policy instruments allowed for rapid uptake of the concept of ecosystem services into policy and planning at a national scale.

#2: Co-production of knowledge for water security

This strategy focused on collaborative knowledge production between water and conservation scientists, provincial and local government authorities, and NGOs. This large team developed maps of strategic water source areas, which supply a disproportionately high amount of a region's water in relation to their surface area. Mapping the strategic water source areas – see Figure 2.5 – and fostering knowledge and awareness of the vitality of such areas through this strategy provided a key message to policymakers: managing these ecologically strategic areas, which form a small fraction of land, contributes immensely to the country's water security, population and economy.

Figure 2.7: Changes in understanding of biodiversity and ecosystem services terminology as a result of the communications campaign



This message found traction in two major areas of national development processes currently underway: national development planning and national water resource management.

Strategies have also been developed for the four key drivers of change impacting the supply of ecosystem services from strategic water source areas, viz. agriculture, plantation forestry, mining and invasive non-native trees. The issue of invasive non-native tree management is currently being used as input into prioritising the clearing operations of the Working for Water programme, a poverty alleviation programme that promotes invasive alien plant control through job creation. ProEcoServ-SA was able to provide leverage for using the information by showing Working for Water managers that invasive alien plants consume just over 460 million m^3 per year – more than the annual water requirements for the KwaZulu-Natal Coastal Metropolitan area, which supports a population of over 4 million people.

Finally, the World Wide Fund for Nature (WWF) is helping to address the remaining drivers of change – agriculture, plantation forestry and mining – though their water stewardship programmes, including the development of a successful civil society campaign called 'The Journey of Water' – see Box 2.8.

Box 2.8: The Journey of Water Campaign

The identification and quantification of the country's strategic water source areas also catalysed the development of a successful civil society campaign by WWF called 'The Journey of Water'. The campaign seeks to raise awareness of the importance of these areas for water security through the messages: 'Water doesn't come from a tap' which is extended to 'Find your nearest source area'. There is a mobile-site where users can type in their location and find out which source area supplies their town. The campaign was launched in November 2011 with a 4-day hike of 85 km, with the attendance of media, celebrities and scientists. The walk started out from a strategic water source area in a restored headwater catchment, and passed through agricultural landscapes, wealthy urban landscapes, poor informal settlements, ending in the city centre of Cape Town. Along the way the ProEcoServ-SA team addressed issues such as bulk water schemes, plantation forestry, invasive non-native trees, winelands and agriculture, water sanitation and storm water management, and water-sensitive design for urban rivers. The walk was highly successful and is planned to be repeated on an annual basis in different strategic water source areas. A short YouTube clip was produced along with several articles in national and regional newspapers.

Source: www.journeyofwater.co.za; http://www.youtube.com/watch?v=5Be6b70yrTM

The team has employed a dedicated manager for catalysing the protection of strategic water source areas, which includes developing sectoral strategies to mitigate the impacts of each of these drivers. These activities are likely to continue well beyond the lifespan of ProEcoServ-SA.

#3 Co-development of national policy instruments

In this mainstreaming strategy, the focus was on bringing in policy changes on the national-scale, which can foster the enabling conditions for local scale decision making. The aim was to integrate ecosystem services into a range of policy instruments in the environment, water, and disaster management sectors as well as national development planning agendas and strategic policies, where consideration of ecosystem services has been minimal. The work drew predominantly on products and knowledge developed as part of other ProEcoServ-SA case studies and mainstreaming strategies. This strengthened engagement with policy-makers, offering tangible and practical evidence and guidelines for policy integration.

In the pursuit of this mainstreaming strategy, several policy engagement milestones were achieved during the implementation of ProEcoServ-SA. In summary, the traction and uptake achieved by these co-produced policy inputs in a relatively short time has enabled progress in mainstreaming ecosystem services into water, biodiversity, and disaster management, as well as into a proposed **Strategic Integrated Project** directing investments for the **National Development Plan**. See Box 2.9 for ProEcoServ-SA's policy impact and Annex for further details on each component.

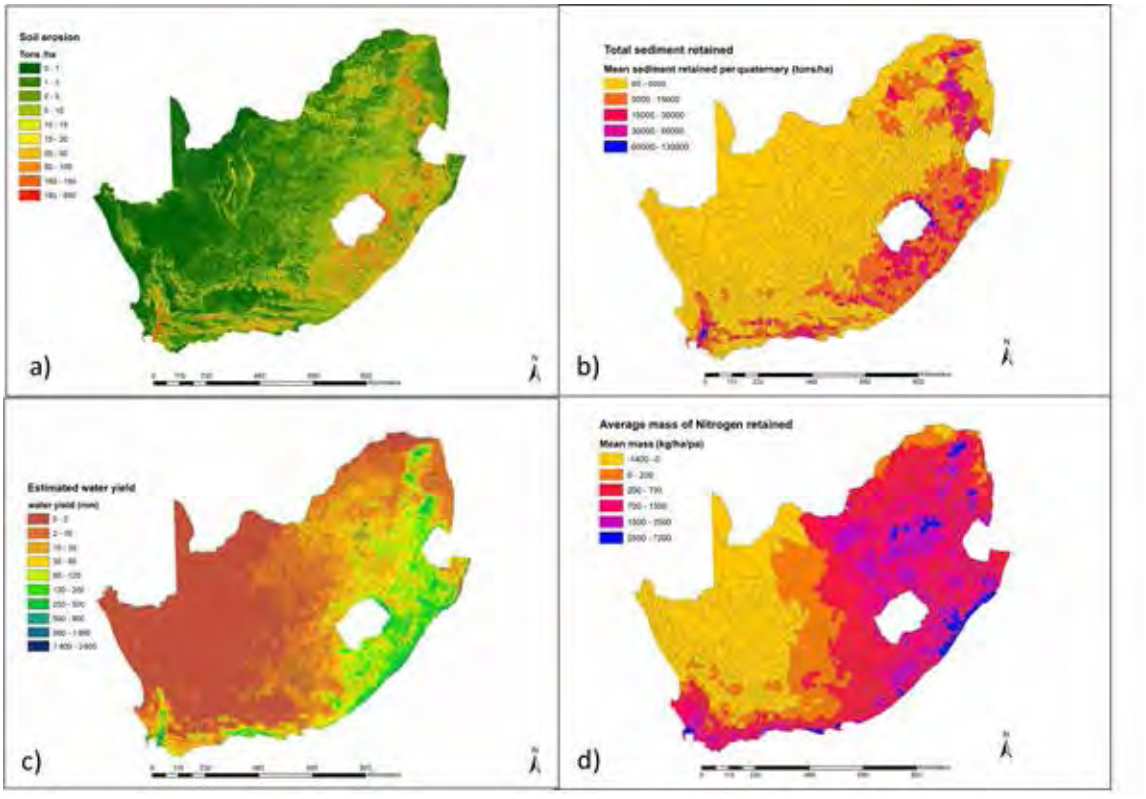
Box 2.9 : Policy Impact

A number of inter-related approaches were applied to engage in policy design through co-development of national policy instruments: expanding policy tools in environment sectors with focus on ecosystem services and ecological infrastructure; tapping into new arenas of engagement in existing policy processes in non-environmental sectors; accessing key policy audiences and partners through existing structures and institutional mechanisms; seizing the opportunity by partaking in new national development and planning processes. The concept of 'Ecological Infrastructure' was used to align with the National Infrastructure Development Plan. The contribution to the development of norms and standards for Biodiversity Management Plans for Ecosystems (BMP-Es), ensuring that ecosystems of special concern are defined to include ecosystems that support the provision of ecosystem services. The norms and standards for BMP-E's were published in 2014. The provision of inputs into the National Disaster Management Amendment Bill, National Disaster Management Centre and National Treasury processes to create opportunities for ecosystem-based interventions in the disaster risk management cycle. In addition, ProEcoServ-SA team contributed to the development of a proposed Strategic Integrated Project on Ecological Infrastructure, particularly with a focus on investing in freshwater ecosystems for water security within the National Development Plan. Moreover, ProEcoServ-SA worked with officials from the Department of Water Affairs to jointly update the National Water Resource Strategy (NWRS) with substantial ecosystem service inputs, including the addition of a new chapter on water resource protection including seven strategic actions adopted directly from the ProEcoServ-SA work on strategic water source areas. These inputs were adopted in the NWRS2 and finalised in June 2013.

#4 Bridging data modelling to inform investment and policy decisions

ProEcoServ-SA developed models and maps of regulating ecosystem services for use in directing and guiding the prioritisation processes used by these programs to guide their operations. By collaborating with South Africa's Public Works Programmes (PWP), the focus was on addressing poverty alleviation by fostering work opportunities in the productive use of land and water. These programs focus mostly on restoring regulating services associated with water security (including quality and quantity) such as water flow regulation, infiltration and soil protection through restoring native and intact vegetation and soils.

Figure 2.8: (a) Potential soil loss for South Africa-based on the universal soil loss equation captured at a 500 m resolution; (b) Total volume of sediment retained in the landscape (equal to the sum of on-site retention and up-stream sediment retention; (c) National water yield (mm) derived at a 500 m resolution and (d) Mean mass of N retained in the landscape (kg/ha) per year, expressed according to quaternary catchments.



Using models (e.g. InVEST[13]), ProEcoServ-SA developed a number of data layers capturing the role and value of intact native vegetation in securing water quality and quantity. These data layers have been mainstreamed into prioritising budget distributions between National Parks in South Africa for these restoration programmes. Managers and decision-makers in these PWPs were trained to utilise these data layers for better-informed investments – see Figure 2.8. Furthermore, these stakeholders are interested in exploring model outputs at finer (catchment) scales, and efforts have started to identify restoration sites for the Ntabelanga Laleni Dam in the Eastern Cape Province of South Africa. Valuation outputs of the models are also being used to highlight the costs avoided through restoring catchments and preventing sedimentation of this dam. This adds support for budget allocations for restoration actions as part of the construction and maintenance costs of the dam. Additional use of these models is evident in new land management programs in the Eden District and in urban planning in the city of Cape Town. For more details on the nature of these data see Annex.

#5 Guiding Investments in Ecosystem Services

Stakeholders involved with the governance of natural resources in South Africa such as the Department of Environment Affairs, national and provincial conservation authorities and the South African National Biodiversity Institute were brought together to co-develop a framework for guiding new investments in ecological infrastructure and to communicate the framework widely across their networks – see Figure 2.9.

The strategy thus focused on incentives for ecosystem service management including payments for ecosystem services (PES)[14]. Following an increased interest in this area, incentives and several pilot payment schemes, ProEcoServ-SA aimed to draw stakeholders together to develop collective thinking around these investments to guide action and support collaboration. These stakeholders co-developed a set of guidelines for new investments in ecological infrastructure. The focus on 'investment' emphasises long-term commitment, the message of 'ecological infrastructure' aligns strongly with National Development Goals, and its emphasis on labour-intensive ecosystem management aligns with national goals of job creation and poverty alleviation. The guidelines make clear key players from the private and public sector and highlights existing sets of tools available for working in an integrated manner within a mosaic of land uses. They are structured to integrate investments into existing approaches for conserving biodiversity and landscape management. The document moves on to explore resources for financing investment in ecological infrastructure from both the public and the private sector, and finally, identifies key research gaps to be addressed.

The framework provides seven principles to guide investments through project development and implementation, as well as developing a more comprehensive approach to investing in ecological infrastructure at a programmatic level. Stakeholders with experience in sustainable financing of ecosystem-based management and job creation programmes were involved in distilling these principles.

In pursuing this mainstreaming strategy to guide investments in ecosystem services, a number of efforts were undertaken to widen the understanding of certain concepts. For example, the framework on investing in ecological infrastructure advances the narrowly-perceived payment for ecosystem services (PES) models in South Africa, broadening of the scope of mechanisms, the target audience, investors, and beneficiaries involved in ecosystem management. The framework terminology shift to 'investing in ecological infrastructure' retains the market commodity value of ecosystems, while at the same time framing ecosystems as a public good. This shift in terminology acknowledges the need for national financing mechanisms to explicitly consider funding the management of ecosystems for the benefit of National Development Goals.

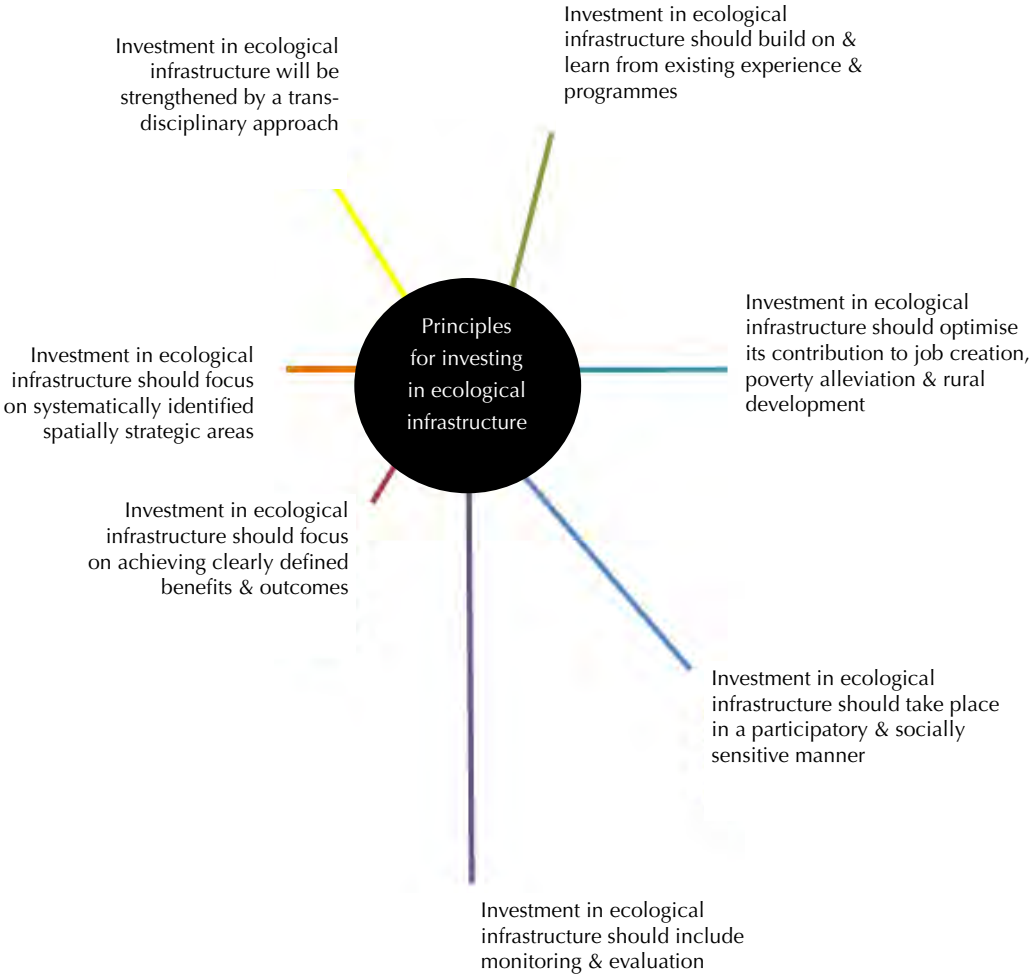
Information for use in making the case for investing in ecological infrastructure was developed for stakeholders intending to apply the framework. This included a factsheet on ecological infrastructure, defining the concept and making explicit its links to National Development Goals, in terms of ecosystem service benefits and job creation[15]. Figure 2.9 is drawn from the framework, and depicts the benefits of investing in ecological infrastructure of relevance to the water, disaster management and agriculture sectors. The benefits would also be relevant to investments in built infrastructure, such as dams, as well as job creation – both seen as strategic national priorities. A number of infographics were also developed to explain these types of benefits, many of which were used in communication and stakeholder engagement within the broader ProEcoServ-SA project.

13 InVest is a computer-based toolbox for mapping, modeling and scenario development for ecosystem services – see http://www.naturalcapitalproject.org/

14 Payments for environmental services (also known as payments for ecosystem services or PES), are payments to farmers or landowners who have agreed to take certain actions to manage their land or watersheds to provide an ecological service. As the payments provide incentives to land owners and managers, PES is a market-based mechanism, similar to subsidies and taxes, to encourage the conservation of natural resources. See further: http://www.iied.org/markets-payments-for-environmental-services

15 To download the ecological infrastructure factsheet visit: http://biodiversityadvisor.sanbi.org/wp-content/uploads/2014/02/Ecological-Infrastructure-Fact-Sheet-2nd-edition.pdf

Figure 2.9: Principles for investing in ecological infrastructure



#6: Building on Public-Private Partnerships for Ecosystem Management

The final strategy builts on South Africa's long history of public-private cooperation in managing biodiversity and ecosystems. ProEcoServ-SA aimed to distil lessons and recommendations based on this experience with the intent to disseminate the examples and lessons widely through local and global networks. Five case studies covering a range of biodiversity features, ecosystems, ecosystem services, production sectors, and combinations of participants were evaluated to discover the ecosystem context and drivers of change, and the way in which the parties involved cooperated – see Box 2.10. The case studies included cooperation in the areas of disaster management, wine farming, forestry sector, water resource management, and wetland offsets. The evaluation highlighted the importance of NGOs in facilitating cooperation as well as the largely voluntary nature of the cooperation.

A number of lessons were drawn from the case studies exploring the public-private cooperation dynamic for ecosystem management. All case studies exhibited a complex and dynamic evolution over time, involving multiple mechanisms of cooperation (informal and formal), many different spheres of government (local, national and even global), and many cooperating networks (public, private, researchers and civil society). Successful case studies had flexibility, applying active adaptive management when things were not going as planned. Many of the case studies evolved from a small, specific purpose to a larger cooperative effort, as actions gained momentum and common sense of purpose and trust developed. As an example, the insurance sector case study (in Disaster Resilience) started out as a small, 'proof of concept' research initiative by three agencies in the semi-public, private and civil society sectors. Over the course of three years, this cooperative initiative had expanded to incorporate a voluntary cooperation around adaptive response to risk and resilience, a contractual memorandum of understanding for developing capacity for local municipal risk management, and a voluntary civil society learning network for coping with and responding to risk.

Box 2.10: Case studies on Public-Private Collaboration for Ecosystem Management

Shared response to shared disaster risk: the Insurance Sector Collaboration. This case study highlights a combination of cooperative efforts in response to increased disaster risk in Eden District Municipality: a research-based insurance collaboration to explore what was driving disaster risk and what the insurance sector, and other influencers, could do to increase resilience across landscapes; a partnership to improve disaster preparedness and management at the municipal level; and a network of coordinating efforts that contribute to successful disaster risk reduction and climate change adaptation strategies.

Shared interests for wine and biodiversity: the WWF-SA Biodiversity and Wine Initiative. This is a case study of a well-established collaboration between wine industry partners, conservation partners and funders, and farmers, to conserve natural areas of outstanding biodiversity value and to promote sustainable agricultural practices in the wine industry.

Forestry, fire and biodiversity at Izanqawe. This case study looks at an example of cooperation around a land reform project in a fire-prone landscape in KwaZulu-Natal where plantation forestry is a major production activity. Landowners and other stakeholders cooperate to manage a complex interplay of environmental, social and economic drivers of fire risk in order to maintain healthy ecosystems, productive landscapes and advance rural livelihoods.

Partnerships for water-secure futures through water stewardship: the Water Futures Partnership. This is a case study of an emerging local level cooperative effort in South Africa as a result of an approach devised at a global level through the Water Futures Partnership. The Partnership set out to prove the business case for private sector engagement in sustainable management of water resources and has demonstrated the shared interest of partners in seeing this happen to address water-related risks for people, business and ecosystems.

Shared interest in gaining clarity: the Wetland Offset Guideline Collaboration Case Study. In the absence of clear guidance on how to implement wetland offsets, a cooperative effort emerged around improving transparency, replicability and consistency in the application of offsets. There was shared interest in gaining clarity in the approach, but the risks of not doing so were slightly different (albeit connected) for different parties.

Source: http://biodiversityadvisor.sanbi.org/?attachment_id=3403

2.7 Keys insights for policy impact

Reflecting upon the four-year project, a number of key insights came forth which can be important in future efforts for mainstreaming ecosystem services into policy and practice.

- **Multi-scale policy and practice** – One of the most crucial components of this project was to work across multiple scales incorporating local, regional, or national stakeholders, institutions, policy mandates and jurisdictions and adapt the project goals to function within the political economy of these scales. The multi-scale nature of our project design, with local cases and several national mainstreaming strategies highlighted that local end-user perceptions and solutions are as necessary as national level policy and planning processes in order to mainstream ecosystem services.

- **Timescales vary –** One of the key emerging lessons was that mainstreaming generally requires long-time frames, as it requires the building of relationships and trust with high-level decision-makers and politicians. Previously established relationships and foundational work proved to be a key asset for the ProEcoServ-SA initiative.

- **A collaborative approach and transdisciplinary engagement** – also known as knowledge co-production approach which builds on cross-scale perspectives and linkages, as adopted through the cases and mainstreaming strategies proved to be deeply insightful and reflected important social and ecological linkages. By bringing a plurality of knowledge sources and types together to address a defined problem

and build an integrated or systems-oriented understanding of that problem[16], ProEcoServ-SA was able to support the production of credible, salient and legitimate knowledge amongst diverse stakeholders, which has been shown to greatly enhance the likelihood of uptake into policy and implementation. Overall, stakeholder engagement needs to be inclusive and recognise inputs from researchers, end-users and businesses equally in order to ensure that research is 'co-owned', context specific and relevant to the local decision making processes. In Eden, a unique partnership of scientists, municipal officials, local government, business and civil society emerged to address issues related to environmental risk.

- **Contextualised knowledge** – it is widely accepted that integrating environmental knowledge into the policy, planning, decision making or management processes in different sectors requires an intimate understanding of the policy and institutional context in those sectors. Based on this insight, environmental projects and programmes often begin with a legal, policy and institutional assessment. While it is possible to conduct this sort of assessment based on existing legal documentation and institutional policies and strategies, we found that the most useful information extended much further than merely knowing what policies exist and the institutions mandated to implement them. The most useful information is not written down, and often exists only as tacit knowledge (i.e. not easily articulated). It can only be developed through substantial contact, careful listening about politics, procedures and day-to-day challenges of implementation, and the nurturing of science-policy interrelationships.

- **Taking advantage of windows of opportunity** that arise is another widely reported precondition for mainstreaming success. These opportunities might include converting disasters, such as those caused by wildfire or floods, into opportunities for incorporating ecosystem-based adaptation strategies into disaster risk reduction, or actively pursuing negotiations around policies or plans that are under development, revision or amendment (e.g. national development plans). For example, ProEcoServ-SA exploited the opportunity provided by the amendment of national disaster risk management legislation at the national level. Inputs were made for including ecosystem-based adaptation strategies in proactive disaster risk management, using the work developed in the case study on disaster risk reduction in Eden to make a compelling case to decision makers. We also went further to suggest revisions to existing municipal tools in order to deal with these amendments in national policy, which will ultimately be devolved to municipalities. Having a broad range of potential communication materials (e.g. maps on ecosystem services, tools, statistics and infographics or guideline documents) can greatly enhance the potential for quick reaction should a window of opportunity arise.

- **The importance of combining credible science with political credibility** (reflecting stakeholder perceptions as well as what can realistically be done by decision makers) in order to facilitate the co-production of knowledge that is not only scientifically robust, but legitimate and aligned with end-user needs. It is through such legitimate engagement, that one can enhance the salience, or relevance, of the resulting products to user needs.

- **Communication is a key enabling factor in developing salient products** – both in terms of promoting common meaning and understanding, as well as in contextualising the purpose of the products within social-economic priorities of the region or country. In the case of the former, the concepts of 'ecological infrastructure' and 'risk' were extremely useful in promoting common meaning and understanding. These concepts can be regarded as powerful 'boundary concepts' which resonated well with diverse stakeholders from different knowledge domains.

- **Demand-driven research work** – Research that is geared to, and situated in practice, and addresses on-the-ground realities have more traction in being utilised by decision-makers for practical purposes. The disaster resilience case study in Eden District proved that demand-driven research along with sustained multi-stakeholder engagement in Eden facilitated mainstreaming efforts and ensured that the research remained relevant.

16 Armitage, D., Berkes, F., Dale, A., Kocho-Schellenberg, E., and E. Patton. 2011. Co-management and the co-production of knowledge: learning to adapt in Canada's Arctic. Global Environmental Change 21: 995-1004

3. TRINIDAD and TOBAGO

3.1 Introduction

As a small island developing country, Trinidad and Tobago's national economic activity, environmental security, and human health crucially depend on its rich biome and diverse ecosystems. And thus, the mandate of ProEcoServ - Trinidad and Tobago (ProEcoServ-T&T) was to focus on mainstreaming ecosystem services into decision making via policy, legislation, national accounting, development planning and a payment for ecosystem services (PES) scheme. This section will discuss the following interventions: 1) the development of ecosystem value maps for spatial development planning; 2) the introduction of natural capital accounting, such as of carbon, water, land use and cover, and biodiversity, into the national accounts; and 3) the piloting of a payment for ecosystem services model to foster the sustainable use of valuable ecosystems. The work was coordinated by the University of West Indies.

3.2 Working plan

The main objective of ProEcoServ-T&T was to demonstrate how to best use findings of ecosystems and their services in policy- and decision making. In particular, the work plan was developed across three main components: (1) **Develop and introduce ecosystem value maps** as well as an associated Decision support system into spatial development planning in Trinidad and Tobago; (2) Explore the potential for **developing natural capital accounting into the** Trinidad and Tobagonational accounts; (3) **Develop and test a pilot eco-finance scheme**, which was developed with the Caura Valley community in Trinidad. From the operational view point, the work was carried out by a multidisciplinary team from the University of West Indies, at St. Augustine Trinidad and Tobago and developed across four different sites. Finally, ProEcoServ-T&T work went hand-in-hand with (4) **various strategies for mainstreaming** that delivered communication and outreach, co-production of knowledge, supported the integration of ecosystem services into national policy and dialogue, including the production of national ecosystem service maps, the promotion of public-private cooperation for ecosystem management, the development of ecosystem-service models to inform investments, and established a framework for investment in ecological infrastructure that in turn has been adopted in national policy and planning.

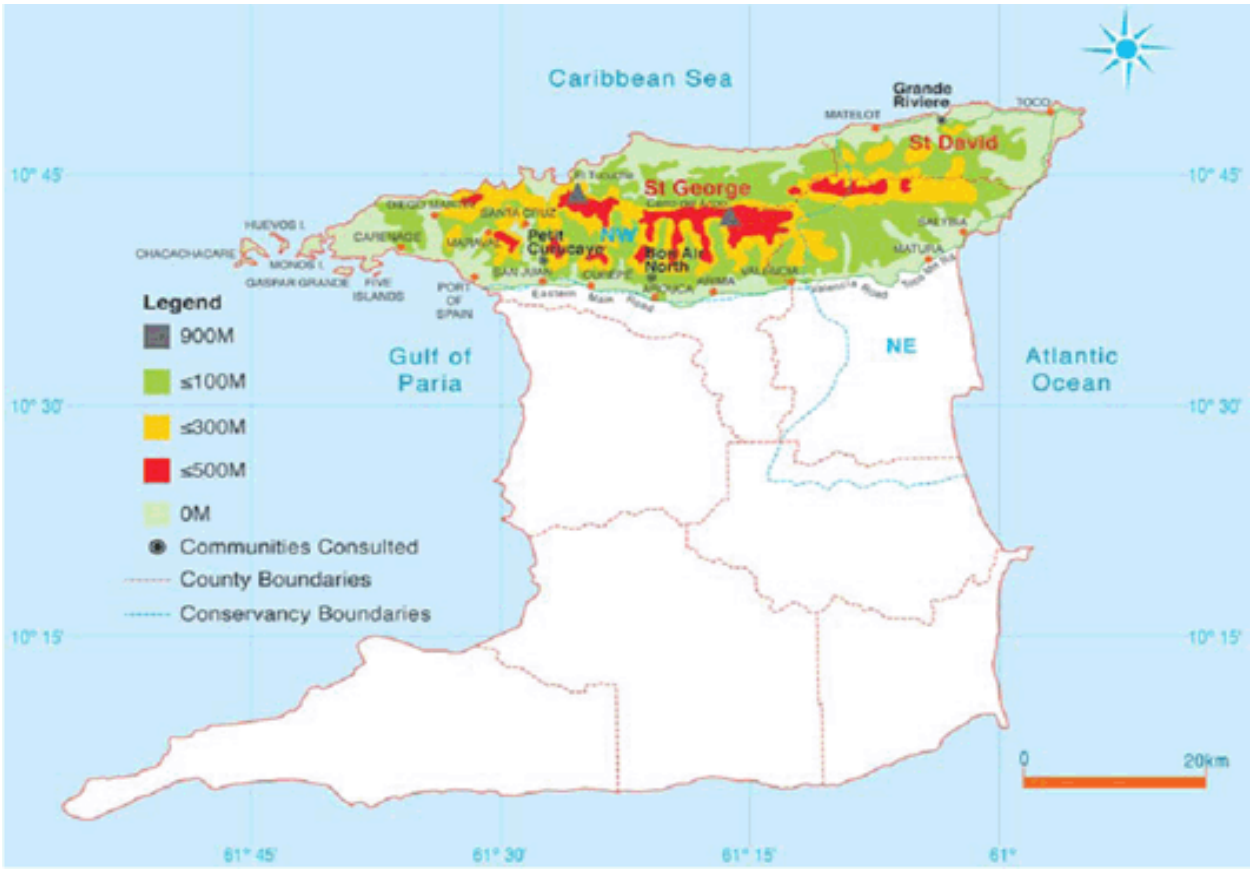
3.3 Ecosystem value maps for spatial development planning

The development and introduction of ecosystem value maps for spatial development planning was piloted for selected ecosystem services that were retained, after stakeholder consultation, as Trinidad and Tobago's key ecosystems in terms of their role and contribution toward the support of local livelihoods. These refer to the forests in the Northern range and their contribution to sediment retention; the Nariva swamp, freshwater wetland designated as a Wetland of International Importance under the Ramsar Convention, and its contribution in terms of carbon sequestration and pollination services to small farmers.

3.3.1 The Northern Range: valuing soil retention services provided by forests

The Northern Range presents the most dominant relief feature and ecosystem on the island of Trinidad. Covering approximately 25% of Trinidad's land mass, this range is covered by a variety of tropical forest, primarily seasonal evergreen tropical forest, also with semi evergreen seasonal forest, deciduous seasonal forest, dry evergreen forest and seasonal montane forest. This range runs in a west to east direction along Trinidad and Tobago's north coast, and is an ever-present feature in the lives of the residents along Trinidad's east-west corridor, the main population corridor of Trinidad located along the foot hills of the entire range – see Figure 3.1.

Figure 3.1: Northern Range area of Trinidad and Tobago



The Northern Range provides a wide variety of provisioning forest ecosystem services to residents of Trinidad and Tobago, including recreational hunting, timber, non-timber forest products for medicine and craft and water. As a mountainous small island state, Trinidad inevitably faces flooding issues, which not only results in rapid runoff in extreme rainfall periods, but encourages development of flatter flood prone areas. Poor management of the Northern Range forests results in the degradation of a key ecosystem service, soil retention. The loss of this ecosystem service results in the degradation of soil quality in agricultural areas as well as in downstream or off site effects, including the increase of the risk of river flooding and siltation of dams[17].

For the valuation of forests' soil retention services, the proposed method was characterized by a biophysical assessment where soil loss from agricultural plots is modelled using the following equation:

A = R * K* LS * C * P

Where:

A is calculated soil loss through erosion from agricultural plots in the northern range

R is a rainfall factor determined by rainfall intensity over a 12 month period

K is a factor based on soil properties such as soil fraction or the relative clay, sand and silt content of soil

LS is a factor based on the length and angle of slope

C is a factor based on land cover

P is a factor based on local conservation practices

17 The valuation of downstream or off site effects of soil erosion proves to be particularly difficult due to the wide variety of off side effects and the difficulty of quantifying mathematical relationship between erosion and downstream impacts such as flooding and ecological disturbance.

This model was coupled with field experiments to validate its applicability locally. Field experiments used three different types of plots of standardized size, that represent the following different land uses options of the Northern Range: secondary forest; secondary forest and cleared low shrub (brush) maintained; and secondary forest cleared and plot maintained weed free. These plots of standard size were placed in Maracas Valley, from November of 2012 and runoff and erosion were recorded on a weekly basis over the course of 21 months. This data and forestry division data of soil erosion under a variety of land uses, slopes and rainfall events will then be used to model erosion across the entire Northern Range by validating a local equivalent of the well-known Revised Universal Soil Loss Equation (RUSLE) model.

Following validation, the model was used in ArcGIS to model erosion on a catchment basis. The ArcGIS platform allowed for the model to be applied adjusting for the changes in the **K, LS, C** and **P** factors on the finest spatial scale of data available for improved accuracy. This method produced results on the volume of sediment production or sediment retention for each hectare of the Northern Range. Table 3.1 presents the estimation results.

Table 3.1: Summary of results from biophysical assessment of erosion prevention services provided by Northern Range forests

Watershed Name	Watershed area (ha)	Sediment exported from watershed (tonnes)	Predicted erosion (tonnes)	Eroded sediment retained due to forest (tonnes)	Sediment export ratio
Tocco	20,920	14,821	598,764	479,644	2.48%
Yarra	4,144	512	104,593	104,265	0.49%
Madamas	8,298	17	145,963	146,810	0.01%
Marianne	4,734	22	13,571	12,690	0.16%
Rest North	4,614	-	115,613	105,464	-
North Oropouche	7,354	56,817	1,586,669	1,534,457	3.58%
Salybia	6,040	13	443,094	369,732	0.00%
Matura	5,267	16,303	788,478	828,189	2.07%
Chaguaramas	10,144	21,107	700,987	661,181	3.01%
Santa Cruz	6,645	11,336	238,694	208,004	4.75%
Maraval	2,570	1	234,142	236,929	0.00%
Maracas	4,886	6,373	31,026	69,451	20.54%
Caura/Tacarigua	4,885	22,986	270,491	247,614	8.50%
Guanapo	4,949	9,887	121,909	106,253	8.11%
Arima	4,414	5,993	173,877	177,960	3.45%
Hollis	1,420	-	807	749	-
Arouca	5,947	3,631	689,039	684,911	0.53%
Aripo	5,248	9,877	281,652	275,641	3.51%
Quare	9,208	88,972	336,986	241,522	26.40%
Rest North Oropuche 1	6,609	871	110,414	99,412	0.79%
Port-of-Spain	3,881	98	80,169	86,870	0.12%
Tunapuna	1,773	43,553	97,822	8,665	44.52%
Mausica	2,125	-	31,708	30,053	-
El Mamo	2,242	1,907	44,714	36,534	4.27%
Orupuna	2,003	-	20,357	19,497	0.00%
Total		**315,097**	**7,261,538**	**6,772,497**	**4.34%**

As we can see from Table 3.1 forests retain a significant volume of soil across all watersheds in the Northern Range. On an annual basis, the Northern Range prevents erosion of about 6.7 million tonnes of sediment, which is valuable for agriculture[18]. As the use of purchased topsoil is a practice familiar to farmers to mitigate soil erosion impacts, it is proposed to assess the value of this sediment erosion by using market values for topsoil. This economic valuation method is known in the literature as replacement cost method and it calculates the financial costs that would be incurred to replace the service provided by a damaged or removed natural asset, in this case top soil. Table 3.2 shows the market price of topsoil in Trinidad and Tobago, ranging from the purchase of 100 lb bags from small suppliers to the ten-wheeler dump truck load from a large supplier.

Table 3.2: Market prices per tonne of top soil in Trinidad and Tobago (transportation included)

Price (USD)	Type of supplier
82.20	From small suppliers
19.90	From a large supplier

In this context, the economic value of soil eroded in a year is calculated as:

VSE = A * PTS

Where:

A is calculated soil loss through erosion from agricultural plots in the northern range

PTS is the average national price for top soil most similar in composition to naturally occurring soil in the NR

Taking into account these market prices, the economic value of soil retention services provided by the Northern Range forests ranges between 374 and 622 million USD – see Table 3.3. This value is quite significant for the national economy of Trinidad and Tobago as it represents about 4.0% to 6.8% of the central government annual revenues, reiterating how important is to have this ecosystem service factored in a National planning policy for Trinidad and Tobago. In this context, ProEcoServ-T&T was appointed by the Government to be a member of the Development Planning Steering Committee of Trinidad and Tobago. In this context, ProEcoServ had a policy intake at the Development of Land Bill before the Parliament, as well as the **Spatial Development Strategy** and **National Development Plan**.

3.3.2 The Nariva Swamp area: valuing pollination services to small farmers

Another key ecosystem service that ProEcoServ-T&T submitted for economic valuation are the pollination services that wild bees and insects provide to small farmers. The valuation study was implemented in the Nariva Swamp, as this swamp and surrounding areas sounded by a vast agricultural area upon which a variety of crops for subsistence and vegetable cash crops such as cucumbers – see Box 3.1. The pollinators support these agricultural activities, impacting the total levels production and this way impacting the livelihoods of the locals. This ecosystem service becomes of particular importance since this area of Trinidad and Tobago is located in one of less developed areas of the country and with the lowest levels of income per capita, about 5,000 USD per year. With comparatively low incomes and levels of development, the economic and subsistence activities supported by Nariva Swamp such as agriculture, together with hunting, fishing, crab and shellfish gathering, are of comparatively higher importance.

18 There is also increasing documentation of the value of soil diversity in maintaining belowground biodiversity, which is critical to the functioning of aboveground ecosystems. See: Bardgett, R. and W. van der Putten. 2014. Belowground biodiversity and ecosystem functioning. Nature 515, 505-511 (27 November). However, this value is not addressed here.

Table 3.3: Summary of economic value of erosion prevention services provided by Northern Range forests (on an annual basis)

Watershed Name	Eroded Sediment retained due to forest (tonnes)	Replacement cost		
		Lower value (million USD)	Upper value (million USD)	Value of erosion prevention (USD/ha/year)
Tocco	479,644	26.50	44.00	1,306
Yarra	104,265	6.50	9.50	1,391
Madamas	146,810	8.17	13.50	978
Marianne	12,690	0.67	1.17	148
Rest North	105,464	5.83	9.67	1,263
North Oropouche	1,534,457	84.83	141.00	11,531
Salybia	369,732	20.50	34.00	3,383
Matura	828,189	45.83	76.00	8,689
Chaguaramas	661,181	36.50	60.67	3,602
Santa Cruz	208,004	11.50	19.17	1,730
Maraval	236,929	13.17	21.83	5,094
Maracas	69,451	3.83	6.33	786
Caura/Tacarigua	247,614	13.67	22.67	2,801
Guanapo	106,253	5.83	9.83	1,187
Arima	177,960	9.83	16.33	2,228
Hollis	749	0.00	0.00	29
Arouca	684,911	37.83	62.83	6,365
Aripo	275,641	15.17	25.33	2,903
Quare	241,522	13.33	22.17	1,450
Rest North Oropuche 1	99,412	5.50	9.17	831
Port-of-Spain	86,870	4.83	8.00	1,237
Tunapuna	8,665	0.50	0.83	270
Mausica	30,053	1.67	2.83	782
El Mamo	36,534	2.00	3.33	901
Orupuna	19,497	1.00	1.83	538
Total	**6,772,497**	**374.33**	**622.17**	**(average) 2,457**

Box 3.1: Nariva Swamp

The Nariva Swamp, located on the east coast of the island of Trinidad about 50 km south east from the capital city of Port of Spain,is extended over a 450 km^2 catchment area, which is about 10 per cent of the surface area of the country. This swamp is the largest and most diverse wetland in the country, covering 11,343 ha, and is a permanent brackish lagoon with extensive mangrove swamps, fresh to brackish swamps, swamp forest and seasonal flooding marshes with elevated areas of humid tropical hardwood forest. It is an important ecosystem providing a number of ecosystem services to both regional and local populations of Trinidad and Tobago: shoreline stabilization, storm protection, natural habitat provision and pollinator habitat. The swamp supports a wide variety of bird, mammal, crustacean , fish and reptile fauna, notably the national bird of Trinidad and Tobago the scarlet ibis (*Eudocimus ruber*), the red howler monkey (*Alouatta seniculus*), the extremely vulnerable manatee (*Trichechus manatus*) and the locally endangered yellow macaw (Ara ararauna). For all these reasons, the Nariva swamp has been designated a wetland of international importance under the Ramsar Convention in 1992. More recently, it has also be designated as an Environmentally Sensitive Area by the Environmental Management Authority of Trinidad and Tobago, in 2006

For the valuation of wild pollination services to agricultural goods produced by the local rural communities in the Nariva Swamp, it was proposed to use a production function where the contribution of pollination to crop A is modelled as follows:

$$Q = K * L * Land * D$$

Where:

Q is production of crop A

K is amount of capital inputs used in the production of crop A

L is amount of labour inputs used in the production of crop A

Land is amount of land inputs used in the production of crop A

D is insect dependent factor in the production of crop A

The method to estimate insect dependent factor in the production of a crop uses a series of plots of varying distances from the edge of the swamp, which are covered by nets of varying sizes in order to exclude pollinators of various sizes from crops and thus remove the influence of these pollinators on crop pollination and thus the yield of the crop. In order to assess the marginal impact of wild pollination on crops, it was used in four different controlled experiment sites: Plot I at each location was covered with ¾" wire mesh to exclude insects with a body width larger than ¾" in diameter; Plot II at each location was covered with ¼" wire mesh in order to achieve the same with respect to insect exclusion of this size class; flower buds of plants in Plot III were covered with mesh bags to exclude all insects; the open Plot IV remained uncovered. All insects were free to access flowers in this plot. Each plot measures approximately 4.9 m x 2.4 m, equalling an area of 11.9 m^2. Crop yields and seed yields are then recorded and examined to determine the relative influence and importance of pollination services provided by insects that rely on the Nariva Swamp as a habitat to the agricultural activities in the areas surrounding the swamp. Cucumbers were selected as the primary crop of study as they were identified as key crops for exploration and listed as a priority commodity in the National Food Production Action Plan 2011-2014 in the recently produced Agriculture Manifesto. D (insect dependence factor) results are presented in Table 3.4

Table 3.4: Insect pollination results across two crops (in the absence of pollination scenario)

Crop	D insect dependence factor (estimated)
Cucumber	0.965
Hot pepper	0.769

As we can see the mean percentage reduction in yield in complete absence of pollinators is very significant, ranging from 76.9 to 96.5 per cent, respectively for the hot peppers and cucumbers crops. The loss of income as a consequence of total exclusion of pollinators from flowers to farmers growing hot peppers would potentially incur weekly losses ranging from 398 to 861 USD, while losses for cucumbers amount to between 2,348 and 12,692 USD per crop cycle, which is approximately eight weeks.

Finally, it is explored scaling up economic valuation the pollination results from ProEcoServ-TT study to Trinidad and Tobago's national economy. The value of agriculture output attributed to insect pollination is calculated as follows:

$$V_{ip} = (D_x * V_x)$$

Where:

V_{ip} is the annual value of agricultural output attributable to insect pollination

V_x is the annual value of crop X as produced in Nariva

D_x is the insect dependence factor of crop X as calculated by ProEcoServ

The insect dependence factors developed in Nariva were multiplied by the total annual value of produce nationally of selected vegetables so as to calculate the annual value of crops produced attributable to pollination. The total value of these crops was determined by multiplying average annual prices and national production data, both provided by the Ministry of Food Production. Table 3.5 summarizes the results. Lower and upper value estimates indicate two pollination scenarios, in the complete absence of pollinators and in the scenario that the activity of pollinators was reduced to a ¼ of the current situation. For example, in 2012 the annual production of cucumbers was 1,355 tonnes, generating a revenue of 1,059,209 USD. Taking into account the results from the field experiments, the marginal value of the insect pollination to the selected crops ranges between 193,387 and 1,022,121 USD. In order words, the scenario of total absence of pollination is associated with a significant expected economic loss, in which the upper value is almost the same as the recorded production. From the national economy view point, the economic value of pollination can be estimated to be in the range of 9 to 13 per cent of the annual value of vegetable production in Trinidad and Tobago.

Table 3.5: Economic value of pollination of cucumbers and hot peppers (in USD)

		2010		2011		2012
Production Cucumber(tonnes)		1,300		1,193		1,355
Market value(USD)		838,279		1,054,744		1,059,209
Pollination(USD)	153,699	808,940	193,387	1,017,829	193,387	1,022,121
Production Hot pepper (tonnes)		700		491		250
Market value(USD)		3,466,400		2,468,297		2,837,051
Pollination(USD)	1,226,204	2,665,662	873,135	1,898,120	1,003,578	2,181,692

This contributory economic value becomes of particular importance as agriculture is vital in supporting the livelihoods of the communities in the Nariva area, not only as an income generator but also as subsistence crops. In this context, pollination also has a key role in supporting a governmental policy targeted at improving food security. The results also show that the impacts of a change in the pollination conditions differ across the two selected vegetables. It is important to note, however, that the wild pollination services are studied here and valued primarily as an input in agricultural production but it is important to note that pollination services are also critical to ecosystem functioning, as they support the propagation and maintenance of key fauna and flora that provide critical habitat and regulatory services that support the delivery of all other services provided by the swamp. The valuation of these ecosystem services are beyond the scope of the present study.

The Nariva Swamp plays an important role in the reduction of coastal erosion in areas it is located. The roots and stems of mangroves, through impact with costal waves, dissipate their energy thus reducing their capacity to erode and transport sediments and other materials. This induces the process of deposition, contributing to a feedback loop whereby mangroves can further settle and stabilize existing sediment deposits. Due to its direction towards the open ocean, Trinidad's west coast encounters significant coastal erosion issues. And thus, the location of a number of key mangrove forests namely the Nariva Swamp, the Fishing Pond Mangroves, Matura Bay Mangroves, Point Galeota Mangroves and Guayaguayare Mangroves are vitally important to reducing erosion rates along Trinidad's west coast. The importance of these coastal protection services must be emphasised in the context of sea level rise associated with climate change. Mean sea level is expected to rise by 0.35 m globally by the end of the century in the A1B scenario (IPCC, 2007)[19]. This rise is expected to vary greatly from region to region and thus the Caribbean, and Trinidad and Tobago may face greater rates of rise.

Nariva is home to 45 mammal species, 30 reptile species, 33 fish species, 204 bird species, 19 frog species, 213 insect species, and 15 mollusk species. From an economic standpoint some of the value of this service is captured in the value of commercially exploited wildlife or other activities such as tourism that are supported by the presence of species which the wetland houses. The Nariva swamp also serves as an important nursery habitat for nearby coral reefs and sea grass beds. Some juvenile fish species spend a portion of their life cycle in mangrove forests, within which they have a much high survivorship rate. Due to this, mangrove forests have been shown to enhance the biomass of Caribbean reefs due to the functional linking between the two ecosystems (Mumby, et al., 2004).[20]

19 Intergovernmental Panel for Climate Change (2007) Climate Change 2007: Impacts, Adaptation and Vulnerability, Cambridge University Press.)

20 Mumby, P., Edwards, A., Arias-Gonzalez, E., Blackwell, P., Gali, A., Gorczynska, M., et al. (2004). Caribbean, Mangroves enhance the biomass of coral reef communities in the. Nature, 533-536.

Finally, the ProEcoServ team investigated the potential of carbon sequestration of the Nariva Swamp. According to computations of the ProEcoServ country team, the average amount of carbon sequestration in this area is estimated at 135 tonnes per hectare per year. This corresponds to annual carbon sequestration service of 1.53 million tonnes of carbon a year. This corresponds to 11.1% of all CO_2 emissions from Trinidad and Tobago[21]. In other words, the Nariva Swamp plays a key role as a nature-based solution to stock carbon and this ecosystem-based tool for carbon sequestration has a great financial potential, including PES for a carbon-based management scheme – see also Section 3.5.

3.3.3 Conclusions

This section provides an overview of the significant economic value of selected ecosystems services, including pollination and soil retention services provided by forests in Trinidad and Tobago. Furthermore, the importance to choose a valuation method in accordance with the selected benefit under consideration is highlighted. Finally, economic valuation results inform the policymaker of the importance in incorporating ecosystem services in spatial development planning. The failure to embed this dimension will imply a significant increase of risk of natural disasters, including flash floods, soil erosion as well as loss of agricultural productivity.

3.4 A natural capital accounting framework

3.4.1 Setting the scene

The key objective here was to integrate natural capital accounting with the standard national accounts in order to broaden the information set available to decision makers when considering macro-economic and national sustainable development and planning issues. The accounting framework is therefore a tool rather than an end in itself. This point is important to recognize since the full integration of natural capital accounts is a challenging task both conceptually and practically. However, there are a range of options of integration that can be described, with each phase broadening the available information set. All in all, there is:

Option 1: Assessing expenditure on environmental protection or resource management with outcomes in terms of changing ecosystem conditions. The ongoing measurement of ecosystem conditions across the country enables the appropriateness of expenditure or other policy initiatives on environmental outcomes. Thus the success of policy is not focused on input measures such as number of people employed, number of dollars spent, etc.

Option 2: Combined accounts for certain economic activities. A combined account is a structured table that brings together data in monetary terms (e.g. output, value added, investment) with data in physical terms (e.g. water use, energy, use, emissions, etc.) to provide a more comprehensive picture of the nature of a particular economic activity. Combined accounts are shown in the System of Environmental Economic Accounting (SEEA) Central Framework, Chapter 6, relating to energy, water and emissions. Also possible are combined accounts for agricultural activity (SEEA Agri is being developed by FAO) and for tourism activity (see SEEA Applications and Extensions, Chapter 4).

Option 3: Balance sheets for natural resources and depletion-adjusted GDP. The SEEA Central Framework describes the way in which standard balance sheets including produced (built) capital and financial capital can be extended to incorporate the value of natural resources. Using these balance sheet values, estimates can then be made for the depletion of natural resources, for example depletion of mineral and energy resources, and measures of GDP can be adjusted for depletion. (Note that this adjustment does not provide a complete adjustment for environmental stocks and flows, only those pertaining to the extraction of natural resources).

Option 4: Recognizing the full value of ecosystem assets and their services. The SEEA Experimental Ecosystem Accounting describes an integration approach whereby ecosystems can be added onto the standard accounting structure to reflect an additional "sector" with which other sectors, such as corporations, government and households, interact. The accounting would show flows of ecosystem services between the ecosystem sector and economic sectors, and also declines in the value of the ecosystem sector due to degradation of the ecosystem assets. The addition of another "column" in the accounting structure is difficult in practice but is a powerful organizing concept. [22]

21 For more information please consult http://data.worldbank.org/country/trinidad-and-tobago.

22 For an complete example of option 4, see the recent UNEP publication Guidance Manual on Valuation and Accounting of Ecosystem Services for Small Island Developing States http://www.esevaluation.org/images/Guidance%20Manual%20SIDS%20Full%20Report.pdf

In the present pilot, it is proposed that focus be placed on developing options 1 and 2 in the short term, for example by developing an extended tourism satellite account for Tobago. At the same time, a discussion on the prospects and role of Options 3 and 4 should commence such that the development of underlying data can be placed in an appropriately broad information and decision making context.[23]

3.4.2 Plan of Action for Implementing Natural Capital Accounting

The starting point for the development of national natural capital accounts for Trinidad and Tobago is providing a complete assessment of the country and its environment. While this would seem like a very challenging task, in fact, it can be separated into a series of manageable stages where increasingly detailed information sets can be progressively incorporated.

In Trinidad and Tobago, a number of key steps can be taken to allow for the implementation of the proposed approach above. The proposed steps are, however, consistent with advice that has been generated by the international statistical community for the implementation of the SEEA (see SEEA Implementation Guide, 2013) and are also being tested for ecosystem accounting in seven pilot countries in a current UNSD/UNEP/CBD project.

Step 1: Establish a core group. The core group should be a high-level cross agency group involving both potential users and producers of natural capital accounting information. This group should involve representatives from central agencies and is intended to provide direction and support to technical work.

Step 2: Strategic planning. Under the guidance of the core group a small team should undertake a planning process aimed at establishing the necessary relationships, legislative requirements, data sharing commitments, staffing and resources, and accounting priorities. The focus here should be on medium to long term planning while also identifying areas in which short-term results may be found. Since the development of accounting experience is not a one-off exercise but requires a sustained commitment of at least 3-5 years, establishing a sense of continuity is important.

Step 3: Involvement of international agencies and regional bodies. For success it is essential that the project be led and owned by Trinidad and Tobago. At the same time, there is ever broadening support for natural capital accounting within the international community – both statistical and elsewhere – and connections to relevant networks are likely to be extremely useful in supporting the establishment of a natural capital accounting program at country level. Further, as more countries within the region develop natural capital accounting programs, the opportunity to exchange experience and share knowledge and techniques should be grasped.

Step 4: Priority accounts. Notwithstanding the outputs from the strategic planning process in Step 2, it is proposed that initial focus be placed on developing land accounts and water accounts. This proposal is based on the requirements for policy, the availability of data and the emerging logic of structuring natural capital accounting programs. In essence the information from these two accounts is likely to provide the most effective broad level assessment of changes in environmental condition. It is noted that an important aspect of the land accounts should be tracking the area of forests.

Step 5: Establish core natural capital accounting team. The lessons from countries that have established programs on natural capital accounting is that it is essential to start small and then build. The challenges lie in part around gathering data but in larger part in establishing the discipline of accounting that requires not only gathering data but organizing, confronting, reconciling and balancing these data to provide a coherent story. Establishing this discipline is best done with a small number of accounts. Consistently, accounting is a "learning by doing" exercise. Hence it is relevant to start with relatively basic accounting structures and over time add complexity. Releasing initial efforts as experimental or demonstration accounts is a standard practice in a number of countries and is an excellent way to generate interest, garner feedback and establish networks.

Step 6: Ensure allocation of resources for the communication and use of accounts. While the release of accounts is an important achievement it is not sufficient. It is important that following completion of accounts there is widespread promotion and explanation of the accounts. Further, it is recommended that specific efforts be made to work with users to understand how the data can be used in decision making situations. Experience from this exchange between producers and users are likely to be invaluable in ensuring that the accounts are appropriately adapted and relevant.

23 For a detailed overview on natural capital accounting and current initiatives see Annex.

It would be anticipated that with sufficient commitment and resourcing (4-6 people ongoing), the establishment of a natural capital accounting program would generate results within 12-18 months. There are a number of agencies that may lead the work and effectively "house" a natural capital accounting program. A close connection with the National Accounts Department of the Central Statistical Office is essential and perhaps this would be a good home for the work. Alternatively a new unit in the Ministry of Planning and Sustainable Development may be an effective solution. A third alternative that is being utilized in Guatemala is the use of an academic institute to compile the accounts that are subsequently reviewed by the Central Statistics Office (CSO). It is noted that it is not sufficient for the data to be released by an academic unit – government endorsement and support is very important.

3.4.3 Demonstration accounts for carbon, land, water, and biodiversity

As part of this project, four "demonstration" accounts were compiled. The intention was to provide a general indication of what some natural capital accounts might look like and also to assess what type of information may be readily available. The four accounts were: a carbon stock account (covering mineral resources and forests), a land cover account, a water resources account, and a species diversity account. A short summary and demonstration accounts on carbon, water, land, and biodiversity can be seen in Annex. In the sections below, the paper discusses key factors surrounding the accounting for the select natural resources.

i) Carbon

Carbon accounting is generally associated with the measurement of emissions of greenhouse gases that arise as a result of economic activity. In the context of natural capital accounting, accounting for emissions is just one aspect, and the broader ambition is to track the stocks and flows of carbon between the different places that carbon is stored.

The relevance of carbon stock accounting to Trinidad and Tobago comes from two perspectives. First, as part of the broad objective of assessing changes in ecosystem conditions and thereby working towards integrating natural capital into economic accounts, changes in carbon, is an important core indicator.

Second, given the relative importance of Trinidad and Tobago's oil and gas industry, understanding the available stores of carbon in the oil and gas reserves and changes in those stores, represents an important aspect of integrating measures of natural capital with economic activity.

Ideally, a carbon stock account would cover all stores/reservoirs of carbon within a country whether as geocarbon or biocarbon. Geocarbon includes reserves of oil, gas, coal and similar resources and also carbon held in rocks, primarily limestone and some minerals (e.g. marine sediments and methane clathrates). Biocarbon covers carbon stored in all plant and animal species (living and dead) and in soil and water resources. From a national perspective, carbon stored in the oceans and the atmosphere is generally not allocated to a country and, as appropriate, would be taken into accounting in global models.

To demonstrate the potential application of carbon stock accounting it is proposed that a demonstration account focusing on carbon stored in oil and gas reserves and carbon stored in forests be developed. Techniques for the measurement of the carbon in these stores will be discussed with experts in Trinidad and Tobago, utilizing experience in the development of carbon stock accounts in Australia, and taking into account the measurement of changes in carbon stock used in the ecosystem condition measures developed by the European Environment Agency.

ii) Land cover

A basic requirement for natural capital accounting is an understanding of how the composition of the land cover of a country has changed over time. Land cover accounts use a broad classification of different types of land cover – e.g. forests, wetlands, agricultural land, inland waters, urban areas, etc. – to record the number of hectares of each land cover type at various points in time. In a second step it is possible to analyse the changes between points in time examining additions and reductions in each land cover types and potentially classifying the changes into whether they are driven by economic or non-economic causes. The development of land cover accounts may be possible using GIS and satellite data and these types of sources should be investigated in the first instance. Trinidad and Tobago may already have land cover maps developed by different agencies for specific purposes (e.g. management of water resources). Thus it will be important to understand existing maps and classifications. Concordance to proposed international classifications in the SEEA would be beneficial.

Ideally, the aim should be to develop land cover accounts over a long period of time but not necessarily every year. A suggestion is to develop land cover accounts from 1990 onwards with data compiled every 5 years. It may also be useful to put together accounts for years further in the past – say 1970 and 1950 such that a longer history can be conveyed.

Land use accounting has a similar motivation to land cover accounting in terms of providing a broad sense of the changing use of land in a country over time. However, its focus is on creating a basic link between the land and economic activity. In many cases there will be overlaps between land cover and land use but some useful distinctions can be drawn. For example, a given area of forest may be split into an area that is used for forestry and an area that is protected as a national park.

Land use maps may be found in planning departments where decisions are made regarding the zoning and re-zoning of different areas. Useful information may also be found from agricultural censuses and related data sources. There may be existing classification of land use that can be applied. Again it would be useful to develop a concordance between any selected classification and the international classification proposed in the SEEA. Although generally discussion of land use is limited to terrestrial areas including inland waters, it is likely to be relevant to extend the scope of land use accounts to include coastal and possibly marine areas out to the edge of the exclusive economic zone (EEZ). Understanding the changing patterns of use of these areas may be important for many analyses. As for land cover accounts, ideally land use accounts would be prepared over a long period of time but not necessarily every year. Accounts from 1990 onwards, every 5 years would be appropriate.

iii) Water

Together with carbon and land cover accounts, water accounting provides the basis for the measurement of the third core indicator for the assessment of ecosystem condition. Further, water's importance in its own right means that the compilation of water accounts can provide information of direct use for policy and analytical purposes.

The methods and techniques for the development of water accounts have been well developed and implemented in many countries. Key aspects of the measurement of water accounts are:

- Tracking the stock of water resources – particularly surface and groundwater – and changes in those stocks through the hydrological cycle (precipitation, evaporation) and due to abstraction and return by economic units and households.

- Accounting for the abstraction of water from various sources including via desalination and recording the economic units undertaking the abstraction and then understanding its distribution and use through the economy.

- Accounting for the collection and treatment of wastewater and its reuse.

Ideally, water accounting would also take into consideration water quality but this aspect has not been fully developed at this stage from a SEEA perspective.

It is proposed that water accounts be developed for Trinidad and Tobago and that to demonstrate the potential in this area, demonstration water accounts be developed for Tobago. Water accounts tend to have most value when implemented for a specific water catchment region and this would seem to be appropriate in Tobago's circumstances. Also, the relevance of water to decisions on Tobago's tourism strategies is high, particularly with respect to flows of wastewater.

Beyond water accounts for Tobago, the development of water accounts for Trinidad is likely to require discussion on appropriate boundaries for water catchments and watersheds that are meaningful for both data collection and integration into the broader sub-national areas to be used for natural capital accounting.

iv) Biodiversity

Discussion with relevant people in Trinidad and Tobago indicated that only a limited amount of information on species numbers was available although for some hunted species information on numbers killed was available. As part of the extensions to protected areas in Trinidad and Tobago and their improved management, a survey

is being conducted on species in those areas and information from such a survey should be able to be used to support compilation of a biodiversity account.

3.4.4 Factors supporting implementation in Trinidad and Tobago

The implementation of natural capital accounting may be considered a daunting challenge. In fact, if approached with the appropriate level of support and with recognition of the need to progress step-by-step, a program of natural capital accounting can be established in relatively quick fashion, certainly within three years. From that base it would be expected that a program could build and improve its outputs over time. This section considers the main factors required for successful implementation.

i) Recognition of the important role of information and statistics within decision making

Without recognition of the benefits that well-compiled and broadly disseminated information can play in the decision making process, successful implementation of natural capital accounting will not succeed. Natural capital accounting can play a role in ensuring (a) that broad environmental changes and risks are monitored regularly, (b) that decision making takes a broader range of information into account, and (c) that the outcomes of policy decisions can be assessed, including outcomes that may not have been envisaged.

It is well accepted that corporations should compile information on their activities for both their own benefit and the benefit of investors. Standard national economic information is seen in the same light – with the investors being the general population. The extension to natural capital accounting should be granted the same level of recognition in terms of the role of information, i.e. it should be accepted as standard.

ii) High-level political support for the integration of information across government

At the early stages of implementation of natural capital accounting it is unlikely that the major barrier to success will be a lack of data. Rather, experience from many countries, suggests that there is commonly a wide range of relevant data but commonly it is controlled within a number of government agencies and under varying institutional arrangements. Since the purpose of natural capital accounting is to integrate environmental data into mainstream economic and development decision making, the available information needs to be shared in open and transparent ways.

One means of advancing this issue is to develop the potential of the Central Statistics Office (CSO) to be the leading integrator of data across the government and private sectors. While the CSO may not have direct or significant experience in the development of environmental information, they do have expertise in (a) the management of national level datasets, (b) the use of standards and classifications for the integration of data, and (c) the dissemination of data to broad audiences. Supporting the application of these important skills is an important aspect of the development of natural capital accounting at the national level.

iii) Technical resources and skills

In establishing a program of work it is recommended that resources be applied to finding and integrating existing data rather than running additional collections. In the first place, this is simply sound practice in the use (re-use) of resources but perhaps more importantly, it places the emphasis on integration and partnership which is so essential in this area of work.

While existing data may be used, the process of finding and integrating data is not cost free. Resources are required to establish a team that is the focal point for the accounting work. The size of the team will depend on the number and detail of the accounts initially envisaged and the number of other agencies with whom the team will need to engage.

The relevant skill set needed for forming a team for natural capital accounting includes economics, statistics, national accounting, environmental measurement, sustainability policy, geo-spatial analysis, and dissemination and communication. Importantly, those with skills in one or more areas must be willing to appreciate the insights and contributions from the other disciplines such that integration of the data and the development of best practice can be achieved.

Experience from other countries suggests that the national accounting aspects of natural capital accounting may be the most problematic to learn but are also core skills. For this reason it is optimal to ensure that

people with national accounts experience are included in the natural capital accounts team and that training programs on national accounting take place. Also, for this reason, and depending on other decisions, it may be appropriate to locate the natural capital accounts team within the established national accounts section. While this is just one of a range of structures that countries have used, it does have the benefit of providing strong national accounts skill set but also the attraction of helping to improve the standard national accounts estimates through consideration of natural capital accounting data.

iv) Data availability

Clearly the preparation of natural capital accounts requires data. Exactly how much data are required depends on the number and detail of the accounts to be compiled. Thus, for example, for the completion of land accounts only information on the stock and changes in stock of land area by type of use and type of cover is required.

One example of the type of data that would help to support a natural capital accounting program are the Annual Reports of the Environmental Management Authority which in 2004 provided a quite comprehensive assessment of the Northern Range essentially using a natural capital accounting approach.

A second example is the 2007 release by the Ministry of Planning and Environment of the First Compendium of Environmental Statistics. While not applying a natural capital accounting approach per se, it covers an impressive range of themes and presents a significant amount of information of direct relevance in natural capital accounting. Indeed, the national accounts section of the national statistical office led its compilation and it includes an energy account reflecting flows of energy through the economy.

What is most impressive about both of these examples is that their development was very deliberately conducted in an open and collaborative manner. Since this approach must underpin any efforts at natural capital accounting, these two publications point to the capability in Trinidad and Tobago to establish and progress this type of work.

Further, in terms of progressing natural capital accounting in Trinidad and Tobago it is not necessarily the case that there must be a sole dependence on locally sourced data. Increasingly, global data sets based on modelled remote sensing and other data are being constructed. Such data sets will no doubt miss the detail and the nuances that need to be taken into account at a country level but, at the same time, such global data sets may be able to provide a supporting role for natural capital accounting work at the national level. Work is currently underway within a joint UNSD/UNEP/CBD project on ecosystem accounting that, among other things, will provide some advice on the use of global datasets for monitoring changes in ecosystem conditions at the national level and assessing flows of ecosystem services.

3.4.5 Policy relevance of natural capital accounting for Trinidad and Tobago

There are a number of areas in which the availability of natural capital accounts for Trinidad and Tobago are likely to be important for policy development and monitoring, which are discussed below.

i) Oil and gas sector

The oil and gas sector in Trinidad and Tobago is of clear significance, accounting for 43% of the country's GDP directly, and supporting a range of other activities (particularly manufacturing) through the availability of a readily available supply of energy. Since oil and gas are non-renewable resources, assessing their long-term impact on national income is reliant on a common understanding of the status of the resources in terms of total reserves and the feasibility of their abstraction. The annual report commissioned by the Trinidad and Tobago government (Ryder Scott Report) on the status of the country's oil and gas reserves is recognition of the need for these data. Also, the developing work of the Trinidad and Tobago Extractive Industries Transparency Initiative (TTEITI) to ensure consistent reporting of oil and gas related flows between government and corporate entities is an important activity in public accountability for the resources. These two reporting activities could be supported by a general program of natural capital accounting for sub-soil resources following the international statistical standard – SEEA 2012 Central Framework (United Nations, et al 2014). Reporting following the SEEA would ensure coherence in accounting for the oil and gas resources with the measures of GDP and other measures of economic activity and also allow comparison to other countries. At a macro level, SEEA-based reporting provides a framework for assessing long-term extraction trends and asset life in a manner comparable across different natural resources and different countries. One of the demonstration accounts, the carbon account, also shows how estimates of oil and gas reserves may be converted into carbon equivalent

measures and hence combined with other sources of carbon, primarily forests, to create a broader carbon stock account.

ii) Land use planning

Land use and land cover accounts provide an ongoing report of the composition and changes in composition of land across the country into standardized classes. Investigation through this project suggests that Trinidad and Tobago has some history in the development of land related data but that there is no institutionalized program to report data on a consistent basis over time. Recently however, there has been an ongoing process to establish the National Spatial Data Infrastructure Program, which would prepare some core data sets on a regular basis. In this context the establishment of a regular set of land use and land cover natural capital accounts following international classifications for these topics would be of considerable value. The value of these accounts lies not only in providing a picture for the country of broad changes in the composition of land use but, given the nature of these data sets, it can also support the analysis of changes at sub-national administrative levels, the development of maps showing the changes in various locations, and programs on monitoring economic and environmental performance.

iii) Water

As with many small island states, maintaining the supply of and access to high quality water is an ongoing challenge for Trinidad and Tobago. While the general situation does not appear to be of significant environmental concern at present, there are particular locations, for example in Tobago, where ongoing investigation and investment is needed to ensure that water supply meets water demand.

Natural capital accounting for water represents an important policy support tool by organizing information over time on changes in the available stock of water through precipitation or groundwater and linking this to rates of abstraction of water from the environment (or production of water through desalination) and rates of consumption by different industry sectors and households. An important aspect of managing water is having an understanding of the situation in different water catchments. In this respect, spatial level accounting information – i.e. recording water supply and demand and water resources stocks in specific catchment areas – may be of particular relevance.

iv) Tourism

Tourism is an important economic activity in Trinidad and Tobago, especially Tobago, and underpins important employment and business opportunities. For both domestic and international tourists the state of the surrounding environment is particularly important. This is true in terms of providing attractive and safe areas for recreation, in terms of providing important inputs to production (such as water) and in providing important ecosystem services – such as the flood protection offered by Buccoo Reef to the seaside tourism facilities. In this context, natural capital accounting can provide useful information that links the economic activity associated with tourism to the environment. Ideally, a natural capital account for tourism would integrate environmental information with data on the economic activity of tourism to support more integrated discussion. An example of this would be linking data on tourism activity in Tobago with data on water availability and supply in the same area.

v) Biodiversity protection and habitat restoration

Trinidad and Tobago is quite heavily forested with around 60% of the country's area under forest cover. Together with some large wetland and other important ecosystems, Trinidad and Tobago maintains important habitats for many species. Recognizing this, the government has established a number of protected areas. Natural capital accounting focusing on the changing condition of those protected areas may be a useful tool to monitor the protected areas and assess the improvements (or otherwise) in biodiversity and related characteristics.

Natural capital accounting for changing species diversity and abundance may also be relevant in the management of hunting activity in the country. A survey aimed at measuring the extent of certain key species is under development and a natural capital accounting framework may prove a useful conceptual basis on which to organize and present the information.

vi) Food security

With growth in the national economy in recent decades being driven by the oil and gas sector, the relative significance of agriculture and food production has diminished. To the extent that there is a desire to address the dependence on imported food products and to support the livelihoods of those living in rural areas, there may be interest in establishing a well-organized set of information on trends in agricultural activity and associated links to the environment. Natural capital accounting may provide such a set of information particularly via the development of specific advice on accounting for agriculture, forestry and fisheries which is currently underway in the FAO (SEEA for Agriculture, Forestry and Fisheries). It is clear that for agriculture, forestry and fisheries it is necessary to draw together information on both economic and environmental factors if sustainable production is to be achieved. Thus information on water use, land use, soil quality, fish stocks and the like are as relevant to development and planning decisions as information on trade, production and employment.

3.4.6 Conclusions

This section provides an overall assessment of the potential for natural capital accounting in Trinidad and Tobago. Following are the four key conclusions.

First, the implementation of natural capital accounting in Trinidad and Tobago is not limited by a lack of data. There is evidence of a wide range of data that would be relevant to the compilation of a number of natural capital accounts and that would be sufficient to kick-start a program of work in this area. Undoubtedly there are data gaps, particularly at the more advanced end of the natural capital accounting spectrum, e.g. in terms of measuring regulating and cultural ecosystem services. However, programs to invest in the development of these data would be best implemented once there was a framework in place to compile land and water accounts which should form the basis for any system of natural capital accounts at country level.

Second, while there are no resources specifically allocated at present to the compilation of natural capital accounts, there is clearly a diversity of people with relevant skills in the country who could contribute to the development of a program of work in this area. The University of the West Indies in particular represents an important asset in promoting and developing the necessary skill sets to advance natural capital accounting work – both in Trinidad and Tobago and in the broader region.

Third, there seems to be a reasonable degree of high-level ministerial and departmental support for work in this area indicated through the support for this program of work on ProEcoServ and in various policy documents. Further, the types of policy issues being confronted in Trinidad and Tobago seem to be ones that would benefit from the use of the type of information compiled through natural capital accounting. These issues include, for example, assessing trade-offs in land use, the potential for expansion in the agricultural sector, assessing the tourism sector in Tobago, management of protected areas and hunting, long-term assessments of the oil and gas sector, and the management of specific water catchments. In all of these cases, data organized via a natural capital accounting approach could be useful in decision making.

Fourth, while these three conclusions would indicate a sound basis for establishing an ongoing program of work on natural capital accounting, there is no clear mechanism within the Government of Trinidad and Tobago that would support cross agency exchange of information and there is no recent evidence of the publication of environmentally related, natural capital information by government agencies in recent years. General support for the national statistical office also appears sub-optimal from a natural capital accounting perspective. Overall, for natural capital accounting to be successful it will be imperative that an effective cross agency information environment is established and that there is application of the United Nations Fundamental Principles of Official Statistics.

3.5 Piloting a payment for ecosystem services scheme

Ecosystems play a crucial role in providing a wide range of services to society. From flows of clean water to productive soil and carbon sequestration, people, companies, and societies rely on these services for raw material inputs, production processes, and climate stability. At present, however, many of these ecosystem services are either undervalued or not financially valued at all. As part of ProEcoServ-Trinidad and Tobago's efforts for mainstreaming ecosystem services in development planning, the objective of this initiative was to provide assistance to the Trinidad and Tobago government in developing a pilot payment for ecosystem services (PES) scheme, which would work towards attaining a number of sustainable development goals – see Box 3.2.

Box 3.2: What is payment for ecosystem services?

Payment for ecosystem services (PES) is a voluntary transaction in which a well-defined environmental service (ESs), or a form of land use likely to secure that service, is bought by at least one ESs buyer from a minimum of one ESs provider if and only if the provider continues to supply that service. (Wunder 2005)

Types of PES can include:

1. Public payment schemes for private land owners to maintain or enhance ecosystem services
2. Formal markets with open trading between buyers and sellers
3. Self-organized private deals in which individual beneficiaries of ESs contract directly with providers of those services

Determining the type of payment for the provision of ESs can be based on the following principles:

a. Direct investments and opportunity cost which include the investments incurred by the landholders in order to protect the ecosystem that provides the ESs. This approach also takes into account the opportunity costs for no developing other economic activities on the land in order to avoid ESs degradation.
b. Beneficiaries' gains when a beneficiary of the ecosystem services compensates the ecosystem provider with an amount that reflects a market price.
c. Cost of restoring (remediating) an ecosystem affected by a human activity.
d. Economic value of ESs.

Source: For more information: Forest Trends, Katoomba Group & UNEP (2008) Payments for Ecosystem Services Getting Started: A Primer: http://www.unep.org/publications/search/pub_details_s.asp?ID=3996

The most substantial impetus behind implementing PES is that the re-defining and re-structuring of the transaction model causes the benefit to occur where it would not have otherwise. In this context, ProEcoServ has proposed a pilot PES in the Caura Valley in the Northern Range, and in the following sections will offer a road map and guidelines for its implementation. This in turn can help facilitate the achievement of many of Trinidad and Tobago's environmental and development policy goals. For Trinidad and Tobago, a PES scheme is particularly crucial in addressing issues of ecosystem rehabilitation, conservation, environmental education and public awareness, the fragility of the islands' ecosystems, social goals, as well as climate change policy, protected areas policy, eco-tourism policy among others. These connections are shown in Figure 3.2.

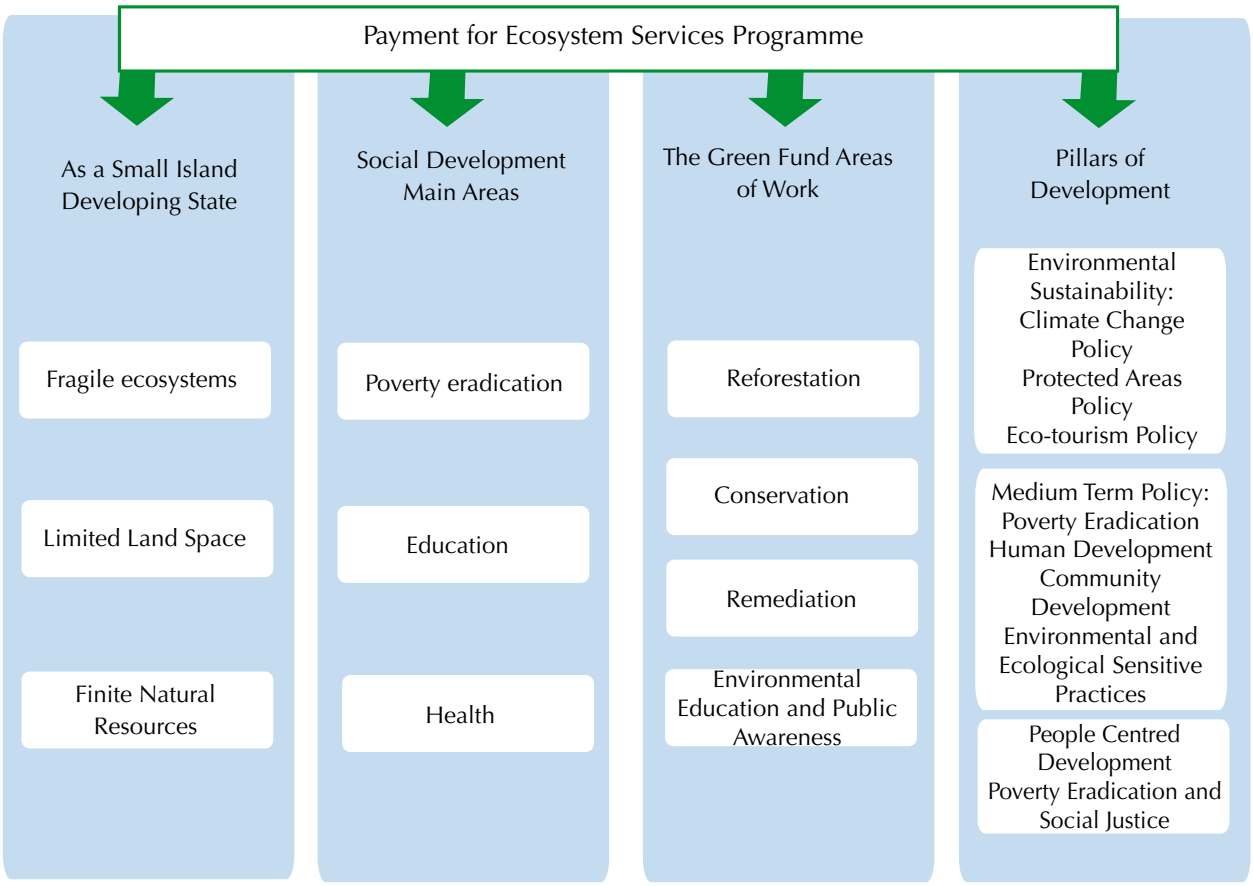
3.5.1 Actors involved in PES pilot in Caura Valley

ProEcoServ conducted a scoping study in the Caura Valley to determine how a proposed PES scheme would be carried out. Conducting a pilot project in the Caura Valley, a mosaic of forests, water streams, and agricultural activity, presents a solid opportunity to analyse how the PES would function in a local context in Trinidad and Tobago – see Box 3.3 for a profile on Caura Valley.

The three main actors involved in the PES scheme in Caura Valley would be the landholders – providing the ecosystem service (ESs), the local organisation – liaising between the buyer and seller of ESs, and the Green Fund entity – the government's public environment fund which would be effectively 'buying' the ESs. The actors involved in the proposed structure are shown in the Figure 3.3, which include the GF (the buyer), a local organisation (the liaison), and the landholders (the sellers).

In this basic structure, several opportunities and potential benefits arise for the three actors involved. For example, there is potential to reduce transaction costs, increase participation, better coordination, and space for the parties involved to maximize their interests and potential outcomes. This structure has the additional benefits of taking advantage of an existing administrative platform, financial resources, and technical knowledge, for the execution of a PES programme which would fit with local community needs and aspirations.

Figure 3.2: Development and environmental policies linked to the PES programme proposal for Trinidad & Tobago



Box 3.3: The Caura Valley, Northern Range

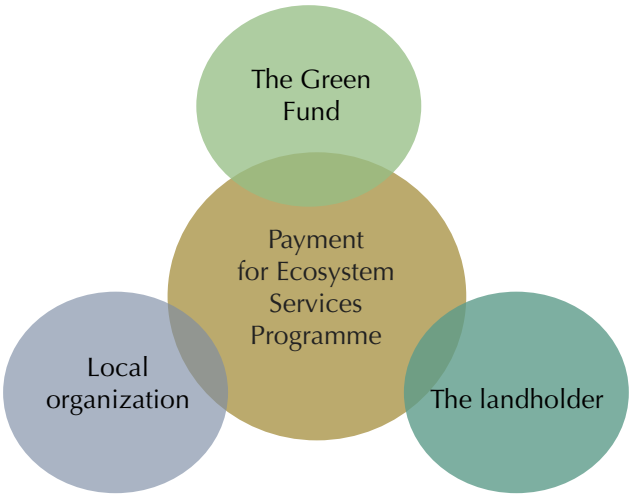
Located in the Tunapuna-Piarco region of Trinidad & Tobago, the Caura Valley (Latitude: 10° 41′ 60 N, Longitude: 61° 21′ 0 W) comprises an estimated 4,836 ha representing 4 per cent of the total Northern Range area. With the Tacarigua River originating in the Northern Range and draining into Caura Valley, the area is not only one of the largest watershed areas in the country but most importantly, it is responsible for the provision of drinking water to the country's capital, Port of Spain.

The population is approximately 776 people; the average age range is between 19 and 24. This age group represents an important economic segment of the population with high demands for educational and employment opportunities. Most settlements and farming activities occur within the lower areas of the valley, to the extent that the soil has been classified as of poorer quality in the lower watersheds than in the upper watershed. The majority of farm activities in the Caura Valley take place in small farms averaging 5 acres with farmers growing crops for the local wholesale market or contract buyers. These farmers cultivate primarily in the rainy season using limited soil conservation technologies such as planting along the contour.

Farming practices also create conditions of vulnerability. The current farming practices by the majority of farmers is the use of harmful non organic based pesticides which contribute to pollution of water courses, reduction of bio-diversity and the degradation of soils (both in physical structure and soil fertility).

Source: Celestain, Beaumont (2010). Baseline Assessment of Caura/Tacarigua and Maracas/St. Joseph Watershed. Final Report submitted to the Cropper Foundation.

Figure 3.3: Tripartite PES Programme Structure for Trinidad and Tobago.



The research and scoping study indicated that a publically funded PES programme scheme would have the potential to work well in Trinidad and Tobago where the scheme will be voluntary for the sellers (the landholders) but compulsory for society as a primary buyer (through the Green Fund). On one hand, the GF is the representative of society as the administering agency that collects the mandatory 0.1% levy on economic transactions in the country. This is the contribution for ESs provisioning from individuals in society through the imposed charge. On the other hand, the landholders who voluntarily decide to participate and get selected in the PES programme become the ESs sellers. See Box 3.4 for a profile on the Green Fund.

i) The landholder as ecosystem provider

In the application of PES in Trinidad and Tobago, it was important to facilitate the enrolment of the population, which would best be suited for achieving the policy goals. Thus, the goal was to identify the individuals that hold land that provides ESs whose characteristics matches the PES policy outcome. Such individuals become the potential sellers of ESs and those who apply to participate in the PES program will be the pool of candidates to receive compensation. This was achieved through a survey conducted to attain information on the landholder profile and other socioeconomic characteristics of potential participants in the PES programme – see Annex for draft of survey.

Box 3.4: The Green Fund

The Green Fund (GF) was established under the Finance Act 2000 and its original frame was changed with amendments in 2004, 2007, 2010 and 2011. The Fund is characterized by a 0.1% Green Fund Levy that is applied to gross sales or receipts of a company carrying on business in Trinidad and Tobago. This levy was introduced on January 1, 2001. As of January 2012, GF carried funds of 425 million USD, making it a powerful funding mechanism for initiatives in remediation, reforestation or conservation of the environment. The creation of the GF was done in the context of a number of policies frameworks that seek to incorporate environmental sustainability in the pursuit of development. This is evident in the National Environment Policy for Trinidad and Tobago that outlines the need for 'environmentally sustainable development' as well as the global UN MDG Goal 7 – which calls for the integration of the principles of sustainable development into country policies and programmes, and reversing the loss of environmental resources. Thus, as a grant facility, the GF can function as a catalyst for transforming policies into action. With the involvement of multiple stakeholders – the Ministry of Housing and the Environment, Ministry of Finance, private sector, civil society organisations – the GF can enable the building of partnerships for greater benefits.

If the PES intervention is structured around environmental issues as priority focus, and in order to favour vulnerable segments of the population, the design of the programme needs to consider decreasing the transaction costs of the application process for individuals with economic needs, allowing other economic activities that do not affect the ESs provision (e.g. ecotourism, agro-ecotourism, sustainable agriculture) to be conducted in the areas incorporated in the PES programme, and giving priority to small landholders.

The types of ESs that would be provided by the landholders are services directly related to existing ecosystems and their conservation. Such services include provisioning services (water, timber), regulating services (climate, water regulation), cultural services (sense of place for people, aesthetics for visitors, religious), and supporting services (nutrient, water, soils, and CO_2 cycles). However, there is room to incentivize actions for remediation of ecosystems such as reforestation, and environmental education and public awareness activities.

ii) The Green Fund: government's key role for sustained local impact

In the proposed PES scheme for Caura Valley, the national-scale Green Fund was identified as one of the three stakeholders, aside from local landholders and local organisations. The Green Fund is the national environmental initiative that provides funding to community groups and organizations that are engaged in activities related to remediation, reforestation, conservation, and environmental education and public awareness (The Green Fund, n.d.). The Fund's institutional framework makes it the logical candidate for implementing a successful project, which can work as a model for a countrywide programme. The PES scheme adheres to a number of policy areas and outcomes that are integral to the Green Fund as a grant facility, fostered through PES's role in environmental education and public awareness, reforestation, conservation and remediation – see Annex for a table on elements of the ESs service focus related to the GF policy goals.

Any PES scheme includes providers and beneficiaries of the ESs. The providers are individuals, communities, and landholders in general (including the State) that are in the position to protect and secure the provision of the services. A provider becomes a seller when there is a transaction (contractual and economic) for the provision of the ESs based on some known cost. Likewise, the beneficiaries of ESs are the individuals, communities, and landholders in general that receive the ESs as a benefit. However, it is not uncommon that ESs are treated as public goods, free to society, and that many human activities cause damages to the ecosystems that generated the ESs. In relation to the formulation of any PES scheme, solving this issue requires the consideration of a series of principles related to the externality problem. These principles are directly related to the role buyers, sellers, the beneficiaries, and the providers play in the PES scheme. In many cases resolving an externality problem requires government intervention, particularly when dealing with public goods. In this context, the government in Trinidad and Tobago can play a critical role in rectifying such market failures, which lead to ecosystem exploitation and degradation. The GF will have to analyse the feasibility and decide on:

- The creation of the PES Sub-Unit within the GF with approval from the Green Fund Advisory Committee (GFAC).
- A selection of the explicit ESs that can be incorporated by the local organizations in the PES modalities to be implemented at their respective community. There may be variation across communities as to their local interest. But selecting explicit types of ESs that can be included in the programme that qualify to receive compensation for their provision would help the GF to narrow its priority focus.
- The type of ESs and PES modalities that will be included as part of the programme.

In addition to administering the programme, the GF will function as the national funding agency that provides the resources to pay for the ESs provided (the buyer), thus, it is not necessary to create a new mechanism to finance the programme. As Wunder, Engel, and Pagiola (2008) suggest, in a PES the negotiation process with many sellers (the landholders) is complex and expensive. This responsibility is left to the local organization as intermediary between the GF and the landholders. It is important to identify an entity that serves as intermediary between the sellers and buyers to minimize transaction costs, to facilitate the negotiation process, and to conduct the contractual arrangements.

As administrator, the GF already possess a structure that can support a national PES program through its Executive Unit and the Community Liaison. However, it is important to have a clear understanding about the role of the Executive Unit in relation to the local organization. At the most fundamental level, the Unit should facilitate stakeholder engagement and conduct training on issues around:

- Governance and transparency
- Finance and project management
- Communication and advertising
- Scenario building
- Investment plans
- Monitoring
- Assessment of implementation (verification)
- Reporting
- Best agricultural practices
- Reforestation
- Local tour guides and group management (if applicable)
- Application processes
- Selection of landholders
- Legal concepts and liability

One key element for the success of the programme is the creation of PES Sub-Unit within the GF. The approval by the Green Fund Advisory Committee (GFAC) for the creation of the PES Sub-Unit, is one of the first steps for institutionalizing the PES programme which will be attached to the existing platform of the GF. The proposed ad hoc Sub-Unit will be part of the Executing Unit of the GF but explicitly dedicated to running the PES programme and all that is required for its success. The general functions of the PES Sub-Unit would follow the same responsibilities that correspond to the Executing Unit as prescribed by the legislation pertaining the GF but its function relates specifically to the affairs of the PES programme – see Annex on core functions of the PES Sub-Unit.

Measuring the effectiveness of any intervention and its impact on policy outcomes (e.g. human welfare, conservation or environmental improvement) entails impact evaluation of the policy using rigorous methodologies. It is important for the GF to conduct impact evaluation studies about the proposed PES programme. The results from these evaluations can be used to make the necessary adjustments to the interventions and to identify gaps in the proposed PES scheme.

iii) The local organisation's role: liaising between the national and local stakeholders

The local organisation as a liaison body between the Green Fund and the local landholders or ESs providers will responsible for various aspects of the PES scheme. This includes, but is not limited to:

- Gathering all necessary information about the community — defining local environmental and development priorities
- Providing key biophysical descriptions of the community and its ecosystems
- Selecting and describing the ESs to be provided
- Providing socioeconomic indicators of the community and the landholders
- Profiling the PES participants
- Developing the package with the PES modalities
- Identify a priori the participant selection criteria

Furthermore, in regards to its collaborative work with the GF, it will be responsible for monitoring, verifying, and reporting implementation activities to all the stakeholders involved, disbursing funds on behalf of the GF, reporting any contracts that need to be reassessed, and other administrative and management activities.

In addition, the local organization could request to the GF additional funding to finance other activities that support the general GF mandate (e.g. recycling, ecotourism, environmental education and public awareness campaigns, water quality improvement, etc.).

Knowledge of the local habits, activities, and particularities is crucial for a well-implemented PES programme. For example, research conducted on the Caura Valley indicated a number of positive aspects such as the fact that the members of the Community Council had previously been exposed to project interventions meant that they had prior knowledge and greater receptivity to such eco-finance mechanisms. While local capacity is increasing, the community still needs assistance for the implementation of the PES pilot project.

In this context, it would be strategically apt to approach the Trinidad and Tobago Association of Village and Community Councils (the TTAVCC) to promote the PES programme. The TTAVCC is nationwide community development organization with membership of 500 Village and Community Councils. This would strengthen the participatory decision making processes and empower stakeholders at the local level.

iv) Legal context of the PES operation

The PES transaction cannot be directly made between the GF and the landholders. The GF legal provisions require that such transaction is made by registered local organizations. In the proposed scheme the local organization works as intermediary between the GF and the landholders. In any event, the process is formalized with a legal contractual transaction signed by the three parties (i.e. the GF, the local organization, and the landholder).

The GF will provide the funds for PES to the local organization according to established GF requirements. In addition, the GF will provide a payment to the local organization as a special provision for managing the PES programme at the local level. This amount will be calculated as a percentage of what is to be paid to each landholder for the duration of active contracts. The disbursement to the local organization will follow the payment schedule of the landholder for whom there is a signed legal contract.

It is fundamental to consider the legal implications in the design and implementing of a PES scheme. This is important to identify whether the PES scheme is in alignment with the legal order of the country. Some of the legal issues linked to the PES scheme include: (1) the land tenure systems, (2) property rights, (3) management of public funds, (4) contractual law, (5) liability and accountability and (6) coupling with other environmental policies. A clear understanding of these issues facilitates pathways for adapting the PES scheme so that it complies with the local or national legal framework. For a detailed account of legal aspects of PES and a draft of the legal contract - see Annex for more details.

3.5.2 Payment in PES scheme

Regarding the type of compensation for the provision of the ESs the PES programme in Trinidad and Tobago, it would include at least direct monetary payments. Based on the experiences from other countries, other forms of reimbursements could include tax breaks on land property, land rights and land tenure protection, protection by the state from land squatters, technical assistance and other forms of in-kind goods and services, and public recognition for contributing to the country's environmental and development policies.

The payment should be scheduled in percentage disbursements subject to a series of requirements. In addition, in-situ verification by the GF and the local organization should also be scheduled. The specific amount of the compensation per land area per given contractual period for each landholder is not included in this document. This amount needs to be determined based on valuation studies and methods to calculate the ESs cost per area per contractual time. The opportunity cost principle is a commonly used guide to determine the compensation amount for the ESs provision. Certainly, this amount changes according to the landholder profile, economic activity, location, etc. As a result, the amount calculated is based on the average net benefit forgone by the ESs provider for refraining from developing a conventional economic activity on the land.

While designing the PES programme for Trinidad and Tobago, it is highly recommended that through prior research and due diligence, a particular priority focus is highlighted for a given policy outcome. Thus, the policymakers play a crucial role in Trinidad and Tobago in defining the policy focus for the PES programme in the country. The proposed strategy presented advocates for a PES programme that is focused on environmental sustainability through land and natural resource management. By doing so, it aims to facilitate the participation of individuals that are most vulnerable to poverty issues as the primary target population but does not exclude others whose participation would increase the policy impact of implementing the PES programme.

3.5.3 A Step-by-step plan for implementation of PES

Implementing the programme in steps with clear ideas as to what is to be tested at each step, reduces the risk of failure, and minimizes the possibility of creating unintended consequences with the policy intervention. For Caura Valley, the following steps are proposed:

STEP 1. Creation of an updated baseline scenario of the current situation. Creation of a landholder profile that defines his/her characteristics, land characteristics, the most convenient and feasible forms of compensation the PES programme will offer, existing knowledge about ESs, assessment of willingness to enter a PES programme, preferences in scheduling for payments, and percentage for disbursements and plans for investment by the

landholders. Annex contains a survey that can serve as an instrument to define the baseline and participant profile. It includes questions about the landholders socioeconomic characteristics, the characteristics of the land, the landholder's perception on ESs, the requirements to participate, and issues related to the opportunity cost of the landholder in case they decide to participate in the PES scheme.

For the pilot project to be implemented in Phase 1 in the Caura Valley community, Step 1 involves the creation of the profile of the landholders for the potential participants in the PES pilot. For Phase 2 which is the first test of implementation at the national level, Step 1 expands incorporating the particularities of the other communities in Trinidad and Tobago. With the consolidation of the PES scheme in Phase 3, Step 1 takes into account the information to make the adjustments.

STEP 2. Information and promotion of the PES programme. This step involves activities to promote the programme through the appropriate communication channels to reach as much population as possible. It is a step to motivate participation and addresses possible concerns that may arise from the communities and the landholders. The channels of promotion could be radio, television, communal meetings, newspapers, and others that can be identified based on the landholder profile.

STEP 3. Identification of criteria for the selection and application process. The identification of criteria for the selection of landholders or communities for the implementation of the PES should be done a priori based on the GF priorities and the landholder profile. All the applications that comply with the requirements that are submitted during the time of application have to be accepted. It is likely there will be more applications than the GF can fund. Thus clear selection process with clear rules needs to be defined ahead of time to avoid misunderstanding and social problems. To facilitate the participation of the vulnerable segments of the population promotional activities have to be organized in the communities to offer guidance in the application process. Ideally, applications can be submitted at locations where the landholder lives to avoid having them to make long trips to urban centres. Avoid asking for unnecessary requirements — for example if proof of land ownership is important, find the basic means that are the most feasibly but that serve the purpose of proof (that is, request property tittle but also other options like leasing documentation, letters of comfort, letters signed by owners of properties around, etc.). Also, an application fee waiver in Phases 1 and 2 may increase participation of the poor. A draft application form for the PES programme is provided in Annex.

STEP 4. Selection of participants for the PES programme. The use of the selection criteria helps identify the priority areas that are ecologically fragile or at risk of deterioration (degradation or deforestation). Priority will be given to landholders located in such areas starting with applicants that are economically more vulnerable. Those environmental and socioeconomic priorities can vary their hierarchies from region to region within Trinidad and Tobago. But the selection rules have to be clearly defined beforehand. The indicator for selection can be based on GF's areas of work, which includes remediation, reforestation, conservation, and environmental education and public awareness. Other elements for selection include land uses and socio-environmental priorities of the community. These criteria are the basis to measure change from the baseline compared to the outcomes after the policy intervention. Once participants have been selected contracts need to be signed.

STEP 5. Implementation for the PES programme. The PES contract outlines the responsibilities between the parties according to the PES modalities. The schedule of payment and the percentage are explicitly stated in the contract as well as other general provisions.

STEP 6. Monitoring, evaluation, reporting, and adjustments. Monitoring will be done by both the GF and the local organization; the GF can also conduct independent monitoring activities. After the evaluation assessment, a report from the local organization to the GF need to explicitly state whether the percentage payment that correspond should be executed or not. The report can recommend if a contract needs to be temporarily suspended or terminated. The monitoring and evaluation process will also serve to make adjustments to the programme when considered necessary to guarantee the success of the PES programme – see Annex for a draft of the monitoring form.

3.5.4 Way forward: PES in phases

Implementing the proposed PES programme in three phases is the strategy most likely to be successful. Within each phase, a series of steps (as indicated in the section above) in each of the three phases would lead to the completion of each phase. Each step represents one level of complexity in the design.

Phase 1 consists of a two-year PES pilot project in the Caura Valley community. The goal of the pilot is to develop experience and capacity as well as to collect information to inform the other phases of the programme. Phase 2 will start at the end of the second year of the pilot project and consists of the implementation of the PES programme at the national level. Phase 3 starts at the end of the third year of phase 2 (five years after the launch of the pilot project). This is the consolidation phase and several adjustments will need to be made in the overall design. For each phase the GF needs to publish in a PES manual the specific requirements, guidelines, rules, deadlines and any operational issue regarding the application and implementation steps.

Scaling-up of the programme in phases provides opportunities to improve the design with new information for decision making. It is also a way to measure how communities and landholders respond to the implementation of the PES scheme. As the programme consolidates, the perception about ESs by the landholders changes from a situation without the policy intervention. In this case the benefits from ESs to society are not fully recognized as such and landholders are simply providers not aware of their contribution; the landholders may not be aware that their actions on the land can also cause ESs degradation. With the intervention the situation evolves and landholders become aware of the value of ESs to society and get recognized by society.

Overall, while this report provides general guidelines for the design of a PES scheme in Trinidad and Tobago, the implementation of PES requires special focus towards the creation of a PES programme that will facilitate achieving many of the country´s environmental and development policy goals. A PES scheme can be designed in a way that is in alignment with other policies that address issues around ecosystem rehabilitation, conservation, and social goals. In the context of Trinidad and Tobago, the national-level Green Fund is an important catalyst for mainstreaming initiatives such as payment for ecosystem services (PES) and subsequently achieving environmental and socio-economic goals at different scales. PES is a concept that must be contextualized and shaped according to local particularities. The achievement of goals or desired outcomes should be assessed and evaluated at every stage to understand overall success. Finally, PES schemes rely on local interest, dissemination of appropriate information and knowledge, access to expertise or technical knowledge & assistance, compensation, and a steady monitoring and evaluation to assess the impact and success of implementation.

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4. CHILE

4.1 Introduction

The work carried out in ProEcoServ-Chile (ProEcoServ-CL) was a collaborative effort led by the Centro de Estudos Avanzados en Zonas Aridas (CEAZA) in partnership with the municipality of San Pedro de Atacama and the Ministry of Environment, which is the pilot working area. During the last two decades San Pedro de Atacama (SPA) has gone through many changes in its territory. These changes are mainly associated with the arrival of new social actors such as entrepreneurs, tourism companies and mining industries to the municipality. The economic development associated to this new social diversity has led to an increase in the local population size (estimated 50% increase from 2002 to 2014), among other changes. Data from the National Institute for Statistics (Instituto Nacional de Estatistica - INE) indicates that tourism in San Pedro has nearly tripled in the last decade, with just over 260,000 overnight visitors registered in 2013. The area's Los Flamencos National Park registered the second highest number of tourists in all of Chile's protected areas in both 2013 and 2014, exceeding Torres del Paine, in southern Patagonia. These figures present a high potential for the economic development of the region – each tourist budgets about 1,000 USD to visit the Salar de Atacama. At the same time, these tourism flows are creating an impact on the high-altitude ecosystems and biodiversity that sustain the well-being of the indigenous communities of the Salar de Atacama.

In this context, the main objective of ProEcoServ-CL was therefore to develop innovative computer-based tools to guide decision making regarding sustainable management of water provision and recreation/ecotourism, the selected ecosystem services (ESs). In particular information on water provisioning and on tourism flows were compiled and collated with the intention of supporting future policy and decision-making regarding this ecosystem service in the municipality of San Pedro de Atacama. Considering relevant policy questions and through the participatory creation of future scenarios, ProEcoServ-CL has made this body of knowledge available through a decision support system (DSS). The DSS was developed and designed together with the local and regional community aiming towards substantial capacity-building and the installation of a powerful tool for the mainstreaming of ESs. The conservation and management of the fragile Andean ecosystems and the traditional lifestyles that take place there require a commitment from policy and decision makers and the people that currently live in the municipality. Hence, a participatory planning of ESs is the key to achieve the sustainable development of San Pedro de Atacama.

This section aims to synthesize ProEcoServ's team work in Chile including modelling water provision and ecotourism, developing a tool to support decisions and policies and planning future scenarios considering the legal and economic context.

4.2 Working plan

The activities of ProEcoServ-CL aimed to present the experiences of the project around key issues for the profound inclusion of ESs in the decision-making process in Chile. As said before, the main strategy was improved through the scientific and community-based understanding of social and ecological resources in the Salar de Atacama. Therefore, it combined quantitative and qualitative approaches to develop a baseline understanding of the region's ESs, identify the trends in social-ecological dynamics, and work within the community to develop the capacity to better manage ESs in the present and future. Furthermore, the physical presence of ProEcoServ-CL team in the San Pedro de Atacama community was a crucial base for the outstanding work of the local team, whose members took different responsibilities and tasks to complete the several components of the project, which was decisive to the increased awareness and capacities now installed across a broad swathe of community members in relation to the ESs targeted. In this setting, the working plan ProEcoServ-CL is characterized by four main activities: (1) **Modelling water provision and ecotourism** (water balance model and ecotourism potential model); (2) **Developing a decision support tool** (Tableau); (3) **Building a participatory, inclusive decision-making process** (with public and private stakeholders). Finally, ProEcoServ-CL (4) **implemented various strategies for mainstreaming ecosystem services that delivered communication and outreach, co-production of knowledge, and policy intake** that supported the integration of water provision services into spatial planning and dialogue, including the production of ecosystem services GIS maps, the promotion of public-private cooperation for ecosystem management, and the establishment of a DSS framework that in turn has been used in spatial planning.

4.3 Modelling water provision and ecotourism

4.3.1 Assembling data

Data collection for the selected ecosystem services, water provision and recreation/ecotourism, was accomplished based on the available data for both ESs. The Region of Antofagasta has a weak monitoring system in real time to understand ESs dynamics in San Pedro de Atacama and institutions are not well prepared for contingent decision making. In the case of Ecotourism, quantitative data on tourism dynamics was identified as a key requirement for developing effective decision support capabilities, however, it found no system in place to monitor visitor numbers at sites of tourism interest on a project-wide basis, largely due to the fact that there has been no coordination between local and regional institutions in this regard. At present, data is only available for a restricted number of tourist sites in San Pedro, and with the exception of those located within formally protected areas, is not efficiently managed or easily accessible in a centralized database. A key challenge was therefore to design and implement systems for near-real time monitoring of tourism activity across the project area. ProEcoServ-CL explored several options in this respect. Firstly, the use of geo-located tourist photos uploaded to public photo sharing websites such as Flickr. Flickr data has been shown to be positively correlated with actual visitation at over 800 tourist sites globally[24], and was incorporated into the decision support tool as a means to derive information on spatial dynamics and relative levels of tourist activity across the project area as an indicator of ESs use. The approach revealed several important and novel insights relevant to decision support, indicating, for example, that, proportionally, just 10 sites generate the majority of ecotourism benefits (30% of visitor total annual visitor days) in San Pedro, with 70% distributed among the remaining 80 recognized sites of tourism interest. These activities also reinvigorated an initiative for the collection of tourist flow statistics in the Municipality of San Pedro de Atacama over the 2014-2016 period, which was proposed in 2013 by the Fundación de Cultura y Turismo SPA. The initiative is currently being evaluated by INE, with the key objective of capturing data and tourist flows from tour operators and hotel companies. The pilot proposal includes 36 months to identify trends and usage patterns in San Pedro de Atacama. Regarding the data collection, the project proposes a monthly online survey that must be systematized by the regional offices (INE Antofagasta).

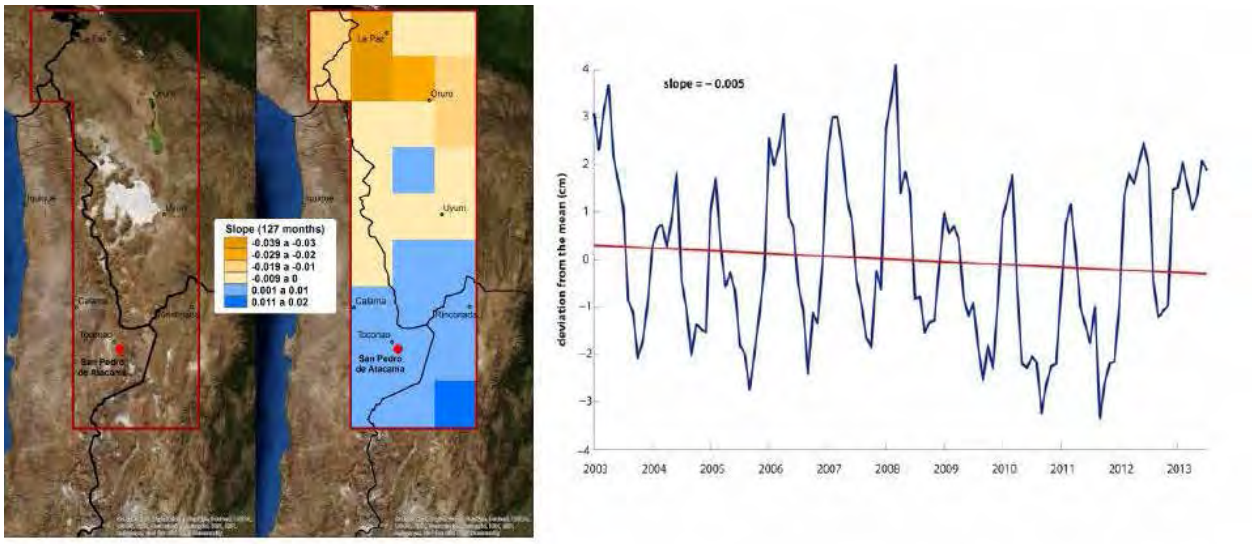
In other respects, information fundamental to enhance decision support capabilities in the context of ecotourism, specifically data on sustainable visitor carrying capacities for a large number of areas of ecotourism importance in San Pedro, was found to be available from pre-existing studies[25], and proved invaluable in developing DSSs in this work.

In relation to water provisioning, ProEcoServ-CL found minimal reliable data available for the Salar de Atacama, as the hydrological and meteorological systems in the Region of Antofagasta are sparse, and measured data commonly has a latency of several years. For instance streamflow data for the San Pedro River at Cuchbrachi (closest and most relevant stream gauge for the town of San Pedro de Atacama) was current through 2013. Precipitation and temperature data needed to estimate evapotranspiration was even more limited, as the meteorological station at El Tatio was current through 2002. This rendered an explicit groundwater model for the region unfeasible due to the extremely limited data. In turn we focused on the San Pedro Watershed, an important watershed for the region that has sufficient, if limited, data from the Dirección General de Aguas (DGA) website for basic statistical analysis of water resources trends and the development of a conceptual water balance model of the storage and fluxes of water in this hydrologically closed basin. ProEcoServ-CL team's approach to examine water provision throughout the Altiplano/plateau region was suggested by the local Steering Committee and was based on remote sensing using Gravity Recovery and Climate Experiment (GRACE). This satellite-based system measures changes in the Earth's mass through time and can reliably detect changes in groundwater. Analysis of GRACE data for the section of the Altiplano where San Pedro de Atacama lies proved a key milestone for ProEcoServ. **This data produced the first hydrological balance for the region** – see Figure 4.1.

24 SA Wood, AD Guerry, JM Silver & M Lacayo (2013) Using social media to quantify nature-based tourism and recreation. Scientific Reports, 3: 2976. DOI: 10.1038/srep02976

25 EUROCHILE (2006) Proyecto Innova Chile Corfo - Puesta en Marcha de un sistema de gestión ecoturística sustentable para el destino territorial San Pedro de Atacama 2005-2006. Santiago, Eurochile.

Figure 4.1 Satellite hydrological balance



The analyses showed that, over the mission period examined (2003-2013), there was basically no trend in groundwater levels (2% slope over the period). This single result, together with a contrast from the literature showing the situation in the Middle East (200% slope) moved the discussion from one based on perceptions towards the need to capture information locally and in a reliable fashion, which underpinned the support to the analysis we detail below.

Analysis of precipitation (P) and streamflow (Q) data show variability with regards to precipitation, but minimal variability with regards to streamflow. From 1978 – 2013 annual precipitation represented a high degree of variability, and annual streamflow remained relatively constant across all years – see Table 4.1. The coefficient of variation, the standard deviation divided by the mean i.e. a normalized measure of variation within a data set, for annual P (0.75 mm) was roughly 2.5 times greater than annual Q (0.32 mm). These data demonstrate that even in years of high or low precipitation, streamflow remains fairly consistent across years; strongly suggesting that groundwater is a major contributor to streamflow. Also there were also no statistical trends associated with these data, indicating that while variability occurs across years, precipitation and streamflow have not shown any considerable changes during the study period.

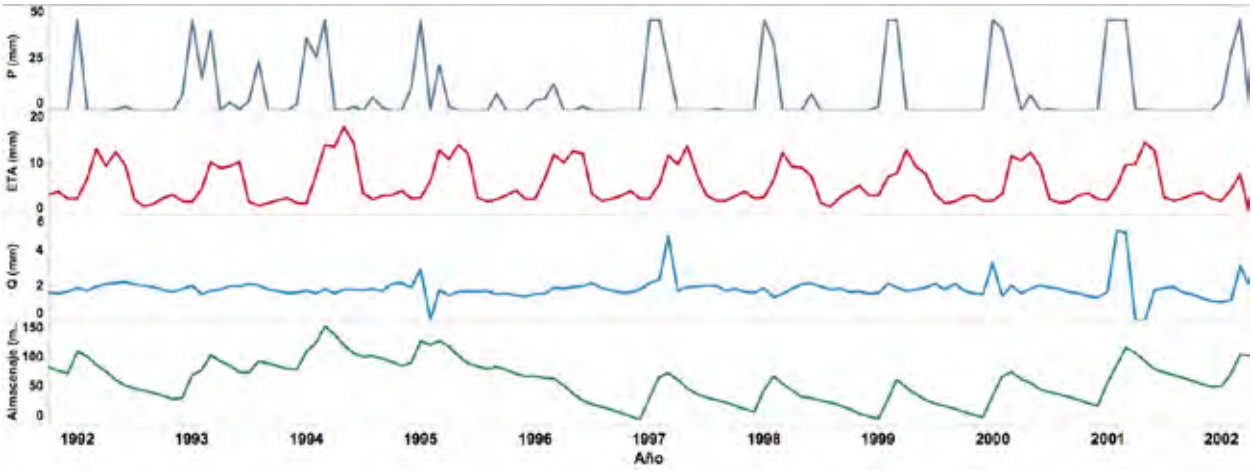
4.3.2 Water balance model

The conceptual water balance model was run for 1992 – 2002, based upon the data that was available from the DGA. The results support the conclusions from straight data analysis – that groundwater fluctuations dominate the hydrological cycle even on a monthly basis – see Figure 4.2. From 1993 – 1995, nine individual months with more than 12 mm of precipitation occur. These inputs are not expressed in streamflow (Q), but are likely responsible for considerable increases in groundwater storage (S). The following year, 1996, has markedly less precipitation. However, Q remains consistent, but S decreases. This suggests that the nine precipitation events in 1993 – 1995 increased groundwater stores that then sustained base flows during the subsequent drier year. Years 1997-2000 each have one month with precipitation over 25 mm, and groundwater recharge fluctuates on an annual cycle.

Table 4.1: Statistical values for annual P and Q for 1978 - 2010.

	P	Q
Coef Var (mm)	0.75	0.32
Median (mm)	123.6	20.0
STD (mm)	104.0	6.4
P-value	0.59	0.68

Figure 4.2: Model results for the Rió San Pedro Watershed.



This same modelling framework was applied to 40-year mean temperature and precipitation data for the region using a distributed data set for the Rio San Pedro and adjacent Rio Vilama. This approach provides an overview of S, the timing and magnitudes of water fluxes, and highlight December as the month of greatest water scarcity.

We next tested the sensitivity to increases or decreases in precipitation and temperature, perturbing inputs by ±10% in order simulate climate variability. Each perturbation was run individually for five total model iterations for 12 months. The results show that December is the most climatologically sensitive month with regards to groundwater, and that variability can range by 25%. From a management standpoint this is important, as December corresponds with greatest water scarcity and the onset of the peak tourist season and irrigation. From June to September, the model suggests there is minimal sensitivity to climate variability, and that the water resources during this time are minimal, but consistent due in large part to groundwater storage during the wet season (January - March). These results demonstrate that climate variability are not expressed equally across the region. The results provide a conceptual analysis and numerical values should be interpreted with caution. This highlights the lack of capacity for a current interpretation of water resources dynamics in SPA and its institutions are not well prepared for contingent decision making.

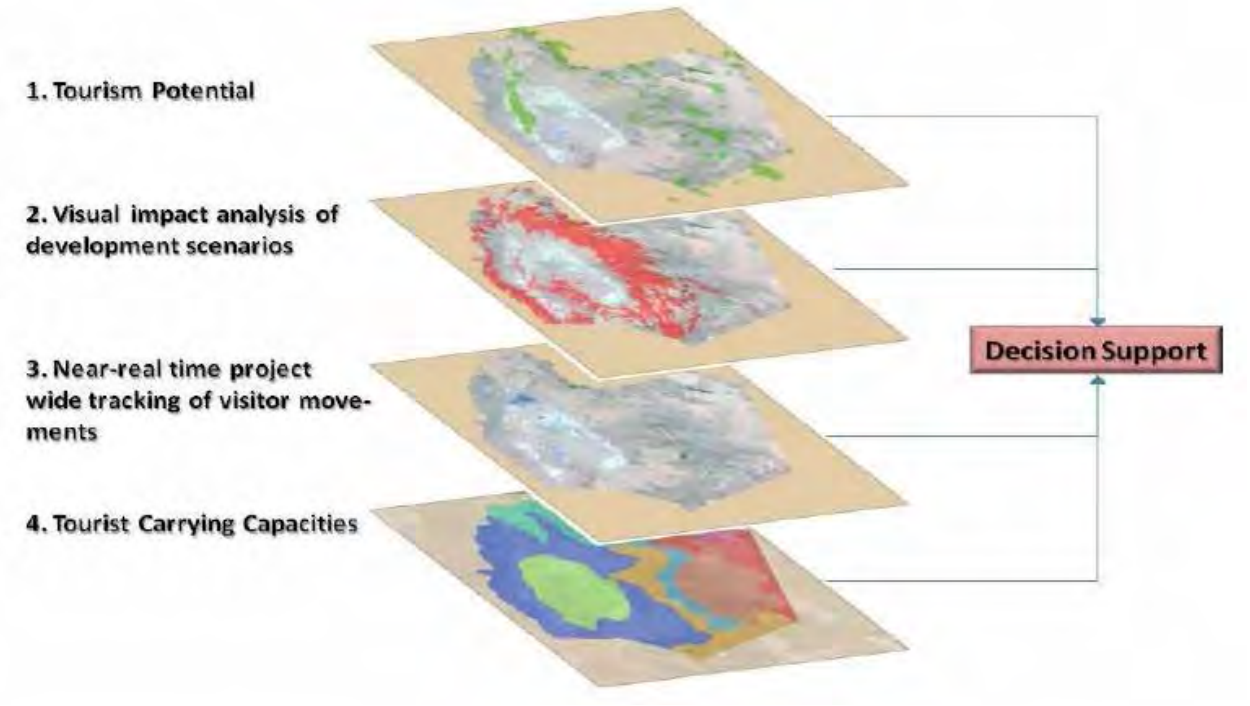
4.3.3 Ecotourism model

In developing decision support for the management of ecotourism in San Pedro, ProEcoServ-CL set out to address four fundamental questions: (1) how and where do ecosystems provide ecotourism services; (2) where and in what quantities are these services finally used; (3) what are sustainable levels of ES use; and finally (4) what local drivers impact the potential of ecosystems to continue providing these services? Measurable indicators that address each of these questions were developed.

In light of the above questions, one of the greater challenges for the key indicator of ES use, was that visitor numbers have not been effectively monitored in San Pedro, largely due to the fact that there has been no coordination between local and regional institutions in this regard. At present, visitor data is only available for a restricted number of tourist sites, and is not efficiently managed nor easily accessible in a centralized database. A key challenge was therefore the design and implementation of systems for near-real time monitoring of tourism activity across the project area. Several options were explored in this respect that were then incorporated into the tool, including the use of geo-located tourist photos uploaded to public photo sharing websites, such as *Flickr*.

A spatially explicit index of ecotourism potential, as alluded to earlier, synonymous with the concept of ES provision, was achieved using Multi-Criteria Decision Analysis techniques incorporating local stakeholder and expert knowledge. This was a fundamentally stakeholder-driven process that included representatives from local and national level private and public institutions linked to tourism in San Pedro (including tour operators) and representatives from indigenous communities. In conjunction with researchers, the group recognized some 15 classes of cultural and natural "ecotourism resources", or infrastructure, in San Pedro, comprising approximately 13% of the total project area. These ecotourism resources, in combination with a range of other factors understood to influence tourism dynamics, form the basis for the model of ecotourism potential, and feed into the DSS – see Figure 4.3.

Figure 4.3: Modelling ecotourism potential



4.3.4 Economic valuation pilot exercise

Considering the information above (assembly data, water and ecotourism models), the ProEcoServ team performed an economic valuation exercise. The valuation scenario was discussed with local and regional stakeholders, particularly by taking into account that scenario changing would affect them more directly than other national actors. This work extended over several workshops. In this framework, 700 surveys were applied to local stakeholders and also to main actors related with productive and development activities in the region: mining companies, tourism operators, NGOs, SMEs, to name a few. Their design also involved the Unit of Environmental Economics from the Ministry of the Environment. The underlying strategy for economic valuation of the selected ecosystem services, water provision, was to influence into the wide development planning working with several actors involved in sectoral, subnational and national economy – see economic value estimates for the tourists in Box 4.1.

These results were discussed in several workshops and showed how SPA is valuated from the internal and external perspective. In other words, stakeholders were able to understand not only how they value their ecosystems but also how external actors are looking at SPA in economic and productive terms (e.g. attractive landscapes and cultural attributes for tourism). Based on the results, dissemination material and practical guidelines were produced to have widespread impact at the national level.

Box 4.1: Contingent valuation study in San Pedro de Atacama

ProEcoServ-CL administered an exploratory economic valuation study exploring the use of questionnaires, which is known in the literature as contingent valuation. In this valuation exercise tourists are asked to express their preferences with respect to a water management scheme that is characterized by guaranteeing a steady and continuous provision of water in relation to the environmental health, hydrological and living resources of the region of the Salar de Atacama. Estimation results show that the tourist's maximum willingness to pay ranges between 6.9 USD and 11.32 USD. This corresponds to about one per cent of budget reported for the visit to the area. Taking into account the visitors' numbers for San Pedro de Atacama, about 260,000 according to the latest figures published by the INE, the introduction of a payment scheme that would collect such a monetary amount would be creating an additional annual revenue to the municipality in the range of 1.79 – 2.94 million USD. This corresponds to a revenue of 20 USD per inhabitant of the El Loa Province, where the Salar de Atacama is located.

Source: CEAZA – PROECOSERV Report 1143/2014

4.4 Developing a decision support tool

4.4.1 Working with Tableau software

One of the key components guiding ProEcoServ's work was the development and application of a tool that allowed streamlined access to the body of information gathered by the initiative and that was validated by the local community. By designing and distributing the tool, and then training its users, ProEcoServ's team sought to mainstream ESs, empowering stakeholders for participatory processes with policy and decision makers involved in spatial planning and management of ecosystems and their services. The participatory process used to design the tool allowed local and regional actors to be a part of the data collection, modelling, assessment and mapping of ESs and the protracted process was key to strengthening the adaptive governance capacities and social learning skills regarding ecosystem services. On the other hand, this adaptive participatory process hinged the identification, discussion and planning of scenarios for San Pedro de Atacama. During the four years of ProEcoServ-CL, several surveys, workshops and meetings were performed to build future scenarios for the municipality allowing a broad array of representatives from the national, regional and local levels to participate in these collective exercises. The results showed different perceptions about future scenarios for 10, 30, 50 and 100 years. The capacity of the local population to respond to these conditions was synthesized in two main possible scenarios. The first scenario was based upon a "social management of water resources", which visualized that the adverse conditions arising from increasing tourism will be compensated with more technological solutions and innovation, which will support a better use and planning of ecosystem services, new policies and opening of new markets. The second scenario was based on "water resources and social mistrust" and showed that water scarcity will precipitate a major crisis involving biodiversity loss, human migration and diseases. This crisis will generate conflicts of interests, increasing the social mistrust. To have a user friendly access to these results, ProEcoServ's team developed a DSS tool using the software Tableu 8.2, which is available to all stakeholders from the community and institutions. The same stakeholders are committed to maintain this DSS and provide access to all interested in the data. This software is a data analysis platform that is easy to learn and use – see Figure 4.4.

Using multiple alternatives for data connection (Excel, servers, etc.) users can visualize trends and dynamics associated with modelling work of ESs. Furthermore, based on the scenarios results that we mentioned above, users can generate and share scenarios using this data. The software allowed governmental institutions and organizations, representing the regional and local levels, respectively, to participate in the design and later in the training of the DSS. Governmental institutions included the Regional Undersecretariat (SEREMI) of Medio Ambiente (Ministry of the Environment, Antofagasta) and SEREMI de Agricultura (Ministry of Agriculture, Antofagasta), at the regional level, Corporación Nacional Forestal (National Forest Service, CONAF) and Servicio Nacional de Turismo (National Tourism Service, SERNATUR) at the regional and local level and finally the Consejo de Pueblos Atacameños (Atacameño Peoples' Council), Ilustre Municipalidad de San Pedro de Atacama, Fundación de Cultura y Turismo, Asociación de Regantes Rio San Pedro, Fundación Tata-Malku, Asociación de Turismo y Medio Ambiente (ATYMA) at the local level.

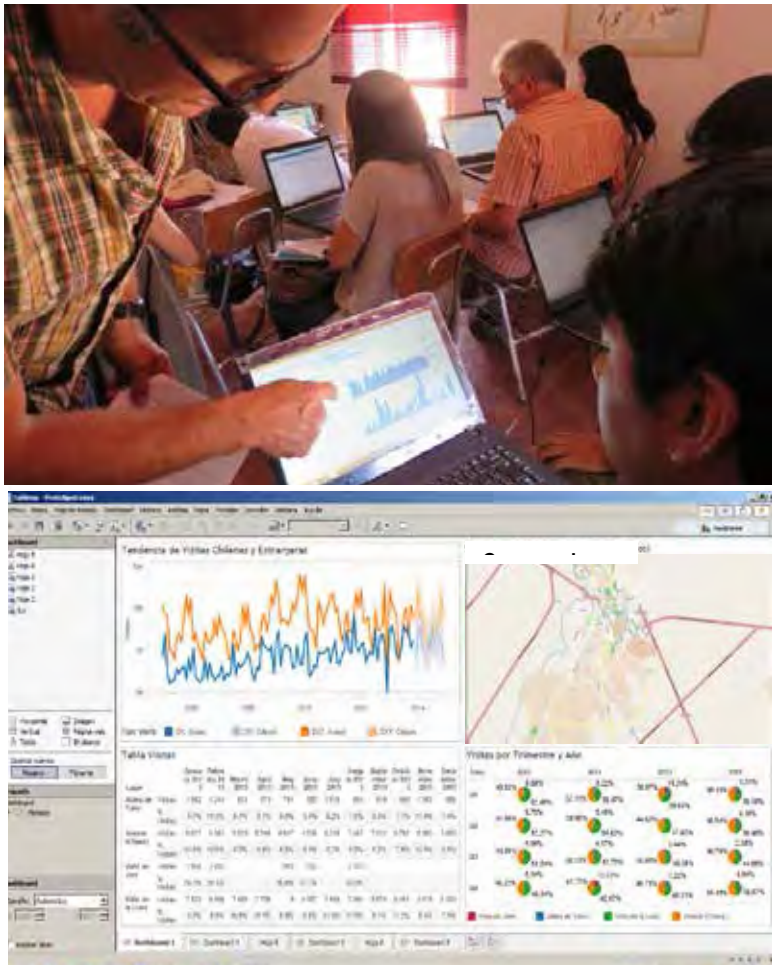
4.4.2 Assessment and evaluation

Overall effectiveness in the assessment and evaluation from these ESs analyses and models was assessed throughout the whole process and through its design. Additionally, hands-on workshops provided an opportunity for business leaders, decision makers, and students from the municipality to use the *Tableau* software beyond simple "button pushing" of the DSS. The workshops included 10 participants and had a considerable focus on how to continue to develop and apply this tool for future decision making. During these instances, participants had the opportunity to make and answer questions, review the database that was being used and also suggest different types of visualization of data using the software.

The performance of the workshops was evaluated by surveys. Participants took a survey before and after the workshops to assess their self-efficacy and abilities in applying data and technology in decision making and problem solving (Hiebert 2012) [26]. With the training workshops, participants showed an overall 24% increase in self-efficacy. However, the distribution showed that those participants with less experience in natural resources or engineering displayed greater improvements in self-efficacy (> 50%), and primarily comprised of business leaders. Additionally the performance of the workshops were evaluated by asking participants what they liked about the workshops, what they did not like about the workshop, and what improvements should be made to the workshops. In this way, we managed to increase the impact on trainees in the use of the DSS.

26 Hiebert, B. (2012), Post-Pre Assessment: An Innovative Way for Documenting Client Change, Victoria, BC.

Figure 4.4: Training workshops in Tableau software, San Pedro de Atacama January 2015



4.4.3 Public discussion, involvement and participatory process

One of our major focus areas regarding the design of spatial mapping products for ESs was the possibility to implement them locally, which will increase participation and trust among stakeholder and policy-makers, ensuring a long-term continuity of the results of ProEcoServ. Using *Tableau* the CL-team developed dashboards, including the model results for both ESs, to be applied in a decision support context. Furthermore, during the closure activity (March 19th 2015) the CL-team presented the DSS tool tutorial hosted in the ProEcoServ web page highlighting some of the main results, and showing some of the activities that ProEcoServ developed with stakeholders during the training workshops in January 2015.

On the other hand, workshops, activities, meetings, documents and material delivery were carried out during this last period to increase awareness and capacity-building regarding ESs at different levels. For example, ProEcoServ-CL coordinated and implemented an educational program at San Pedro schools and Talabre schools named "Los caminos de la Patta Hoiri", whose main objective was to raise awareness among primary and secondary students about the ecosystems and natural environment around San Pedro de Atacama. Furthermore, during December 2014 we carried out the final dissemination workshops with the Atacameño indigenous communities. Workshops were conducted in seven different communities including Solor, Rio Grande, Yaye, Socaire, Talabre, Toconao and Sequitor.

4.5 Building a participatory and inclusive decision making process

4.5.1 Social learning, communication and adaptive governance

Overall, the strategy of ProEcoServ project was to strengthen the awareness and understanding of ESs at the local level, with a large emphasis on the social learning process behind this strategy. This approach promoted a better communication with regional and national policy- and decision makers, but it is necessary that national policy-makers understand better how their decisions affect populations that depend directly on different ESs (e.g. you cannot run out of water in the desert). For this reason ProEcoServ-CL has coordinated a series of

workshop learning sessions, including a set focused on disseminating a strategy for small and medium-sized enterprises (SMEs) and entrepreneurs at the local level, including NGO's, guilds, organizations, communities and companies related with ecotourism in the municipality. This activity was aimed at establishing a strategic plan, and underlying policy instruments, to valuate and develop ecosystem services in the context of SMEs administration. For example, within the indigenous communities and ecotourism operators there are concerns over minimizing the loss of cultural identity and biodiversity while managing sustainable economic growth, especially regards changes in water availability. From a scientific perspective, interpreting changes in the flow of ESs and its impacts was constrained by a sparse monitoring network and a limited understanding of ESs processes at and around SPA. At a human level, concerns over changes in water resources and tourism dynamics are unique across individual communities. This dynamic requires appropriate research initiatives to balance scientific objectives and community needs within the realities of limited data. Considering the governance perspective, the assessment survey from the DSS training workshops also collected information about the capacity levels among stakeholders and decision-makers. This information is useful as it will allow improved training and dissemination of ProEcoServ project results to other members of the community, thus increasing awareness and capacity-building in relation to the feedback from the surveys. Furthermore, communication and coordination between levels of policy actions revealed to be the key in promoting a better planning and management of ESs in the country. Chile already has the task of implementing ESs into the national policy. Outcomes from ProEcoServ, delivered though activities, workshops, dissemination material, educational program and a community-based DSS are tangible guidelines for future initiatives at the national level that want to protect ESs.

To conclude, scientific and community-based understanding of ESs has been demonstrated as a key ingredient throughout the whole participatory process and it underpins the outcomes of ProEcoServ's work. During this process, the presence of a local team was a determinant for consolidating and strengthening the exchange between science and political knowledge. Furthermore, many key actors (including citizen's organizations, government institutions and technical experts) collaborated with this objective in many ways, such as providing information, systematizing data, providing physical spaces, disseminating information and participating in the activities that ProEcoServ organized.

4.5.2 Implementation, outreach and enforcement

ProEcoServ team's efforts were aimed at preparing the institutional and organizational conditions to maintain and monitor DSS for the ESs package. These conditions implied a strong organizational strengthening work with decision- and policy-makers and stakeholders, to accurate the sustainable development of the ESs decision tool. Two workshops at local and regional level (SPA and Antofagasta), were developed to accomplish this objective. One of the strategies during these meetings (to assure a long-term continuity of the results of ProEcoServ) was to maintain a copy of the database inside CEAZA's computational infrastructure while decision makers and stakeholders decide which institution will be in charge of update and maintenance of DSS. The systematization and validated data provision will depend on the collaboration of several institutions related to both ESs: Corporación Nacional Forestal (CONAF), Servicio Nacional de Turismo (SERNATUR), Seremi Medio Ambiente (SEREMI MA) and Dirección General de Aguas (DGA). An interesting outcome of this particular objective was that none of the different government institutions were particularly qualified or willing to take on the responsibility. This emergent finding highlighted to the stakeholders one of our strategic recommendations, which was to implement the ESs strategy within locally-constituted intermediate decision making bodies. These kinds of findings are probably one of the keys for the long-term sustainability of the results from ProEcoServ and currently are being pushed forward in the national ESs agenda.

4.5.3 Training and capacity-building

As we mention above, ProEcoServ-CL decided together with decision makers and stakeholders to use *Tableau* software as the DSS for both water provision and ecotourism. Consolidation of this platform was ready in December 2014. At the end of January 2015 it was organized an intensive workshop of two days in San Pedro de Atacama as the first pilot implementation, dissemination and training of this DSS to decision-makers and users. This workshop was intended to empower locals with the capacity to better understand what is going on in their community with both ecosystem services and provide them the information they need to better manage their resources.

During the closure activity of the project, ProEcoServ's team also provided to local and regional communities the book called "Memoria de Gestión ProEcoServ 2011-2015" that collects and summarizes the major work products of ProEcoServ project and also tries to guide decision- and policy-makers on how to understand and to manage ESs selected at different levels of decision- and policy-making. This particular outreach product also provides some leads for the online training material for stakeholders and was launched together with a

Figure 4.5: Guideline and promotional material: Memoria de Gestión ProEcoServ 2011 – 2015

webpage (http://proecoserv.ceaza.cl/) where all the key deliverables, training material and databases will be permanently posted on the web – see Figure 4.5.

4.6 Mainstreaming ecosystem services and influencing policy

4.6.1 Participatory-decision making at the local level

Probably one of the most important results from ESs mainstreaming during the project implementation was the social learning process attached to each one of the objectives. This approach implies not only strengthening ESs knowledge exchange between local, regional and national levels, but also a community-based understanding of ESs which, linked with a sectoral political framework, can also support planning at the national level. That is why one of the main proposals from ProEcoServ, in association with a political strategy to mainstream ESs into sustainable national development planning, is the central role of participatory decision-making at the local level. The proposal aimed to link policy support tools at different levels based on local and multi sectoral interests that promote actions to protect and conserve ecosystems relevant for national development.

Considering this strategy, each outcome can be introduced into the policy support tools selected, especially at the local level, to influence national development planning. The ESs mainstreaming through a participatory process had been already validated by many of the project outcomes: (1) identification and weighting, together with stakeholders, of spatial factors that determine areas of ecotourism potential in San Pedro de Atacama, (2) developing and training of models for water provision and ecotourism using *Tableau* software, (3) training and dissemination of trade–off matrices for both ESs, (4) identification and review of scenarios for San Pedro de Atacama, including the design of a final guideline material in this issue and (5) conducting several meetings to identify potential SMEs and engaging with other private-public projects, to name a few.

In this context, ProEcoServ-CL team worked closely together with twelve government institutions and organizations participating into a local Steering Committee (LSC) that was chaired by the Municipality of San Pedro de Atacama. During the period of project implementation the group worked closely with the ProEcoServ team, above all, linking activities and outcomes with national, regional and local policy processes and also providing important feedback for research (see Water Provisioning section above). Each government institution chosen for the LSC was related directly or indirectly with the ESs targeted by the proposal. Within the government institutions there was also an Advisory group who also supports several other participatory processes at the local level. The main institutions and organizations that were part of one or both groups were the Municipality of San Pedro de Atacama (Municipalidad de San Pedro de Atacama), the Council of Atacameños People (Consejo de Pueblos Atacameños, CPA), Rio San Pedro Irrigators and farmers Association (Asociación de Regantes y Agricultores Río San Pedro), National Service of Tourism (Servicio Nacional de Turismo), National Forestry Corporation – Los Flamencos Reserve (Corporación Nacional Forestal), Water Authority (Dirección General de Aguas), Foundation of Culture and Tourism (Fundación de Cultura y Turismo), Regional Ministry of Agriculture, Secretary of Regional and Administrative Development (Subsecretaría de Desarrollo Regional y Administrativo), National Indigenous Corporation (Corporación Nacional Indígena), Association of Tourism and Environment (Asociación de Turismo y Medio Ambiente) and Tata Malku Foundation (Fundación Tata Malku). At the local level as well, ProEcoServ identified the Comunal Development Plan and Municipal Ordinance for Local Environmental Management as the two major entry point for policy intake. It is worth noting that ESs are not clearly integrated into this political and legal framework although the ecosystem concept is mentioned in the higher-level policy tools.

4.6.2 Engagement with regional and national development planning

As we mentioned above, the core of the methodological proposal was a participatory decision-making process at the local level. In this sense, the major concern was to generate a strategy for the sustainable management of ESs from a multi sectorial perspective, which articulated several actions to protect the ESs in San Pedro de Atacama and ensure the well-being of its people. From this perspective, innovation and adaptive governance for a sustainable development of ESs in San Pedro de Atacama depended on the strategies used to link national policy tools with regional and local decision tools and decision making. One of the key lessons learned is that the participatory processes together with a scientific and community-based understanding of ESs was key to reach these goals and now the community is truly empowered to manage their ESs.

At the regional level ProEcoServ identified two main tools which included ESs in the policy and decision making: Regional Development Strategy and the Action Plan for Biodiversity in the Antofagasta Region. ProEcoServ-CL team also collaborated with Ministry of Environment, including the regional undersecretary office. Hence, it was possible to work very closely, have the Minister participating in important activities and discuss perspectives regarding ESs, especially in relation to the design and training of the DSS. Furthermore, ProEcoServ local team was able to link several initiatives at the national and regional levels. A concrete achievement in this regard was to submit a proposal to the Antofagasta's Regional Fund for Innovation and Competitiveness that aimed to strength the capacity of regional decision- and policy-makers to analyse decisions on key ESs. ProEcoServ also secured funding for two projects for 2015 period. One of them is the Environmental Protection Fund sponsored by the Ministry of the Environment whose project called "Ckapin isaya Ckonicks: Sol para nuestros Ancianos" will work on renewable energy. The second project, called "Valorización de la Quínoa Atacameña a través de la caracterización nutracéutica, elaboración de productos funcionalesy cadenas de comercialización" (highlighted above) was funded through the Agricultural Innovation Fund and sponsored by the Comisión Nacional de Investigación Científica y Tecnológica and will bolster cultural ESs related to traditional crops and techniques.

4.6.3 Policy impact

One of the strategies of ProEcoServ to mainstream ESs into policy support was to identify and link existing high-level policy support tools (such as international conventions, laws of the republic, regulations, political strategies and national plans) with other tools operating at the regional and local level. At the regional level

ProEcoServ identified two main tools which included ESs in the policy and decision-making: Regional Development Strategy and the Action Plan for Biodiversity in the Antofagasta Region. At the local level as well, ProEcoServ identified the Communal Development Plan and Municipal Ordinance for Local Environmental Management. It is worth noting that ESs are not clearly integrated into this political and legal framework although the ecosystem concept is mentioned in the higher-level policy tools.

In this context, training and dissemination of *Tableau* software is a milestone for how policy-makers and stakeholders have used the ProEcoServ results to support their decisions. During the change in government highlighted above (March 2014), the Municipality of San Pedro de Atacama has experienced many changes in the local policies aimed at protecting and managing ecosystems in a sustainable way. It is interesting to note that presenting the satellite-based water balance for the Central Altiplano proved that highly sophisticated scientific tools and approaches can be boiled down to one simple figure that can still drive home a powerful point. In the SPA case, it allowed the discussion to move from speculation to fact-finding, something that had never been achieved before in the current national context of broad mistrust of established authorities and suggests a way forward for dialogue around ESs.

Another concrete policy-making impact is that the Municipality of San Pedro de Atacama is actively working on the first-ever tourism development plan for the Comuna (PLADETUR). To do this they need to determine firstly which will be the area to propose an area to be assigned a special zoning status designed for tourism development (ZOIT). To achieve this objective, decision-makers are using *Tableau* software platform to visualize the tourism data that has been recollected and systematized by the ProEcoServ team during the project. Furthermore, representatives from the local office of the National Forestry Corporation (CONAF) and of the National Service of Tourism (SERNATUR) have learned from *Tableau* how to interpret tourism dynamics and how they can affect ecosystems and tourism attractions and how the water provision between seasons determines the water availability for local communities and tourism activity. Both activities are interesting achievements as they highlight the potential for engaging with local-level actors in the design of policies that have an enormous potential to cascade into other local initiatives across the country. Given the very limited room for compromise that currently exists between local development and national authorities, particularly where indigenous groups are involved in decision-making, these achievements are providing a nationwide benchmark of how to design effective ESs policies.

Another important aspect of ProEcoServ-CL refers to the inclusion of ESs into regional policy and national legal tools. This objective was, however, solidly based on the local assessment of environmental policies, the developing of scenarios for SPA and the application of different strategies for economic valuation of ESs (surveys, workshops and meetings). Each one of these actions was carried out during the ProEcoServ project execution in order to influence national policymaking. Naturally, this work approach also considered the local relevance of such actions, plans or policies. Without this consideration, the impact that an initiative could have on national policy could not contribute in the same way to the welfare of local communities and their ecosystems. Therefore, a constant exchange of knowledge is necessary between the different levels of decision-making to strengthen the ecosystem approach in the development of the country.

Probably one of the clearest indicators of this ESs integration assessment and political engagement are the projects that CEAZA has been registered in during the last's ProEcoServ-CL working year, 2015. Two projects awarded have included the local criteria into their proposals using regional (FPA – Regional Ministry of Environment) and national (FIA – Ministry of Agriculture) funding. The implication is that ProEcoServ results have been internalized to support the continuous integration of ESs criteria into the national policy, considering the local relevance as the framework. At this stage, it is also worth mentioning two key results that emerged from the installation of the ProEcoServ team in SPA. Firstly, CEAZA has access to a very good network of professionals that are interested in the sort of applied science activities that the Center scientists are engaged in. This way, the ecosystem concept and the whole concept of evidence-based decision-making around ESs, and the direct benefits a long-term view may bring about to local communities, is now firmly established in SPA. Secondly, the Council of Atacameños People (Consejo de Pueblos Atacameños, CPA) was explicitly included in a high-level Presidential consulting body, which delivered an major policy white paper on the future of lithium mining in Chile, which is now centered in SPA. This policy document explicitly and profusely includes the ecosystem concept, water provisioning, ecotourism and the need for sustainable development to preserve the fragile ESs that are key to local communities and represents a very concrete proof of the national-level impact of ProEcoServ-CL work.

To summarize, the policy impact can be assessed in different ways and perspectives. As noted above, there is a lack of state-level tools to project decision making from the national to local level, the ProEcoServ team

chose as a core strategy to focus on the local work within activities from component 2 to accomplish this objective. The work was focused on sectoral strategies to achieve a bottom-up influence on higher-level ESs policy-making. Our results show that complex initiatives, such as ProEcoServ–Chile, can be developed at the scale of municipalities only if they are validated with decision makers from within the local community (e.g. CPA & Municipality of San Pedro) only requiring support from national-level institutions (Ministry of the Environment, Ministry of Agriculture). In this sense, ProEcoServ is a clear precedent for future projects related to ESs in SPA and the country.

4.7 Overall lessons and recommendations

ProEcoServ-CL work suggests a series of strategic and practical recommendations to ensure a better understanding and capacity building for sustainable management of ESs in San Pedro de Atacama. To ensure a rigorous scientific assessment, modelling and valuation of ESs, it is still necessary to establish monitoring networks in real time, in order to understand ESs dynamics and improve the future scenarios for the region and the municipality. Thus, implementing an observation platform with continuous measurements and providing constant information of ESs throughout the internet and social media, will support decisions and better management of ESs in areas under study. In this concrete regard, ProEcoServ-CL has made a significant contribution to social infrastructure ahead of the construction of physical infrastructure (hydrological and meteorological stations, groundwater measurements or monitoring visitors in real-time) to nurture sustainability as communities are prepared to assimilate these key pieces of information. Furthermore, ProEcoServ-CL established local leaders and participatory processes that can provide interesting technical options. Managing and designing physical ESs infrastructure in a participatory way can be replicable in other projects with the tools that every country has available. Using this methodology, specific solutions to ensure human welfare and a better management of ESs for each country can emerge. Implementation of the *Tableau* software platform in the local administration of SPA (Municipality of SPA, Council Atacameños People, CONAF, SERNATUR) is a concrete example in this regard. To our knowledge, ProEcoServ is the first successful participatory process in the country that empowers and matches indigenous people with the ESs concept managed by national authorities. As the unrest among indigenous people in the country is increasingly about access to ESs and there is a lack of tools to match the contrasting views about them held by authorities and indigenous leaders, it is under consideration implementing it in other contexts, such as Easter Island, were CEAZA scientists have a strong local presence. Similarly, ProEcoServ-CL have currently submitted a proposal to the regional government of Antofagasta, where the SPA indigenous community will participate in the monitoring effort highlighted at the beginning of this section and is intended to translate into a permanent regional study centre focused on ESs sustainability in the broader Altiplano region.

Directly from ProEcoServ San Pedro de Atacama experience, the recommendation is to strengthen and monitor the bridge between science and policy throughout participatory process at different levels. This must be done during the entire project, emphasizing the evaluation stage and the design of products (deliverables). As noted above, implementing agencies (i.e. CEAZA), should be provided with higher-level counterparts within the central administrations that are in more powerful technical positions and not politically appointed. It was a huge burden to restart talks with low-level officials, who had no clout in the central administration and who did not understand very clearly what the proposal was aiming at. Although resources and personnel were dedicated to train them, it was to no avail as their requests or motivations were dictated from a political vantage point, with no room for the compromise that ESs mainstreaming required.

5. VIET NAM

5.1 Introduction

The work carried out in ProEcoServ-Viet Nam (ProEcoServ-VT) was a collaborative effort led by the Institute of Strategy and Policy on Natural Resources (IPONRE) in partnership with the Ministry of Natural Resources and Environment. The main objective of ProEcoServ-VT is to support the Ca Mau Division of Natural Resources and Environment and the Ca Mau National Park management to integrate ecosystem services (ESs) into land use planning. For this reason, a pilot valuation study was implemented. The pilot work took place on the Cape Ca Mau Mao National Park, in the Ca Mau Province, that covers 12 per cent of the country and comprises one of the largest remaining contiguous mangrove forests in Viet Nam – see Box 5.1.

Banking on the results of this study, ecosystem services are now present in the land-use and planning policy-making processes, including both the regional and the national level. In fact, the ProEcoServ-VT team took the lead in making "Increasing Investments in Natural Capital in the Greater Mekong Sub-region" the theme of the Fourth Greater Mekong Sub-region Environment Ministers' Meeting held in 2015. One of the objectives of the high level session was mainstreaming natural capital considerations into socio-economic planning and investment decision making processes. The Viet Namese officials presented ProEcoServ-VT as a "best practice" initiative in the mainstreaming session of this meeting.

5.2 Working plan

The activities of ProEcoServ-VT aimed to inform decision makers of the wide range of economic values that mangrove ecosystems provide to the population of Viet Nam. Since most of these values are not directly associated with a market price, they are often viewed by policy-makers and land use planners as having zero economic value. The association of non-priced benefits to a zero economic value is incorrect. Therefore, the main strategy in this project is to develop and implement a pilot economic valuation study of the mangrove forests in Ngoc Hien, the southernmost rural district of Cau Mau Province – see Figure 5.1. In this context, the project proposed (1) development of valuation tools that capture the true economic value of mangroves, which results were made available to land use planning policy in the Cau Mau Province; (2) awareness raising and capacity building for national and provincial decision makers on ESs; and (3) mainstreaming and uptake of ESs in the policy agenda in Viet Nam, at both provincial and national levels.

Box 5.1: Cape Ca Mau National Park

Ca Mau is the southernmost province of Viet Nam, with the total area of the province estimated to be 529,487 ha including 462,968 ha of agricultural land accounting for 87.44% of the total area; 57,974 ha of non-agricultural land occupies 10.95% of the total area; while 8,545 ha (1.61%) is unused land. The total forest area of the province is 99,173 ha with mangrove-type forests comprising the largest area with 62,436 ha. The Cape Ca Mau National Park (also known as Mui Ca Mau) is located within Ngoc Hien District of the province. The Mui Ca Mau houses a rich mangrove ecosystem, among other ecosystems and natural features. In fact, the Ngoc Hien District has the largest area of mangrove forests in the province with 43,523 ha attributed to its long stretch of coastal areas. Ca Mau's mangrove area was listed in Recommendation of National Marine Priority by Ministry of Aquiculture in 2005. It was also listed to be nominated as a coastal Ramsar site in 2006. More recently, the Viet Namese Prime Minister approved the "National Action Plan for Biodiversity to 2010 and Strategy to Implement Biodiversity Convention to 2020", within which Mui Ca Mau is one of the critical sites for conservation of biodiversity in Viet Nam – being today a UNESCO Biosphere Reserve and a Ramsar site. Today the Park is managed by using National Policies for National Protected Areas and Forests by Decision No 142/2003/QDTTg and Decision 08/201/QD-TTg of Prime Minister, for Protected Mangrove Forests.

Source: ProEcoServ-VT; UNESCO

Figure 5.1: Map of Ca Mau Province in the context of Viet Nam

5.3 Economic value of mangrove ecosystem services

5.3.1 Setting the scene and the rational for valuation exercise

Mangroves in Ca Mau Province support millions of people with market priced goods, including wood, timber and food. At the same time, this ecosystem provides a wide range of services to the local communities, whose benefits are not recorded in market prices, including flood control, water purification and erosion reduction and the supply of natural habitat to hundreds of fauna and flora species, including endangered ones. Indeed, BirdLife International listed 4,388 ha in Ca Mau as an Important Bird Area (IBA), and in 2009 it was established as a UNESCO Biosphere Reserve. Against this background, the main objective is to implement a pilot valuation study of the mangroves in Ca Mau Province so as to assess the true economic value of mangrove ecosystems, including both market and no market priced benefits, and use this information (now is missing) into spatial planning and development policies for the Ca Mau Province and this way provide a significant contribution to the National Green Growth Strategy.

Ca Mau's mangrove forest area, notably located in the Ngoc Hien District, is about 43,523 ha, including 18,762 ha of production forests, 12,765 ha of protected forests and 11,996 ha of special-use forests. Currently, most of the mangrove forests have been allocated to forestry companies, forest management committees, military units and only around 5% of the total mangroves (production forests) are allocated to households. The exploitation and utilization of mangroves in Ngoc Hien is fully compliant with the guidelines of Ministry of Agriculture and Rural Development as well as documents related to forest management plans for each stage of the Department of Agriculture and Rural Development in Ca Mau. Therefore, for mangroves that are production forests, forest owners are allowed to cut trees in the entire area when the forest reaches the age of exploitation (usually 12 -15 years). After exploitation, forest owners have to re-plant the forests for 12 months with funds deducted from the profits of exploitation. For protected forests, when the forest is up to standards for exploitation, forest owners are allowed to exploit them in the form of clearing in each group. For special-use forests, the exploitation can only be conducted in some areas of protected landscape areas and under close monitoring of the administration services. The harvests are mainly fallen trees, dead trees and non-timber forest plants.

In this context, it is proposed to implement a valuation study that assesses the services provided by mangroves, including timber and firewood, commercial fish nurseries and aquaculture benefits (mangrove provisioning services), coastal protection, carbon sequestration benefits (mangrove regulating services), and recreational benefits (mangrove cultural services). The economic values of these services are presented in the next paragraphs. All economic value estimates are expressed in 2014 prices.

5.3.2 Mangrove provisioning services

Timber is a main product provided by mangroves and it is often used for house construction, building fishing boat and other purposes. It is harvested through forest timbering activities, which are carried out every 12 to 15 years, depending on forest quality. In the most cases, households, following contracts signed with mangrove forest Management Boards, do the timbering activities. Harvested timber is sold at local markets. Table 5.1 summarizes a number of indicators measured in mangroves used in this study so as to characterize the bio-physical productivity of this asset.

Table 5.1: Indicators measured in mangroves of exploitation

Indicators	Unit	Production forests	Protective forests	Average
The average height of trees cut	m	10.50	12.00	11.25
The average diameter of trees cut	cm	10.05	11.00	10.53
Density	tree/ha	2,150	2,400	2,275
Volume	m^3/ha	83.75	105.10	94.43

Source: Management Board of Protective Forests in Ca Mau

Combining this information with exploitation data of the various types of mangroves and the market prices associated to the different mangrove outputs, as shown in Table 5.2, we can characterize the income derived from forest production of mangroves.

Table 5.2: Different types of mangrove forest outputs

Output	Unit	Production forests	Protective forests	Average
Timber	m^3/ha	8.53	7.48	8.01
	USD/m^3	34.50	53.90	43.70
Firewood (high quality)	stere/ha	69.34	98.38	83.86
	USD/stere	31.30	37.70	34.70
Firewood (low quality)	stere/ha	14.29	15.19	14.74
	USD/stere	24.80	24.80	24.80

Note: The stere is a unit of volume in the original metric system that is used for measuring large quantities of firewood or other cut wood and it equals to one cubic metre – see https://en.wikipedia.org/wiki/Stere

In addition, this economic activity involves production costs, ranging from labour costs with management, planting, and cut as well as shipping costs. The production costs depend on factors such as terrain conditions and technical design (seeds, cost of the land, density, planting techniques, care and protection) with an average estimate of 862 USD/ha. Income is also subject to taxation. The net income from mangrove exploitation is presented Table 5.3.

Table 5.3: Net income from the exploitation of mangrove forests (per cycle)

	Production forests	Protective forests	Average
Income from timber and firewood (USD/ha)	3,120	4,087	3,603
Land-use tax at 4% (USD/ha)	125	164	145
Production costs (USD/ha)	862	862	862
Net income (USD/ha)	2,133	3,061	2,596

Thus, currently the net income from timber and firewood for forest owners ranges from 2,133 to 3,061USD/ha, per cycle. One cycle is 12-15 years, so the net income from the exploitation of mangrove forests ranges between 164–235 USD/ha/year.

There are two main types of fishing in Ngoc Hien District: inshore and offshore fishing. Although mangroves affect both types of fishing, the study assessed these impacts on inshore fishing, as inshore fishing plays an important role in the livelihoods of communities in the Ngoc Hien District. Currently there are 488 households participating in inshore fishing, and with an annual harvest of about 24,020 tons. The equipment used for inshore fishing is relatively simple, such as trawls, grill nets, and squid. Fishery harvest is rich and diverse in species including shrimps, crabs, squids, fish, snails, and clams.

To estimate the value of inshore fisheries, interviews were conducted with 50 representative households who regularly participate in inshore fishing. Table 5.4 compiles the information obtained from the interviews. With a total of 488 households participating in inshore fishing, aquatic resource value is valued at 2.19 million USD/year. In other words, income from the inshore fishing in the mangroves of Ngoc Hien is about 50 USD/ha/year, on average. [27]

To clarify the relationship between mangrove forests and fisheries production, a quantitative research has been conducted using the same approach used for valuation of mangroves for fisheries in Thailand by Barbier and Cox (2004)[28]. According to this paper, the area of mangroves is an important parameter in the equations explaining the relationship between fisheries production and (1) efforts for exploitation (as shown by the number of vehicles or total extraction time or capacity of vehicles used for exploitation) and (2) the area of mangroves (supply of food and safe shelter for aquatic species). Econometric estimation results show that the impact of these two parameters is statistically significant. In particular, if the mangrove area does not change

Table 5.4: Income from inshore fishing in Ngoc Hien

Species	Number of households	Average volume (kg/household/year)	Price (USD/kg)	Income (USD/year)
Shrimp	23	500	11.50	132.250
Crap	6	275	8.28	13,662
Squid	4	494	7.13	14,089
Fish	19	520	3.68	36,358
Snail	14	982	1.84	25,296
Clam	4	400	1.38	2,208
Total income of households interviewed (USD)				223,864

27 This is gross income. One should deduct costs of fishing to get net income. However, no systematic information on costs of fishing has been assembled.
28 Barbier, E.B. and Cox, M. (2004) An economic analysis of shrimp farm expansion and mangrove conversion in Thailand, *Land Economics*, 80(3), 389-407.

and the number of households licensed for fishing increased by 10%, the volume of fisheries exploitation will be increased by 3.8%. Otherwise, if the number of households licensed for fishing does not change and the area of mangrove is increased by 10%, the volume of fisheries exploitation will be increased by 1%. Under the assumption that the results from Thailand can be extended to Viet Nam, this means, that a 10% increase in the mangrove area will be associated with an increase in the annual income of the fishermen in the mangrove between 21,849 and 177,957 USD, depending on the final composition of the species harvested. In other words, a 10% increase in the mangrove area will be associated with an increase in annual income between 0.50 and 4.10 USD/ha from inshore fishing in the Ngoc Hien mangroves.

In 2013, the area for aquaculture of Ngoc Hien was 24,222 ha, of which an area of 10,270 ha was used for ecological cultivation, accounting for over 40% of the total area. Currently, this form of cultivation was only applied to the shrimp species and the productivity is higher than traditional forms of cultivation. Specifically, the production of ecological cultivation is 650-750 kg/ha/year and that of traditional cultivation is 250- 300 kg/ha/year.

The idea of mangrove forests affecting aquaculture production was proposed firstly by Eric Heald (1969) and Bill Odum (1972). This idea was strengthened by various studies around the world. These studies are based on three hypotheses to explain the relationship between mangroves and aquaculture production in coastal areas. These are: (1) mangroves provide food for aquatic species, (2) mangroves provide shelter for aquatic species from physical disturbance and predators and (3) mangroves can reduce pollution affecting aquatic species, thus, enhancing the health and viability of aquatic species under forest canopy. Results of studies on the relationship between mangroves and aquaculture production in a number of regions of the world are summarized in Table 5.5.

To estimate the impact of mangroves on aquaculture production, it is prescribed to collect information related to each cultivation model including: area, the depth of the pond, production costs (labour, breeding, food), water quality, mangrove cover, and fishery production. However, due to the limited time and resources, this study uses only general information related to aquaculture production, cultivation area and mangrove forest area to analyse data from 2004-2013. The equation used in this study was as follows:

$h=AE^{a}\ S^{b}$

$Ln(h_i)=A_0+aLn(E_i)+bLn(M_i)+m_i$

With:

h_i : aquaculture production harvested in year$_i$ (ton)

E_i : the area of aquaculture in year$_i$ (ha)

M_i : the area of mangrove forests in year$_i$ (ha)

Estimation results of the analysis are shown in Table 5.6. Estimated coefficients are positive and statistically significant. Specifically, if other factors are not changed, the expansion of aquaculture area by 1% will increase aquaculture production up to 2.95%. Whereas, if the area of mangroves increased by 1%, the aquaculture production will be increased by 1.96%.

Table 5.5: Study results on the relationship between mangroves and aquaculture

Study areas	Relationship	Correlation (sample number)	Reference
Tropical regions of the world	Shrimp productivity – vegetation areas	0.54(27)	Turner (1977)
Tropical regions of the new world	Shrimp productivity – vegetation areas	0.64(14)	Turner (1977)
Indonesia	Shrimp productivity – mangrove areas	0.89 (N/A)	Martosubroto and Naamin (1977)
Carpentaria-Australia	Shrimp productivity – length of mangrove forests	0.58(6)	Stapbles et al. (1985)
Gulf of Mexico	Fish productivit – mangrove areas	0.48(10)	Yanez-Arancibia et al. (1985)
Tropical regions on the world	Shrimp productivity – mangrove areas	0.53(N/A)	Pauley and Ingles (1986)
Peninsular Malaysia	Shrimp productivity – mangroves areas	0.89(10)	Paw and Chua (1991)
Philippines	Shrimp productivity – mangroves areas	0.61(18)	Paw and Chua (1991)
Philippines	Fish productivity – mangrove areas	0.34(18)	Paw and Chua (1991)
Viet Nam	Productivity of fish and shrimp – mangroves areas	0.95(N/A)	de Graaf and Xuan (1998)
Viet Nam	Shrimp productivity – mangroves areas	0.88(5)	de Graaf and Xuan (1998)
Tropical regions on the world	Shrimp productivity – mangroves areas	0.38(37)	Lee (2004)
New South Wales-Australia	Fish productivity – total area of mangroves and wetland and sea grass strip	0.32-0.75(49)	Saintilan (2004)
Malaysia	Shrimp productivity – mangroves areas	0.37-0.70 (36)	Loneragan et al. (2005)
Queensland-Australia	Shrimp productivity – mangroves areas	0.37-0.70 (36)	Manson et al. (2005)

Source: Alongi (2009) [29]

Thus, if the area of mangroves increased by 60%, the aquaculture production will increase by 117%. This result is relatively reasonable compared to the reality of the aquaculture industry in the Ngoc Hien District in recent years.

29 D.M Alongi (2009) The Energetics of Mangrove Forests, Springer, Dordrecht, The Netherlands.

Table 5.6: Estimation results

	Coef. Estimate	Std. Err.	t	P>|t|	[95% Conf. Interval]
lnE	2.953193	1.56756	1.88	0.109	[-0.882481; 6.788868]
lnM	1.962833	0.96213	2.04	0.087	[-0.391410; 4.317076]
_cons	-40.606591	14.89403	-2.73	0.034	[-77.05097; -4.162209]
Number of obs = 9		F(2,6) = 6.49		Prob > F = 0.0316	
R-squared = 0.6837		Adj R-squared = 0.5783			

According to the statistics of Ca Mau Agency of Statistics, in 2012, aquaculture production of Ngoc Hien recorded an income of 87.5 million USD (Provincial Statistical Yearbook of Ca Mau, 2012). With a total of 51,646 ha allocated to aquaculture production this corresponds to an income from aquaculture in the Ngoc Hien mangroves of about 1,695 USD/ha/year. Between 2011 and 2012, the change of cultivation area is insignificant. On the other hand, the area of mangroves increased by 5.67% and the aquaculture production increased by 2,545 tons, from 49,010 tons in 2011 to 51,555 tons in 2012. The value of the increased aquaculture production is valued 4,154,808 USD. Thus, on average, an increase in area of mangrove by one ha is contributing to a 187 USD/year increase in value of aquaculture production.

5.3.3 Coastal protection, carbon sequestration benefits (mangrove regulating services)

Mangrove forests are well-known for their role in coastal protection from storms and other forms of extreme weather events. Recent studies indicate that forest mangroves with a coastal belt of 100 m, or more, are able to reduce the height and power of waves by 50%[30]. This way, the local communities that are living in these coastal regions suffer less damage than those who are living in coastal regions with destroyed mangroves. In order to estimate the benefits from coastal protection that mangrove forests provide to the coastal community of the Ngoc Hien District, the Expected Damage Function (EDF) is used. According to the economic valuation approach, the economic value of coastal protection refers to the expenditure saved in terms of forgone costs incurred to property, infrastructure and production when mangrove services that protect economically valuable assets are lost – see Annex for more technical information.

Two critical steps to implementing this approach include: (1) analysing the influence of mangrove area on the expected incidence of economically damaging natural disaster events and (2) monetizing economic damage incurred per event. From the operative perspective, it is necessary to collect data on the incidence of past storms and changes in mangrove area in coastal regions. Related to extreme weather events, information was collected on impacts on human lives, including dead/missing, and injured; damage to man-built assets, including damaged houses, roads and boats; as well as damages on production, including losses of income from agriculture and fishery activities. Table 5.7 summarizes the occurrence and intensity of damage caused by storms and other forms of extreme weather events in Ngoc Hien in recent years.

Table 5.7: Damage caused by natural disasters in Ngoc Hien

	No. of disasters	Dead/ Missing	Injured	Destroyed houses	Destroyed boats	Total damage (in USD)
2007	7	-	2	92	-	217,590
2008	7	-	-	6	-	147,610
2009	8	1	1	82	3	533,048
2010	11	-	-	21	-	776,756
2011	8	5	-	-	4	418,968
2012	7	-	-	19	4	212,152
2013	6	-	-	55	6	117,162

Source: Department of Statistics of Ngoc Hien District

30 Das, S., & Jeffrey, V. (2009). Mangroves protected villages and reduced death toll during Indian super cyclone. PNAS, 7359.

To estimate the value of protective services on mangrove forests, the study has analysed the relationship between damage from a disaster and the area of mangroves between 2007 and 2013. According to Barbier (2008)[31], a number of factors will affect the intensity of a disaster in a certain period of time, including: 1) the number of events, 2) the area of mangroves, and 3) the socio-economic conditions of localities – see Annex for more information. The functions describe the relationship between parameters as following:

$$LnC_t = a + b_E E_t + b_M M_t + b_x X_t + m_t$$

With:

C_t: the total damage caused by natural disasters in the year t, with t= 2007, 2008…, 2013

E_t: the number of extreme weather events (storm, tidal) in the year t

M_t: area of mangroves (ha) in the year t

X_t: socio-economic factor can affect the level of damage

Results of regression analysis show that the coefficient associated to the number of extreme weather events is positive, and its parameter estimate is 0.137. This means that when other factors are unchanged, any additional extreme weather event increase the socio-economic losses by 13.7%. Similarly, the coefficient of area of mangroves is negative and its parameter estimate is -0.01649. This demonstrated that when other factors are unchanged, an increase in one ha in the area of mangroves will be associated with a decline in 1,649% of the total damages.

According to the statistics for the period of 2007-2013, Ngoc Hien experienced 54 extreme weather events causing damages of 2,475,674 USD. The average cost of damages for each of the recorded extreme weather events is about 45,000 USD. With a 1 ha increase in the forest mangrove area the expected damage is reduced by 742 to 756 USD. In other words, the annual economic value of the protective function of mangrove forests is valued at the range of 742 to 756 USD/ha.

Mangroves have an important role in terms of as carbon sequestration services. Similar to other ecosystems, mangrove forests have five main types of mechanisms for carbon storage, including: (1) wood tree biomass above the ground, (2) wood tree biomass below the ground, (3) dead trees, (4) litter and (5) soil/sediments. As far as mangroves are concerned, reservoirs in litter usually account for a very small proportion. The reservoirs in dead trees also are not large unless entire ecosystems have recently undergone physical disturbances such as natural disasters or land use changes. The reservoirs in wood biomass of mangroves are the most noticeable because they account for a large proportion of the total amount of carbon of ecosystems (Alongi, 2009)[32]. Table 5.8 shows the ratio of major carbon stocks in various types of mangrove forests. The reservoirs of carbon in biomass of trees (both above and below ground) only account for a relatively small proportion (average of 25.25%) compared to other reservoirs in soil (average of 74.75%). With regard to mangrove ecosystems of Ngoc Hien District, to estimate the value of carbon storage, the ProEcoServ-VT team determined the amount of carbon in the biomass above the ground (including above ground roots). For the soil reservoir, due to limited time and human resources, it will be determined based on the equivalent proportion as shown in Table 5.8.

31 Barbier EB (2007) Valuing ecosystem services as productive inputs. Economic Policy 22:177–229
32 D.M Alongi (2009) The Energetics of Mangrove Forests, Springer, Dordrecht, The Netherlands.

Table 5.8: The ratio of major carbon stocks in various mangrove forests

Country	Research area	Genus	Above ground (%)	Underground (%)	Soil, in sediment (%)
Micronesia (1)	Coastal area	Sonneratia	18	14	68
Palau (1)	Coastal area	Rhizophora	16	11	73
Bangladesh (2)	Estuary	Avicennia	17	8	75
Indonesia (3)	Estuary	Rhizophora	12	5	83
Average			15.75	9.50	74.75

Note: (1) from Kauffman et al. (2011)[33], (2) from Donato et al. (2011) [34], and (3) from Murdiyarso et al. (2010) [35].

The amount of carbon in the biomass above ground is assessed by estimating the fresh biomass of parts such as trunk, branch, leaf etc. Secondly, fresh biomass samples are taken to the laboratory to determine dry biomass and the amount of carbon in dry biomass (the weight of carbon usually accounts for 48-52% of the dry biomass weight). Finally, to be converted to equivalent CO_2, it is multiplied by 3.667, as one ton of carbon equals 44/12 = 11/3 = 3.67 tons of carbon dioxide.

Based on analysis of data of the total amount of carbon stored in sampled trees and the density of reservoirs of carbon in mangrove forests, Table 5.9 shows the estimation results of the amount of carbon in main reservoirs of various types of mangroves in Ngoc Hien District.

Table 5.9 shows that the amount of carbon in biomass (above and below ground) and entire forests (biomass and soil) depends on the age of the tree, on the ability of each tree species to absorb CO_2 and the density of forests. In many cases, forests that are older and with low densities can absorb the equivalent amount of carbon as those are at high densities. Soil biomass is calculated with the proportional principle as shown in Table 5.8, i.e. soil biomass is approximately 4.5 times greater than above ground biomass.

Table 5.9: Estimated CO_2 content in different mangroves in Ngoc Hien District

					Relevant CO_2 content (ton/ha)		
	Age	Density (tree/ha)	Above ground biomass(A)	Under-ground biomass(B)	Tree biomass (A)+(B)	Soil biomass (C)	Forest biomass (A)+(B)+(C)
Rhizophora apiculata Blume species	3	7,500	25.142	15.09	40.23	30.85	71.082
	7	4,500	62.476	37.49	99.96	76.67	176.631
	13	4,016	172.285	103.37	275.66	211.42	487.076
	16	3,766	297.326	178.40	475.72	364.87	840.589
	18	3,150	289.757	173.85	463.61	355.58	819.191
Avicennia alba species	n/a	2,790	107.096	64.26	171.35	131.42	302.777
	n/a	2,770	150.570	90.34	240.91	184.77	425.686
	n/a	2,660	207.058	124.24	331.29	254.09	585.388
	n/a	2,540	328.870	197.32	526.19	403.58	929.769
Avicennia offcinalis species	6	4,800	335.898	201.54	537.44	412.20	949.638
	10	3,900	579.258	347.55	926.81	710.84	1637.650

33 J. B. Kauffman, Heider, C., Cole, T.G., Dwire, K.A., Donato, D.C. (2011), Ecosystem Carbon Stocks of Micronesian Mangrove Forests, Wetlands, Volume 31, Issue 2, pp 343-352.

34 D.C. Donato,Kauffman, J.B., Murdiyarso, D., Kurnianto, S., Stidham, M. and Kanninen, M. (2011), Mangroves among the most carbon-rich forests in the tropics, Nature Geoscience, Volume 4, pp. 293–297.

35 Murdiyarso, D., Donato, D., Kauffman, J.B., Kurnianto, S., Stidham, M. and Kanninen, M. (2010) Carbon storage in mangrove and peatland ecosystems: a preliminary account from plots in Indonesia, CIFOR Working Paper no. 48, Center for International Forestry Research (CIFOR), Bogor, Indonesia.

Table 5.10: The value of carbon storage for mangrove forests in Ngoc Hien District

Species	Age	Relevant CO_2 content (ton/ha)	Value (USD/ha)	Average value (USD/ha/year)
Rhizophora apiculata Blume species	3	40.23	320	107
	7	99.96	795	114
	13	275.66	2,192	169
	16	475.7	3,782	236
	18	463.6	3,686	205
Average			2,155	166
Avicennia alba species	Na	171.35	1,362	n/a
	Na	240.91	1,915	n/a
	Na	331.29	2,634	n/a
	Na	526.19	4,183	n/a
Average			2,524	
Avicennia offcinalis species	6	537.44	4,273	712
	10	926.81	7,368	737
Average			5,821	724
Average for the mangrove in Ngoc Hien District			3,072	326

Note: n/a – not applicable

With regard to mangrove forests in Ngoc Hien, the amount of CO_2 used in the computations is the one related to the tree biomass (above and below ground) because mangrove forests are usually cleared to increase the area of aquaculture. In that case, the amount of CO_2 emitted is located mainly in the biomass of mangrove trees. There are very few cases where land use changes lead to draining water from forests and soil improvement that causes the loss of the amount of CO_2 in soil. In order to calculate the economic value of the carbon storage services, information is needed on the market price of carbon. In this study, it a conservative value of 8 USD per ton of CO_2 was used, which is in agreement with the price data provided by the European Emission Allowances - Europe Energy Exchange, a well-known carbon market and its information are often used in putting a price on carbon. The results are presented in Table 5.10.

Results show that mangrove forests, when managed and protected, provide a significant economic benefit, as measured from the sale of carbon emissions credit, amounting to 2,155 USD/ha (Blume species); 2,524 USD/ha (Avicennia alba species); 5,821 USD/ha (Avicennia offcinalis species) – corresponding to an average value of 3,072 USD/ha. This corresponds to an annual benefit of 325 USD/ha. In other words, the economic value of carbon sequestration from mangroves in Ngoc Hien District is about 325 USD/ha/year. Alternatively, if we use the social cost of carbon value in the range of 42 USD per ton of CO_2[36], the economic value of carbon sequestration from mangroves in Ngoc Hien District is about 1,720 USD/ha/year.

5.3.4 Recreational benefits (mangrove's cultural services)

The calculation of recreational benefits was estimated by exploring the use of the travel cost method and using the information collected by a questionnaire – see Annex for more information. According to survey responses, visitors to the Mui Ca Mau resort, Cau Mau National Park, come from 14 different provinces in Viet Nam. However, the number of visitors is concentrated mainly in the southwest, including Ca Mau (68%), Kien Giang (17%), Can Tho (6%). The mode transport used is automobiles (residents of other provinces) and motorbikes (local people). The average respondent is 38 year old, travels in groups and stays in the region for about 1.3 days.

36 This value corresponds to the revised Social Cost of CO_2 as indicated by the Interagency Working Group on Social Cost of Carbon, United States Government – "Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis – Under Executive Order 12866", May 2013. This value is also in agreement with the recent technical discussion of the current values of the Social Cost of CO_2 – see van den Bergh, J.C.J.M., Botzen, W.J.W. (2014) A lower bound to the social cost of CO2 emissions, Nat. Climate Change 4, 253–258.

Table 5.11: Some descriptive statistics of the respondents

Variable	Average	Minimum	Maximum
Age	38.9	23	58
Gender (1=male)	0.6	0	1
Education (study years at school)	15	12	16
Income (USD/month)	157	55	382
Visits (per year)	2.3	1	5
Stay duration (number of days)	1.3	1	3
Group (number of people/group)	16	4	34
Travel cost (USD/visit)	52	12	223

During this period, the average respondent spends about 55 USD. The main distinguishing characteristic of Mui Ca Mau Resort from other resorts is that the number of visits by tourists is quite high at 2.3 visits/year. For other resorts in Viet Nam, this number is under 1.5 (Hanley and Barbier 2009)[37]. This suggests that this national park, and its well-known mangroves ecosystems, play a significant role in attracting tourists – see Table 5.11. The main purpose for travelling to Cau Mau National Park is to enjoy the natural landscape (88%) and other activities such as scientific research and understanding local cultures (12%). Despite tourists' interest in natural landscapes of the area, 95% of respondents report being unsatisfied with the current infrastructure situation, including the poor conditions of roads, the lack of hotels and other lodging services, while 65% of respondents complained about travel services, information and transportation, and guides. Finally, about 35% of respondents expressed their concerns about issues related to the health of the natural environment, in particular those due to the lack of waste treatment systems.

Taking into account the statistical information collected by the questionnaire, it was estimated a demand for the number of visits. The number of visits was estimated in accordance to the following equation:

$$LnV_i=\beta_0+\beta_1 age_i+\beta_2 gen_i+\beta_3 educ_i+\beta_4 inc_i+\beta_5 sd_i+\beta_6 gs_i+\beta_7 tc_i+\varepsilon_i$$

With:

age_i : age of respondent *i*
gen_i : gender of respondent *i*
$educ_i$: education of respondent *i*
inc_i : income of respondent *i*
d_i : duration stay of respondent *i*
gs_i : number of people/group of respondent *i*
tc_i : reported travel cost of respondent i (in million Viet Namese Dong – VND)

Results of econometric analysis show that the estimated coefficients have expected signs: young people tend to travel more than older people, men visited study sites more than women or people with high income are able to visit tourist areas more than those with low incomes – see Table 5.12. However, only length of stay and total travel cost variables are statistically significant. According to valuation literature on travel cost – see Loomis and Walsh (1997) 38 –, individual consumer surplus from each visited is computed by:

$$CS = -1/\beta_{tc}$$

Taking into account the parameter estimates from Table 5.12, we can infer that the consumer surplus from each visit in accordance to

$$CS = 1/\beta_7 = 1 / 0.0000058 = 172{,}413$$

37 Hanley, N. and Barbier, E.B. (2009) *Pricing nature: Cost-Benefit Analysis and Environmental Policy*, Edward Elgar, Cheltenham.
38 Loomis, J.B. and Walsh, R.G. (1997) Recreation Economic Decisions: Comparing Benefits and Costs, Venture Publishing, Second Edition.

Table 5.12: Estimation results of the demand for visits (Poisson model)

$LnV_i = \beta_0 + \beta_1 age_i + \beta_2 gen_i + \beta_3 EDUC_i + \beta_4 INC_i + \beta_5 SD_i + \beta_6 GS_i + \beta_7 TCi + \varepsilon_i$	
age	-0.010
	(0.02)
gen	0.170
	(0.36)
educ	-0.091
	(0.10)
gs	-0.016
	(0.02)
sd	0.567**
	(0.19)
inc	0.000
	(0.00)
tc	-0.006*
	(0.00)
constant	1.685
	(1.32)
N	282
chi2	35.494***
bic	124.300

p<0.05, ** p<0.01, *** p<0.001 *

In other words, on average a visit to the park generates welfare benefits estimated to be 3.9 USD, which is the equivalent to 172,413 Vietnamese Dongs. Since a respondent visits the park up to 5 days, therefore his/her annual welfare benefit is estimated to be up to 19.5 USD. With an annual number of visits to the park that is estimated to be 60,000[39], the economic value of recreation benefits is estimated to be about 1.1 million USD per year. In other words, the economic value of recreation values of the mangroves in Ngoc Hien District is about 25 USD/ha/year.

5.3.5 Summary and policy impact

Estimation results for the four main types of mangrove ecosystem services in Ngoc Hien District, Ca Mau, are summarized in Table 5.13. Estimation results show that economic value of the four selected ecosystem services of the mangroves in Ngoc Hien District ranges between 1,390 – 1,560 USD/ha/year. This magnitude is equivalent to 76% of the annual income as reported by individual respondents in the travel cost questionnaire. Furthermore, the great majority of the economic value, 71%, is only captured by the use of other market information, including the social cost of carbon, damages by extreme weather events and travel expenditures incurred with visiting the site. In other words, only 29% of this benefit is currently captured by existing markets. In fact, provisioning services represent 29% of the total economic value of the mangroves.

However, if we take into account the revised social cost of carbon, the economic value of the four selected ecosystem services of the mangroves in Ngoc Hien District is estimated to be in the range of 2,621 – 2,985 USD/ha/year. In this scenario, by existing market prices only capture 15% of the ecosystem services benefits provided by mangroves. These economic values may be useful in many ways. For example, for policy assessment purposes, the valuation results helps: (1) to determine whether or not a development policy that may alter the status of a mangrove ecosystem creates welfare for community and society, (2) provide a scientific basis in selecting how to use natural resource in the most efficient way by looking at the trade-offs among the different ecosystem services and (3) identifying the winners and the losers when proposing changes in land use. Furthermore, (4) the economic valuation of the carbon sequestration services show that the greatest potential of the 43,523 ha mangrove forest area in Ca Mau is in ecosystem-based carbon mitigation, because this area alone is responsible for the off-set of 1% of Viet Nam's total annual CO_2 emissions.

39 Department of Statistics of Ngoc Hien District.

Table 5.13: Economic values of mangrove's ecosystem services: summary

Mangrove services	Value (USD/ha/year)
Provisioning	352 – 454
Coastal protection	742 – 756
Carbon sequestration	325 – 1,720
Recreational value	25 – 55

Finally, these results constitute a scientifically-based argument for developing future policies on payment for ecosystem services, enabling policymakers to calculate the true value of mangrove ecosystems for a transition to a green economy, as highlighted by the National Green Growth Strategy to 2020 for Viet Nam.

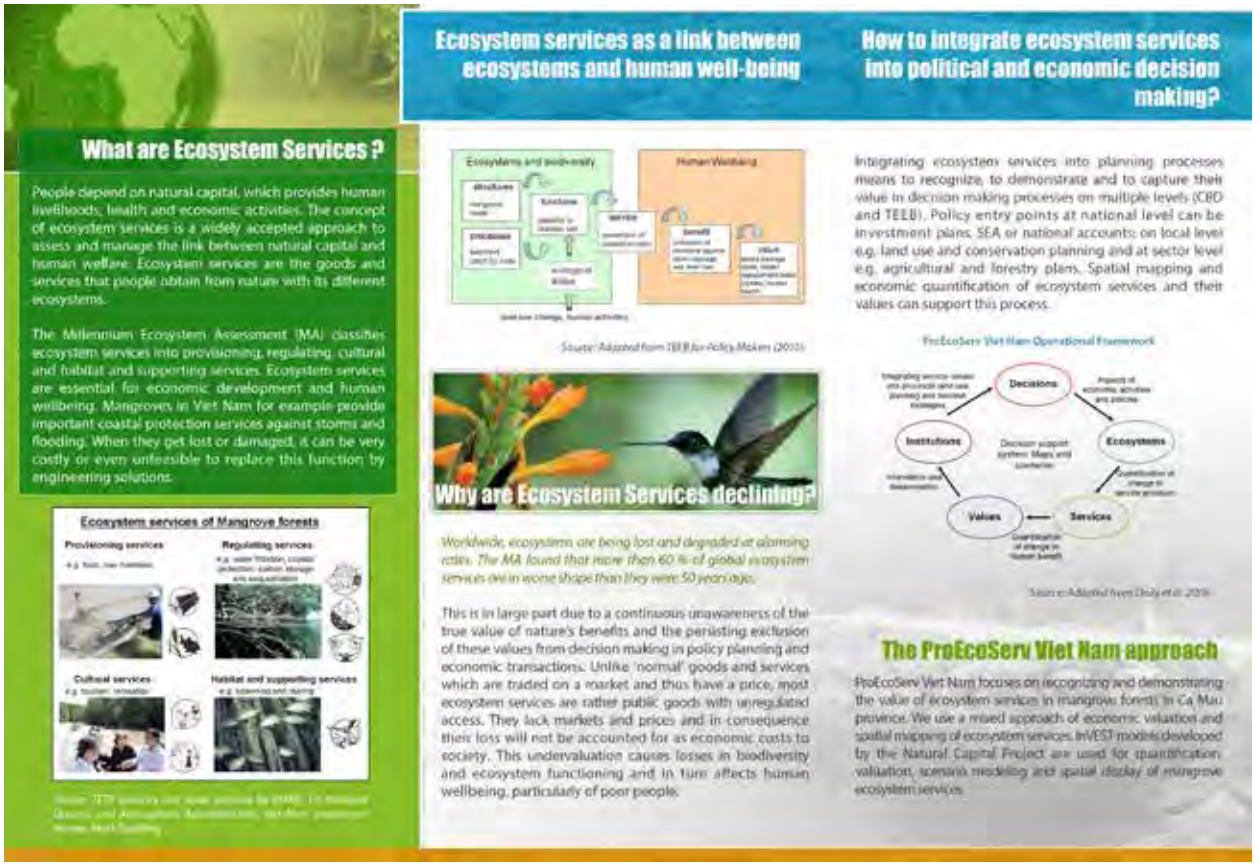
5.4 Mainstreaming activities

ProEcoServ engaged in wide range of mainstreaming ecosystem services related activities, ranging from capacity-building activities, awareness raising and building partnerships. The target audience and stakeholder groups included, but were not limited to, the following: (1) government ministries, public agencies and policymakers; (2) national and international development partners; (3) scientists including academic institutions and researchers; (4) non-governmental organizations and; (5) local communities, civil society and small and medium enterprises. This section reviews these activities.

5.4.1 Capacity building

ProEcoServ engaged in capacity-building activities in Viet Nam in a systematic way in order to disseminate long-term impacts from the four-year project. Between 2012 and 2015, thirteen workshops and training sessions with more than 600 participants were conducted both at the national and provincial level. This brought together ministries, specialized departments, international organizations, NGOs, and other stakeholders that are focused on raising awareness and improving technical capacity of target groups on ecosystem services (ESs), the application of mapping tools, and policy development. To disseminate the appropriate tools for learning, a number of manuals were produced under ProEcoServ, including a Manual for Valuation of Ecosystem Services and a Manual for Mainstreaming of ESs into Decision Making Processes. Furthermore, a series of policy briefs have been produced such as mainstreaming of ESs through the System of Environmental-Economic Accounts, economic incentives for mainstreaming of ESs. Brochures of ProEcoServ were also produced to introduce the project and its results – see Figure 5.2.

Figure 5.2: Illustration of a ProEcoServ brochure



From 29 - 30 May 2014, ProEcoServ organized "Policy Dialogue on Mainstreaming Natural Capital into Development Decision: Bringing Environment into Center Stage" in collaboration with the Asian Development Bank and the Hanns Seidel Foundation to share approaches of mainstreaming with other partners. Also, the "Greater Mekong Sub-region Workshop on Implementation of Sustainable Development Goals – Bringing Natural Capital into Center Stage" was organized on 14 – 16 May 2015 in Ha Noi with participation of more than 100 participants from development partners, government officials, NGOs, research institutes. Such initiatives played a crucial role in expanding the knowledge, tools, and skill set associated with ecosystem services and natural capital more broadly, while targeting the relevant stakeholders so that future initiatives can stem from such strengthened capacities.

5.4.2 Communication strategy for awareness raising

ProEcoServ's work in Viet Nam was characterized by a communication strategy built on the overall message of how well-managed ecosystems are the cornerstones of ecological infrastructure, and therefore they must be recognised as assets that provide a solid return on investments. See Table 5.14 for information on the multi-pronged approaches deployed in the communication strategy.

In this context, the main purpose of the strategy was to support the integration of ecosystem services into the planning processes and national policy framework through conveying information and knowledge on ecosystem services and biodiversity management to policymakers and other stakeholders, including the local communities and the private sector. Communication activities included:

- Establishing the project website, connecting project material, content, resources, and allowing easy access for anyone interested in the work. (See website: http://proecoserv.com.vn/index.php/en/
- Publishing communication materials (such as brochures, policy briefs, and case studies) and organizing communication events for different target groups
- Organizing training courses for different target groups at the relevant local to national level
- Organizing policy dialogues and consultation workshops

- Developing training materials and workshop presentations
- Fostering awareness and interest in ecosystems and their role in human welfare through creative mediums such as a photography competition – see Box 5.2

5.4.3 Building partnerships at national and international level

ProEcoServ involved participation of a number of policymakers both at the national and provincial level. The Project Steering Committee was established with representatives of ministries (i.e. Ministry of Planning and Investment, Ministry of Finance, Ministry of Agriculture and Rural Development, and Ministry of Natural Resources and Environment). Moreover, the Steering Committee was chaired by the Deputy Minister of Natural Resources and Environment. At the provincial level, a task force group included different departments (i.e. Department of Agriculture and Rural Development, Department of Planning and Investment, Department of Natural Resources and Environment, Ca Mau National Park) to facilitate implementation of the various aspects of the project. The task force group's members have been invited to consultation workshops and training courses at the provincial level. The project also involved working expert groups at the national and provincial level to participate in conducting project studies and peer review processes. At the provincial level, a peer review group with participation of representation from government was established to contribute to review the land use planning of Ca Mau National Park before submitting to the Provincial People Committee for approval

In addition, ProEcoServ worked closely with different initiatives working on natural capital, which brought an opportunity to share project experiences and establish partnerships with similar initiatives working in the same area. The mapping tools developed under the project were replicated under a study done by the World Wide Fund for Nature (WWF) in Ben Tre Province (a Mekong Delta region of Viet Nam) on development of a technical guideline on mainstreaming of ecosystem-based adaptations into planning process.

Box 5.2: Photo Competition

On 14 June, 2013, the "Ecosystem and Ecosystem Services in Ca Mau" photography competition was held by the Project Management Unit (PMU) of ProEcoServ in collaboration with the Ca Mau Department of Natural Resources and Environment (Ca Mau DONRE) and the Ca Mau Association of Art and Literature. Its main aim was to use artistic and creative mediums to raise stakeholders' awareness of the role and importance of ecosystems and ecosystem services to human welfare. The event was able to collect a total of 62 photograph submissions by 23 professional and amateur photographers.

Furthermore, ProEcoServ collaborated with Ca Mau DONRE and Youth Union of Ngoc Hien District with participation of more than 100 students. The event contributed to enhance awareness of community in general and children in particular on the importance of mangroves for human well-being.

Source: ProEcoServ-VT

Table 5.14: Communication Strategy

Communication objectives	Target audiences	Medium
A. Establishing information exchange between scientists and policymakers in integrating ecosystem services into the policymaking process both vertically and horizontally.	Researchers of institutes, policymakers	ProEcoServ database, websites, maps, case studies, project publications and training workshops.
B. Informing about ecosystem services, diffusing tools for integrating ecosystem services into national and local planning processes for policymakers.	Policymakers	ProEcoServ policy briefs, leaflets, posters, website, policy dialogues, communication strategies.
C. Reinforcing awareness and knowledge about the value of ecosystem services for related target audiences, including governmental agencies and local community.	Policymakers and leaders of enterprises	Multi-media communication, traditional communication, posters, leaflets, maps, case studies, training courses, communication strategies.
D. Enhancing the coordination between related initiatives and stakeholders working on ecosystem services (IPBES, IHDP, GLOBE, TEEB)	Policymakers and social and communicational organizations, researchers and related institutes.	Scientific publication of the project, linkages to relevant websites, case studies and presentations.
F. Enhancing the profile of ProEcoServ: heightening the position, role and image of the project to other organizations; raising awareness of related entities in over the world about the project contribution.	The Government, intergovernmental organizations, UN agencies, sponsors, policymakers at central and local levels, enterprise community.	Press releases, news, videos, posters, leaflets, on-line documents and case studies.
G. Building and improving communication capacity from national to local levels	Staffs, scientists, NGOs, social organizations, religious or youth groups, for the purpose of social equality.	Training seminars, presentations, FAQs, sets and lists of communication means.

The project team collaborated with WB in Viet Nam to develop the natural capital roadmap for Viet Nam, which is a key document in the preparation stage to support Viet Nam to become a Core Implementing Country (CIC) of the WAVES global partnership. Furthermore, the project team has worked with the Asian Development Bank under the Core Environment Program to further accelerate activities on natural capital in Viet Nam and in the Greater Mekong Sub-region. Lessons learnt from ProEcoServ have been shared with other Greater Mekong Sub-region's countries for wider replication in the region.

Furthermore, ProEcoServ-VT's team also worked with GIZ, the German development agency, to implement a project on mainstreaming of ecosystem-based adaptations into strategic planning to mobilize funds from the German government. The lessons learnt from ProEcoServ on mainstreaming approach can be applied in the project as well. The establishment of partnerships with different initiatives was very important to ensure that the synergy among different initiatives contribute effectively on the sustainability of the project, and ultimately provide an opportunity to scale-up project benefits to a wider audience. Finally, ProEcoServ-VT's team participated in different international events to share its experiences on mainstreaming processes in Viet Nam at the global level. Some of the important events include the World Forum on Natural Capital, 20 – 22 November, 2013; the Regional Workshop on "Valuing and Accounting for the Environment in the Asia Region Workshop", 6th and 7th Annual International Conference of the Ecosystem Services Partnership; 12th meeting of the Conference of the Parties to the Convention on Biological Diversity from 7 – 12 October, 2014 in Pyeongchang, Republic of Korea (the experiences of ProEcoServ were presented at Ecosystem-based Adaptation site event organized by CBD Secretariat and GIZ); 5th Sub-Global Assessment (SGA) Network in Dubai, UAE, 26 - 28 October, 2014; GMS Core Environment Program Technical Workshop-Strengthening Partnerships to Increase Natural Capital Investments in the GMS and WGE 9th Semi-Annual Meeting from 11 – 12 November, 2014 in Bagan, Myanmar and the GMS Environmental Minister meetings from 27 – 29 January

2015 in Myanmar. All in all, these activities have brought an opportunity for the project team to expand partnerships and develop further collaboration with similar initiatives working on natural capital.

5.5 Policy intake

5.5.1 At the provincial level

At the provincial level, the project has support from the Department of Natural Resources and Environment and the Ca Mau National Park to mainstream ecosystem services into land use planning of the Ca Mau National Park through the application of supporting tools (i.e. mapping tool and valuation tools) to assess how development processes impact mangrove ESs. The project organized policy dialogues and consultation workshops to raise awareness for policymakers on the importance of ESs and identify the entry points for mainstreaming of ESs in to development processes. Land use planning (LUP) for Ca Mau National Park was identified as an appropriate entry point and received agreement among the relevant agencies. Mapping tools were applied to the mainstreaming of ESs while developing the LUP – see Figure 5.3 and Figure 5.4. The Peer Review team, with reviewers from DARD, DONRE, DPI, and the Ca Mau national Park, participated in the review processes of LUP before submitting to the Provincial People Committee for approval.

Figure 5.3: Total carbon storage in 2005 and 2010

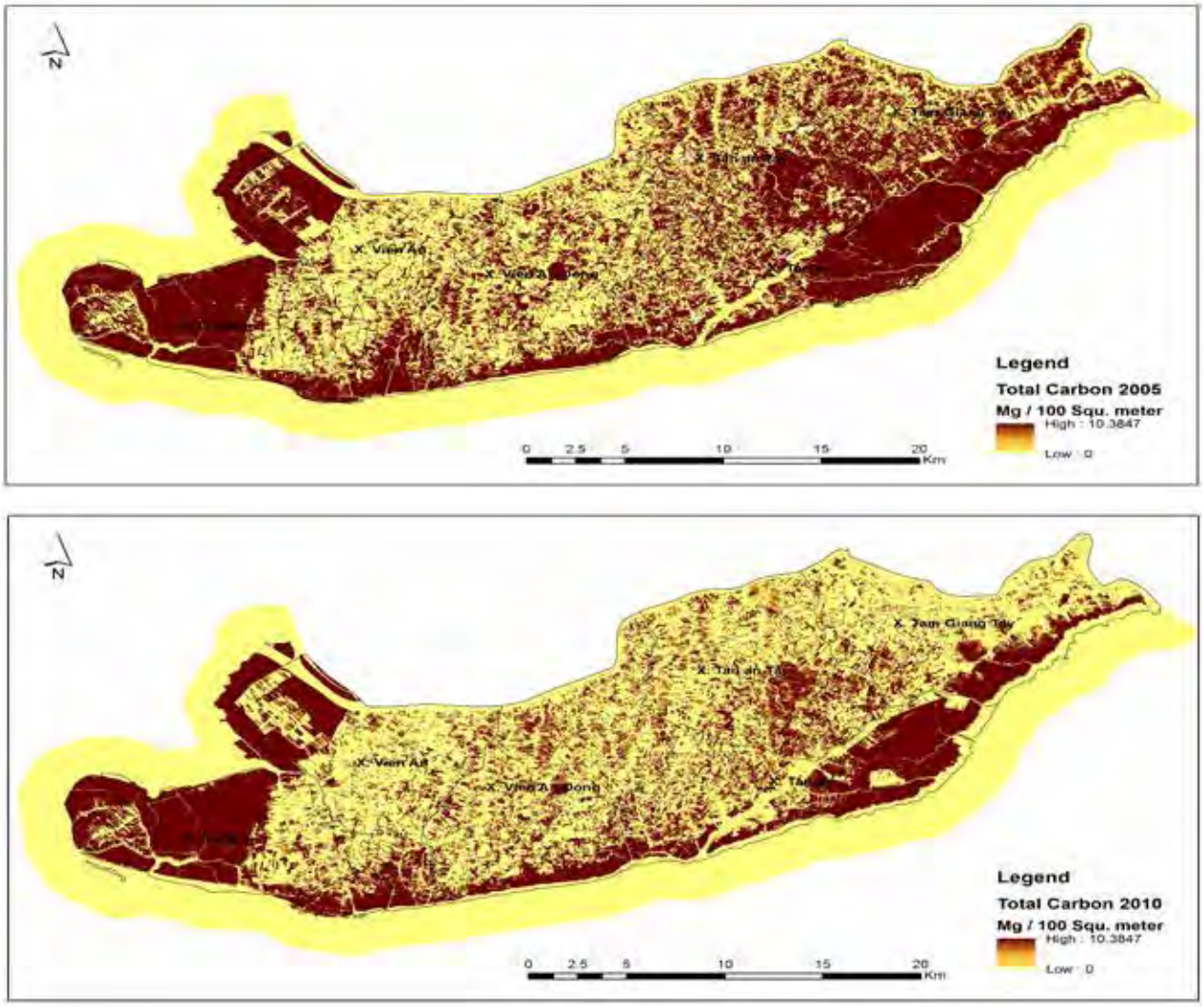
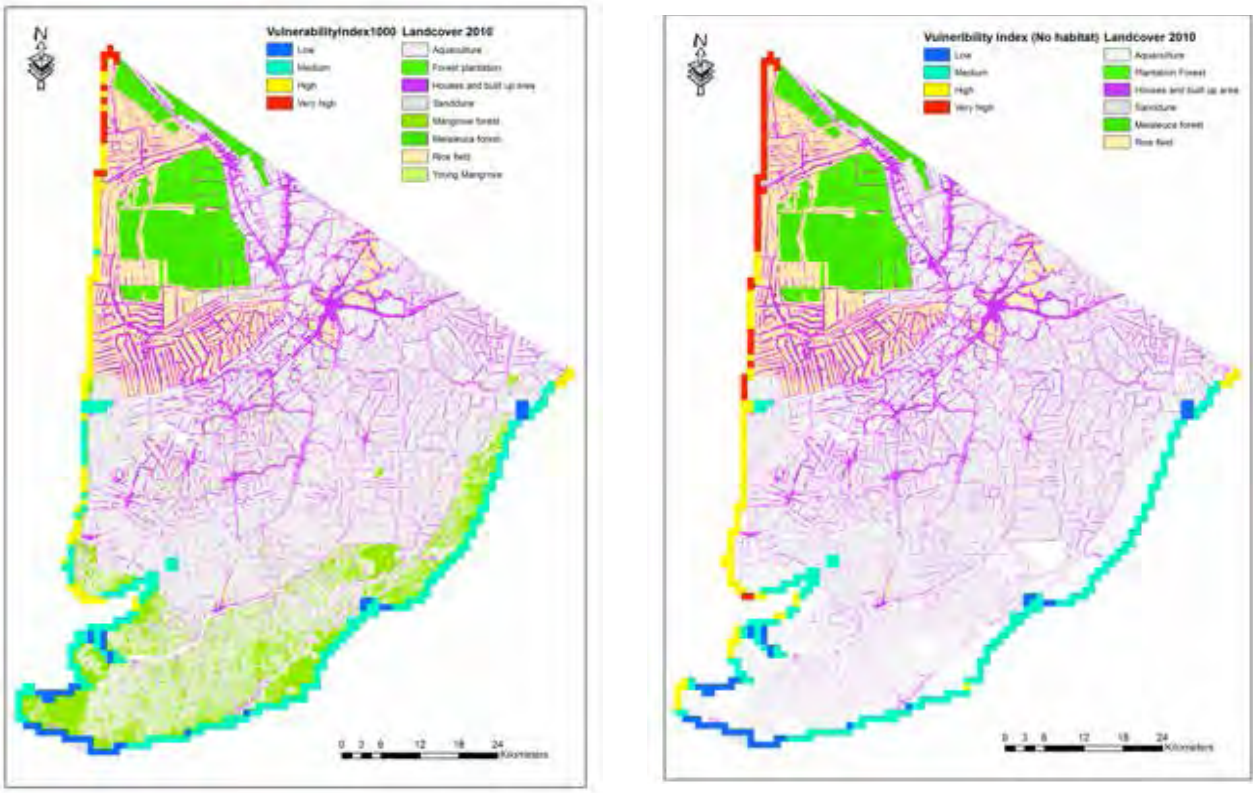


Figure 5.4: Vulnerability index in the coastal area with presence of mangrove and without mangrove



Moreover, ProEcoServ was among a range of investments focused on mangrove forests including (1) project on restoration of mangrove forests through sustainable shrimp farming and emission reduction in Ca Mau (Project MAM); (2) Program UN-REDD Phase II, which plans to reduce greenhouse gas emissions by 20 per cent from agriculture and rural development sector of Viet Nam in 2020; (3) project on mainstreaming adaptation to climate change into coastal areas management plans of Ca Mau carried out by GIZ; and (4) enhancing forest carbon stocks under the mechanism of reducing emissions from deforestation and forest degradation through Project ENRICH, among many other initiatives. It was indicated that interest in acknowledging the value of ecosystems and their services was rising and various international and national entities were coming to collaborate in pushing forward this critical agenda.

5.5.2 At the national policy level

Natural capital in general and ecosystem services in particular have been well recognized under three national legislations of Viet Nam, namely, Party Resolution no. 24-NQ/TW, responding to Climate Change, natural resources management and environmental protection, the National Green Growth Strategy to 2020, with a vision to 2050, and the National Strategy for Environmental Protection to 2020, with a vision to 2030. Party Resolution no. 24-NQ/TW was led by the Ministry of Natural Resources and Environment (MONRE) and ISPONRE is assigned as the lead agency to support MONRE in developing the Party Resolution – see Figure 5.5 and Box 5.3.

Moreover, at the regional level the project team has participated in contributing to the Greater Mekong Sub-region Ministerial Joint Statement for Promoting Investment on Natural Capital, which was approved at the GMS Ministerial meeting on January 2015 in Nay Pyi Taw, Myanmar. The statement has highlighted the importance of strengthening partnerships on natural capital and strengthening the collaboration among GMS countries to enhance investment on natural capital. The commitment to promoting regional collaboration to invest in natural capital has been reflected in the Joint Ministerial Statement. This provided a great foundation to promote regional collaboration in the area, bringing forward key insights of ProEcoServ to the Greater Mekong Sub-region.

Figure 5.5: National Strategy for Environmental Protection to 2020

5.5.3 Conclusive notes

Inclusion of the ecosystem services narrative into national discourse is crucial for promoting investment in natural capital and providing a legislative framework for sustainable use of natural capital and ecosystem services. The work ProEcoServ-VT's team played a crucial role in this domain. In addition, ProEcoServ-VT's team contributed in mainstreaming of ecosystem services in policy at the more local, provincial level, with particular attention to the mangrove ecosystem and the Ca Mau National Park. In addition, ProEcoServ contributed significantly to awareness-raising for policymakers on the economic value of ecosystem services and the importance in bringing this information to spatial planning. Furthermore, ProEcoServ contributed with the provision of technical capacity to ensure adequate application of the tools for planning processes, including in Cau Mau. Finally, ProEcoServ facilitated the participation of national and provincial government stakeholders in building partnerships, both at national and international scales (including WAVES), and this way contributed to enhance the awareness of the natural capital and ecosystem services in country as well as the technical capacity in the area of economic valuation of ecosystem services for policy and spatial planning.

Overall, the ProEcoServ-VT has brought positive impacts to mainstream natural capital/ecosystem services to policies at regional, national and provincial levels though mainstreaming of ESs at these levels. Ecosystem services have been successfully mainstreamed into land use planning of Ca Mau National Park which will contribute to conserve the important mangrove ecosystem in Ca Mau.

Box 5.3: Mainstreaming of natural capital into key national legislation

Guiding Principles in Party Resolution no. 24-NQ/TW
This Party Resolution identified under its guiding principles that "natural resources are the national assets, resources and important natural capital for country development. Therefore, natural resources need to be fully assessed, prized and accounted for in the national economy". The Resolution is an important key document to guide different line ministries/sectors for inclusion of natural capital/ecosystem services into their planning processes. Therefore, natural capital – including natural resource and ecosystem services - need to be fully assessed, and accounted for in the national economy. ISPONRE is assigned as the lead agency to support the Ministry MONRE in this mission, and ProEcoServ contributed to this goal with piloting valuation work in Ca Mau.

National Green Growth Strategy in the period 2011 – 2020
This strategy plans to achieve a low carbon economy and to enrich natural capital and will become the principal direction in sustainable economic development for the country. This strategy brings along with it the implementation of four main activities, which are directly fed by ProEcoServ piloting work. These include: (1) studying and issuing economic and financial policies for restoring and developing natural capital resources; (2) mobilizing and encouraging all economic sectors to invest in ecological services infrastructure, conservation areas and restoration of degraded ecological systems; (3) formulating the green accounting system through valuating natural resources, and (4) restoration and development of natural capital.

National Strategy for Environmental Protection to 2020
This strategy plans to achieve the objectives of rehabilitating and regenerating degraded natural ecosystems, especially coastal mangrove ecosystems. This strategy includes working activities such as (1) investigating and conducting assessments to identify the degradation and shrinkage of natural ecosystems in order to develop relevant plans for rehabilitating typical and representative natural ecosystems, especially coastal mangrove ecosystems; and (2) increasing the degree of rehabilitation of natural ecosystems to strengthen their resilience to climate change-related impacts, and in the development of relevant mechanisms for payment for ecosystem services toward natural ecosystem rehabilitation, regeneration and conservation. ProEcoServ piloting work in Cau Mau is contributing to these activities.

Source: Party Resolution no. 24-NQ/TW, National Green Growth in the period 2011 – 2020, National Strategy for Environmental Protection to 2020

The Project for Ecosystem Services (ProEcoServ) is UNEP's flagship project focused on the valuation and mainstreaming of ecosystem services into policy design within the larger ambit of sustainable development. Implemented in Chile, South Africa, Trinidad and Tobago and Viet Nam over four years, ProEcoServ has facilitated policymakers in the four pilot countries to access scientific information on how ecosystem services impact human welfare and economies. This report summarizes and highlights the key findings and decision makers' uptake process of ecosystem assessment tools developed throughout the implementation of ProEcoServ.

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