

TITLE: LAND USE MANAGEMENT IN GALAPAGOS: A PRELIMINARY STUDY ON REDUCING THE IMPACTS OF INVASIVE PLANT SPECIES THROUGH SUSTAINABLE AGRICULTURE AND PAYMENT FOR ECOSYSTEM SERVICES

SHORT TITLE: MANAGING INVASIVE PLANT SPECIES IN GALAPAGOS

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Abstract:

Terrestrial invasive species have been identified as one of the largest threats to endemic plants and wildlife in Galapagos and their spread remains one of the biggest challenges for the region. The management of these species is a common link among all land use activities and their spread impacts all residents as economic activities in Galapagos are linked to its status as a unique landscape. The study explores the management/control of plant invasive species through the potential of sustainable agricultural production and Payment for Ecosystem Services (PES), currently being proposed/implemented in the region. It aims - through the use of key informant interviews, policy documents and literature to provide new insights into the challenges and opportunities of invasive species management through these interventions, and how they can create bridges and be beneficial to both conservation *and* development. The study finds that, whilst the initiatives offer real opportunities to manage/control invasive species, challenges remain in the form of how these activities will be carried out and by whom. Findings show that probable success is dependent on community inclusion with coordinated and integrated approaches from robust Institutions, which focus on connectivity among land use actors/managers. In addition, support is needed for organisations and stakeholders that are currently tackling the invasive species issue. Studies on land use remain crucial as relatively contained and pristine landscapes such as Galapagos are likely to be increasingly important as a means to detect human-induced alterations and to test the impacts at the frontiers of ecology.

Key words: Sustainable Agriculture, Invasive Species, Land Use Change, PES, Galapagos

1. Introduction

The Galapagos archipelago contains some of the least degraded islands world-wide, with 97% of its unique species still present, due to late colonisation of the islands and its protection as a national park (Bensted-Smith et al. 2002). However, development in the archipelago has turned unsustainable - despite conservation efforts by the Ecuadorian government (González et al. 2008) - due to anthropogenic pressure mostly related to tourism, population growth, increasing demand for goods and services, and the spread of invasive species. In this context, the increasing array of invasive alien species has been recognised as the single largest threat to Galapagos biodiversity in the short term (Snell et al. 2002, Trueman et al. 2014), as well as to its long-term development objectives, as the region relies heavily on its status as a place with unique species and landscapes to attract tourism, the main economic activity in the islands (Epler 2007).

Terrestrial invasive plant species – the focus of this study- can adversely affect natural ecosystems by altering both the diversity and abundance of species (Trueman et al. 2010). They can alter ecosystem conditions, such as the intensity of wildfires (D’Antonio et al. 2011) and the soil chemistry which in turn will affect water and nutrient cycling (Vitousek 2004). The spread of invasive species not only impacts the environment but also affects a wide range of diverse sectors. In 2005, the global economic cost of invasive species, including human health and safety, was estimated at over \$1.4 trillion annually, which represents 5% of the global economy (Pyšek & Richardson 2010, Pimental 2011). The study thus proposes their management and control should be viewed beneficial to both conservation *and* development. It aims to provide new insights into plant invasive species management by exploring two land use interventions - and the associated challenges and opportunities – currently being proposed by policymakers, academics and other relevant actors in Galapagos. These are 1) local sustainable agricultural production and 2) policies and mechanisms, such as ‘Buen vivir’ (an indigenous concept which emphasises harmony between humans and nature and a sense of collective, and exemplifies Ecuadorian (and Bolivian) development paradigm) with/and Payments for Ecosystem Services (PES), the incentives landowners/farmers receive for the protection of Ecosystem Services (ES), and where ES are the benefits humans derive from ecosystems e.g water, food, recreation (MEA, 2005).

Studies have been carried out that quantify the impacts of some of the most invasive plants in Galapagos, like blackberry (*Rubus niveus*) and the quinine tree (*Cinchona pubescens*), which are replacing native vegetation and are transforming ecosystems (Renteria et al. 2012, Jaeger et al. 2007). Many invasive plant species spread rapidly and are difficult to eradicate once they are established and cover more than 1 ha (Rejmánek & Pitcairn 2002), resulting in changes in ecosystem functions, including the alteration of physical conditions which can act as irreversible

barriers to restoration (Jäger & Kowarik 2010, Gardner et al. 2013). A few examples of the environmental impacts caused by quinine (*Cinchona pubescens*) and blackberry (*Rubus niveus*) are 1) changes in species composition and community structure, 2) changes in microclimate regimes (light, humidity, precipitation, etc.), 3) changes in nutrient cycling (increase in nitrogen and/or phosphorus), in combination with a faster decomposition of the leaves (Renteria et al. 2012, Jäger 2015). Many of the invasive plant species were introduced in the agricultural zones of the larger islands and have spread from there into the humid highlands of the Galapagos National Park - in the past 30-50 years - where conditions are more favourable than in the drier lowlands.

There is a dearth in studies that address the broader societal impacts of invasive species e.g. they can reduce recreational opportunities, land values and land/water utilisation as well as shrink productivity in the forestry, agricultural, and fishing sectors (Charles & Dukes 2007). One such study by Garcia- Llorente et al. (2008) highlights, that the understanding of the human dimension of invasive species management is critical to effectively tackle the problems associated with their spread. The authors found that different stakeholders had remarkably different perceptions about the impacts and benefits caused by invasive species, and different attitudes toward their introduction or eradication. They suggest that these views should be considered in any decision-making process to facilitate the successful management of invasive species.

The ES approach provides a powerful way of examining the interaction between ecosystems and human well-being. The Millennium Ecosystem Assessment (MEA 2005) has classified a number of ES, namely cultural, provisioning, regulatory, and support services. The scale of ES losses due to habitat destruction and degradation has prompted growing interest in PES schemes to incentivise widespread conservation measures (Wunder 2007). PES schemes involve the transfer of resources between social actors to create incentives that align individual and collective natural resource management decisions with the social interest (Muradian et al. 2010). Increasing awareness of these types of issues have also highlighted how seemingly ‘outside’ factors can fundamentally shape PES function (Freiss et al. 2015). In particular, biophysical stressors that are external to PES sites, such as forest fires, pollution, sea level rise, and invasive species can deeply affect ecosystem stability and service provision (e.g. Funk et al. 2014, Khatun et al. 2015, 2016). Thus, there is a clear need to include the external physical and ecological factors that can also shape sustainable, long-term ES provision through PES.

There is a growing literature that argues for including invasive species in PES schemes (Charles & Dukes 2007, Evinar et al., 2012, Naeem et al., 2014), due to their multifaceted impacts. These

have highlighted the effects of invasive species on biodiversity, ecosystem processes and services, yet the links between these and PES are largely lacking in literature. Charles & Dukes (2007) state that the assessments of the economic impacts of invasive species cover costs beyond those associated with ES (e.g., control costs), and generally do not differentiate by ES type. Studies of the application of PES in Galapagos are non-existent; as are studies on the socio-economic impacts of invasive species, but remain crucial as such relatively contained and pristine landscapes are likely to be increasingly important as a means to detect human-induced alterations and to test hypotheses at the frontiers of ecology.

2. Background:

2.1 Geographical location of the study

The Galapagos archipelago is located about 1000 km off the Ecuadorian coast, straddling the Ecuador. It was declared a World Heritage Site by the UNESCO in 1978, with 2015 marking the 180th anniversary of Charles Darwin's visit to Galápagos on the HMS Beagle in 1835 (UNESCO 2016). The Islands are known for their unique marine and terrestrial species, many of which are endemic. 97% of the terrestrial archipelago is protected as a national park and the remaining 3% used for human settlements and agriculture, see figure 1. It includes the marine areas as well as all the un-inhabited islands.

INSERT FIGURE 1

The archipelago was un-inhabited by humans for most of its history (discovered in 1535), it became permanently inhabited in 1832, followed by 140 years of colonization (Toral-Granda et al, 2017). Five of the islands are currently inhabited; Santa Cruz, San Cristóbal, Isabela, Floreana (as circled in figure) and Baltra¹. The agricultural area is located in the highlands of the inhabited islands ((Trueman et al. 2010). In Santa Cruz and San Cristóbal, the islands with the largest populations, as much as 100 and 76%, respectively, of the very humid zone and 94 and 88%, respectively, of the humid zone have been transformed (Watson et al. 2010). The population has continued to rise, and the National Institute of Statistics and Census (INEC- Spanish acronym) in 2015 report that the islands are home to approximately to 25,244² citizens- see table 1. The main economic activity and employment opportunities for local residents lie in tourism, contributing to heightened interactions between people and the ecosystems. Galapagos

¹ Baltra is mainly used for airport and transport activities. No date available for population

²The total population of Galapagos probably exceeds the official count if temporary and illegal residents are included in the tally, but there is no official data to date.

tourism generates \$418 million annually, of which an estimated \$63 million enters the local economy (equal to 51% of the Galapagos economy). The fisheries sector is 1.6 % of the economy and agriculture is known to be low, but no reliable data is available (Epler 2007).

2.2. Invasive species and their management in Galapagos

Introduction of a plant species is defined when “the plant (or its propagule) has been transported by humans across a geographical barrier. Naturalisation starts when abiotic and biotic barriers to survival are surmounted and when various barriers to regular reproduction are overcome and invasion species as “Alien naturalised plants that produce reproductive offspring, often in very large numbers, at considerable distances from parent plants and thus have the potential to spread over a considerable area” (Richardson et al. 2000). Of the approximate 1400 species in the Galapagos flora, approximately 870 are introduced (Trueman et al. 2010). Despite the significant efforts and resources that have been invested to improve the inspection and quarantine systems, introduced plant species have also increased and now clearly outnumber the native flora (Trueman et al. 2010).

Invasive species management scenarios range from total eradication of introduced plants (invasive or not) to implement measures to control their spread (Gherardi & Angiolini 2004). Apart from the most invasive plant species on Santa Cruz, exact distributions are not known (Trueman et al. 2014). Table 1 illustrates the estimated hectares of invasive species for Santa Cruz San Cristobal, Isabela along with their respective populations, the amount of protected area, agricultural land and size of the three main inhabited islands³. Figure 2 shows the total number of recorded species (including species beyond plant species) per island categorised per naturalisation status

INSERT TABLE 1.

INSERT FIGURE 2

Many of the invasive plant species in Galapagos e.g blackberry (*Rubus niveus*), quinine tree (*Cinchona pubescens* guava (*Psidium guajava*), and cedrela (*Cedrela odorata*), are already so widespread that eradication seems unlikely. Continuous work is required for maintenance, particularly for species that resprout vigorously after control or regenerate from the seed bank, (Buddenhagen et al. 2004, 2005, Jäger & Kowarik 2010). Moreover, control actions themselves

can have negative impacts on the environment and resident species ((e.g. Hoddle et al.2004). Manual control often involves the upheaval of soil which can facilitate the establishment of the same or other introduced species (Jäger & Kowarik 2010) and chemical control in form of herbicide application can affect the resident flora and fauna. The successful biological control of the cottony cushion scale (*Icerya purchasi*) by the introduced Australia ladybug (*Rodolia cardinalis*) in Galapagos, gives way to the hope that other invasive species, could be controlled by means of biological control; methods that are less harmful for the environment.

Inspection and Quarantine was initiated in 1999 and carried out by The Quarantine Inspection System for Galapagos (SICGAL) to reduce the potential for new introductions of exotic species (Epler 2007), with some of the responsibilities currently being undertaken by the Agencia de Regulación y Control de la Bioseguridad y Cuarentena para Galápagos (ABG). In addition, there is the Consejo de Gobierno de Régimen Especial Galápagos (CGREG), which is responsible for the overall management of the inhabited areas of Galapagos. This includes the administration, planning, and zoning, as well as the management of resources, research and organising activities aimed at local development under the new Ley Orgánica de Régimen Especial de la Provincia de Galápagos, LOREG (CGREG, 2015). Invasive species are being managed per jurisdiction, through the Galapagos National Park Directorate GNPD in the protected areas and with ABG and the 'Ministerio de Agricultura, Ganadería, Acuacultura y Pesca' (MAGAP), with all having overlapping responsibilities in some rural areas.

3. Methodology

The study, through the application of qualitative semi- structured in-depth interviews provides preliminary data and analysis on understanding of how land use management decisions and their impacts are perceived and understood by key- informant interviewees. The broad aim of these interviews was to collect information from a wide range of people, who have first - hand knowledge about land use issues specific to Galapagos and can provide insights on the nature of problems and offer recommendations for solutions. The respondents were identified through snowball sampling among the organisations and agencies involved in land use activities at regional level, including governmental institutions as well as civil society organisations. The interviewees were either involved directly in the formation of policy, had a 'stake' in land use management decisions in Galapagos, or were involved in the study and/or management of invasive species. They include people who had participated in the development of land use activities e.g. PES, sustainable agriculture and invasive species management.

Twenty-three⁴ in-depth interviews were carried out with government officials, scientists, consultants, NGO employees, people involved in the farming sector, and community development representatives (for community members and farmer groups). Informants were asked open-ended questions through a pre-prepared questionnaire, arranged for the purpose of minimising variation in the questions posed. Probing follow - up questions were asked, wherever it was deemed useful by the researcher. The interviews were approximately 2 hours, and were carried out over two stages in 2015, with the second phase covering the development of land use policy, and territorial planning covered in the LOREG approved in December 2015. Responses were categorised based on the themes that will be discussed in the following sections of the paper. The interviews were carried out in English and Spanish, recorded, and the Spanish subsequently translated to English. Other methods used to understand the different components encompassing land management practices and debates in Galapagos include a review and analysis of technical reports, published literature and existing data (e.g. maps, socio-economic and species abundance/change data) as well as of current and past policies (LOREG 1999, 2015). The policy texts were studied to assess the potential for incorporating PES within local policy and practices, and with themes and solutions identified by the interviews. The study recognises that the development of many of the activities in the land use sector in Galapagos is highly dynamic and evolving, and encourages ongoing research into when, why, and how these priorities and institutions change over time.

4. Results

4.1. Implementing sustainable agricultural for invasive plant species management

Results from this study suggest that the agricultural sector is perceived as both a cause and a potential solution to the problem of plant invasive species. A cause, because many species- were brought in to Galapagos for cultivation, then became invasive over time. The intervention efforts are aimed at minimising further arrivals, and utilising under-used and invaded agricultural land for production, thus agriculture is also proposed as a solution. Local produce grown sustainably will lessen the risk of introducing new species through cargo ships either with arriving goods (insects, protozoa, seeds) or with ballast water (marine invasives). However, the study has identified several obstacles that need to be addressed to enable sustainable agriculture to succeed. On an Island level, food production is difficult due to unreliable water resources, ineffective irrigation systems, rocky soils, and the lack of available labour (source: Interviewee 8, Farmer representative). According to governmental officials interviewed, landowners have only focused

⁴ The number of key informants included is based on the scope and the relatively small population, and thus there are few relevant key informants. Interviewees often moved around agencies and were generally aware of their own activities as well as of other institutions and relevant actors.

on managing the areas that they are able to cultivate and have abandoned the rest. Approximately 11,000 ha on Santa Cruz are designated for agricultural production but are currently underutilised/idle encouraging invasive species growth (source: Interviewee 3, Government official). In addition, the success of the tourism sector means that as island resident, people can gain employment easily, due to lack of workers overall. This in turn, has effects on the productive sectors' (such as agriculture or fisheries) requirement of human capital "*you need one or two people minimum for every four hectares to clean, prepare, and harvest in a farm*" (Interviewee 8, Farmer representative) and "*we have calculated that what we have here is one worker for every thirty-one hectares*" (Interviewee 3, Government official). Altering perception of food production has also been difficult as it must involve the whole community to encourage behaviour change. Community members believe that food products from the mainland are better because they are '*big and clean*'. However, the reality is that such products take several days to arrive, are kept in storage in ships over that time, raising questions on their freshness (source: Interviewees 2 and 4, Consultant and Government official). Moreover, the living standard in Galapagos is high compared to the mainland - as are the associated costs - with local products unable to compete with cheaper prices in the mainland; formal data on this aspect is unavailable and further studies needed. Additional reasons given by government officials for the price discrepancies are the intermediaries, transport subsidies and that there is simply more food produced in the mainland (source: Interviewees 3 and 4, Government officials). Yet, despite these challenges, the discourse in Galapagos has moved from "*agriculture is bad because you are bringing invasive species to agriculture is good because it helps us keep invasive species further from the park*" (Interviewee 4, Government official) as incorporating the vast amounts of under- utilised land for production can contribute to ecosystem preservation by 1) reducing the likelihood of introducing new species from imported goods and 2) acting as buffer zone to the adjacent national park area.

Interviews with government officials reveal that the lack of workers as well as resources and technology are high on their agenda, and are being bought up at all levels of future land use planning. Agriculture is now perceived as a trade-off, rather than in direct competition with tourism in economic and livelihood terms; that incentives for better land use management are required "*It isn't a question of which is going to give you the most money, that is tourism. It is the other question; to what degree do you satisfy internal food demands through internal production?*" (Interviewee 10, Farmer). Eighteen institutes incorporating the agencies governing land use, consultants, scientists and others are in the process of planning and implementing 'the Plan de Bioagricultura'; a conceptual model that includes controlling invasive species, conserving native and endemic species as well as facilitating direct sales from producers to consumers of products. The aim is to quantify both imported and locally grown produce, and subsequently

replace as many of the imports as possible with local production. Promotional activities are carried out at the weekly 'feria libre' as part of a campaign to draw attention to local produce alongside nutritional workshops to better inform consumers. The Campaign also aims to raise awareness among the population about the challenges of farming and encourages support of local farmers. *“[It] is recognising people and people’s feeling of pride... People sympathised with farmers, realised how hard it was, and their daily concerns”* (Interviewee 2, Consultant). Alongside the working quarantine program - which makes it difficult to intentionally bring in new species- the Bio-agriculture Plan aims to contribute to the conservation of the terrestrial ecosystems by restructuring the agro-productive areas to create more favourable conditions for local production. Main threats to food production in Galapagos were identified from focus groups, meetings and stakeholder feedback. For example, many introduced species are already present in Galapagos and are used e.g. for wood – these can be replaced by natives (or introduced species) that are non-invasive⁵. This end goal will potentially secure a reliable and sustainable food supply, which will need to be cost effective, to reduce reliance on the mainland and can complement the PES approach discussed below.

4.2. Payments and Ecosystem Services (PES) and Buen Vivir: Potential and synergies for invasive plant species management

The Ecuadorian government is implementing a set of paradigms changes, such as the indigenous Quechua concept of Sumak Kawsay (Buen Vivir) into the country’s development plan. Buen Vivir lists the following as explicit policy objectives among the government’s commitments and development priorities to “better the quality of life of the population: develop their capacities and potential; rely on an economic system that promotes equality through social and territorial redistribution of the benefits of development” (Asamblea Nacional 2008). In Chapter 3, Article 281 of the Ecuadorean Constitution, food sovereignty is considered an integral part of national security and is a priority for the country development strategy and is listed as a specific objective of the government. (Asamblea Nacional 2008). Moreover, Buen Vivir focuses on decentraliation, participation and encourages the establishment of a social economic system based on community, solidarity and sustainability, with a harmonious coexistence with nature; many of which correspond with safeguards under PES schemes and can thus work synergistically in Galapagos.

There is currently a zoning process underway led by the GNPD based on socio-ecological and the agro-ecological criteria, where ecosystems and the characteristics of ES are in the preliminary stages of identification and categoriation. Alongside sustainable agriculture, there is a view to

⁵ Included from reviewer 2 comment

implementing PES within and beyond the national park areas. According to an interviewee from the GNPD, ES benefits and implementation will be managed by each canton, and the community will receive monies from the initiative. Initial discussions carried out by the GNPD through focus groups found some people initially opposed to the PES idea, but ended with a consensus that PES provides a common currency, once concerns were better understood regarding how natural resources can be collectively shared and managed through compromise among local stakeholders (source: Interviewee 11, Government official). Several key informants admitted that conservation actions and policies are unpopular in the archipelago and it is generally difficult to get the public on board “*they don't want policies that affect their pocket*” (Interviewee 12, Government official). However, Government officials interviewed for this study see PES as a way to provide opportunities for economic incentives and social engagement, where, if people benefit from ES, they may see value in conservation “*The amount of money created in Galapagos has not been reinvested here...If you want sustainability you have to invest in the people*” (Interviewee 1, Government official). A farmer suggested that ES can be sold to the tourism sector (airlines and boats) and achieve possible carbon neutrality through offsets under reforestation schemes in the highlands. The cost for cleaning invaded lands, ranges from \$3000 to \$5000 overall per hectare for the farmer in question. This is in accordance with numbers by Buddenhagen & Yanez, (2005) where the costs for managing invasive species e.g. quinine in one hectare of land in Galapagos depends on the species and the method used and can be up to \$2225. Usually the land owner or institution in charge pays for the control actions. In the park area, it is the government or external organisations, e.g. tourist operators or governments of other countries (e.g. Japan). The biggest problem is funding, coming in ‘pulses’ with no money available for the follow-up work, or it takes a long time for money needed to be released (Source: Interviewee 18, Scientist).

The exploitation of ES is limited, where no detailed quantification or valorisation has yet to be carried out. As with the agricultural sector, there is a shortage of qualified people to carry out these activities. Moreover, for PES to succeed, robust institutions involved in the various aspects of land use will need to co-ordinate actions. The findings show that there are challenges in involving the many institutions in Galapagos. There were differing opinions among interviewees on who has ‘*the most power*’. Some state that there are problems with the individual mandates of the different institutions, and that at times there are conflicts. Until recently, there has been a prevailing distrust by local communities of institutions due to a perceived focus on conservation and not development “*Galapagos is always last. In terms of policy there is a big discrepancy between what Galapagos generates, compared to benefits or policy implementation*” (Interviewee 1, Government official). However, there is a consensus among interviewees, including the above quoted, that the model of management is changing, and institutions are now

working with better connectivity, more transparency and improved co-ordination. The new LOREG (2015) supports this, as it includes citizen participation (article 3) due to the recognition that stronger efforts are required to link people's understanding of the importance of conserving Galapagos to their own development and livelihoods. As such; there is a need to show that the impacts of invasive species go beyond the environmental; they are also economical and social in nature with large interdependencies between the land use sectors, community well -being and tourism. A holistic approach that incorporates land use managers, partnered with academic scientists, private landowners, the public sector, and communities to quantify the impact of invasive plants on ES provision is in the process of development in Galapagos and will benefit from future research.

5. Discussion and conclusion

The Galapagos archipelago is one of the better-preserved places in the world, but all evidence suggests, if current trends and practices continue, its unique properties are under threat. Land use is a complex subject and lies at the base of many conflicts in the Islands. According to Ospina (2006), the controversy is situated between an isolated territory (claimed by conservation advocates) and an increasingly open one (demanded by residents and local authorities). The implementation of sustainable agriculture and PES can create bridges between the two territories, with the management of invasive species as an indicator for broader land use planning. In addition, PES creates incentives by transferring resources between actors and as noted earlier, can align natural resource management decisions with social interest (Muradian et al. 2010).

Agriculture is currently playing a minor role in supplying local provisions and a strong dependency on mainland products prevails. This study finds that improving the quality and quantity of local produce could aid in invasive species control and strengthen food security but a realistic approach to helping the agricultural sector/ producers is required in terms of incentives, resources and support in conjunction with re-investment in basic services such as education, water and health. This will require flexibility in implementation of current restrictive labour laws, aid in technology and commercialisation of produce (support price regulation and subsidies and create a market for local produce of high ecological quality), which in turn, will reduce the risk of accidental introduction of new potential pests which – even with the ABG carrying out extensive quarantine work - are brought in with products from the mainland. It is worth noting The Global Invasive Species Programme (GISP 2007), states that the need for a better understanding of the economics of these issues should not delay the development and implementation of strategies to deal with them. Possingham et al. (2001), corroborate the need for strategic restoration as in the long-term, the cost of restoration is hundreds of times greater

than that of protection. In this vein, PES efforts or land use more broadly in Galapagos cannot afford to overlook the external processes that are shaping its ecosystems and their services. Thus, identifying and quantifying ES with the inclusion of the impact of invasive species at landscape level is required. Freiss et al (2015) identify three broad strategies to operationalise such schemes, these are: 1. Define target ES, establishing a baseline of ES supply, and the expected conservation outcomes 2. Identify PES participants, notably service providers and beneficiaries and 3. Design an institutional mechanism whereby ES beneficiaries compensate ES providers. In short, PES can take many forms and involves a combination of positive incentives, policy programs as well as private - led conservation projects (Khatun 2011). It can offer a real opportunity, but current unresolved aspects the form of how these activities are going to be carried out and who will be in charge need to be resolved, with success dependent on community inclusion and effective benefit sharing. A participatory approach, to land use management and planning is required for behaviour change to encourage successful long-term commitment to resource protection, with a broad vision for the future as shown in several studies on PES worldwide (e.g. Nkhata & Mosimane, 2012, Pham et al., 2013, Khatun et al. 2015). These have focused on equitable distribution, participation, benefit sharing and effective land management, which can be utilised for the Galapagos Islands., with the Buen Vivir policy offering a robust and complementary framework to PES.

This study is in line with others (Perrings 2005, Pejchar & Mooney 2009), in corroborating the threat of invasive species to ecosystems and their services as well as to human livelihoods and well-being. Charles & Dukes (2007) note, that despite the challenges in quantifying the impacts of invasive species, it is critical to recognise their widespread influence, on development, ES and society. It is also important to acknowledge current structural and institutional limitations that threaten the potential for a true transition towards sustainability and to identify to what degree Galapagos can maintain its unique ecosystems and still raise the living conditions and satisfy food demands through internal production. In a place where the economic development model shapes ecosystem dynamics, sustainability of the Islands will only be reached through an integrative and inclusive process. There is a clear need in Galapagos to abandon the historical perspective of the separation of humans from nature, which has only exacerbated conflicts between conservation and development objectives. Applying a 'conservation for development' paradigm proposed by Folke (2006), is needed. It simply highlights the need to demonstrate how conservation efforts can aid in the sustainable development of a region. It is essential for a range of stakeholders, as their economic activities are highly dependent on the preservation of the natural system, and therefore conservation of natural capital is not an option, but a requirement; without the conservation elements, profitable sectors such as tourism will in the long term also be impacted (as the biodiversity is what draws people to the region) creating a cycle of unsustainable practices.

Invasive species management thus needs to be related to broader economic debates, where approaching development beyond a sectoral point of view can result in diversification of economic activities, which can, in turn, prevent over-reliance on tourism. Dependence on a single sector as the main driver of growth, can create a risk of the economic system of a region collapsing (e.g. Baumgartner & Hogger 2004, European Central Bank 2015), as it can be impacted by external factors such as markets, national and international economies,

In sum, including the control of invasive species in land use planning can aid in their management, and benefit regional biodiversity, conservation and development (Perrings 2005) and facilitate effectiveness of initiatives such as PES and sustainable agriculture. Ignoring the associated social context and the impacts of invasive species, may lead to expense towards ecosystem preservation being for minimal results. A number of socio-economic and governance factors have been noted to shape PES function, including the contexts within which schemes operate (Karsenty & Ongolo 2011), and Galapagos is no exception. Both PES and Buen Vivir place communities at the centre of ecosystem management activities, in line with studies which state that the failure of top-down conservation approaches is partly due such initiatives being implemented without taking local socio-economic considerations into adequate account (e.g. Sodhi et al. 2011). One of the biggest lessons one can take from Galapagos is that it must be viewed in a holistic and integrated way. Maintaining the uniqueness of the archipelago must extend beyond its geography to connecting local people to their environment, whilst providing support for organisations and actors that are currently tackling the invasive species issue. The archipelago offers an ideal opportunity to develop and implement ideas in practice, with concepts such as the Buen Vivir and PES, which present inspiring frameworks for implementing development policy and practices.

6. Acknowledgement

I would like to thank the many people in Galapagos who assisted and advised on the research. I would especially like to thank Paulina Couenberg and Ana Roussard for their invaluable help and guidance in terms of comments, data and, logistics for the research. I would also like to thank the reviewers for their very helpful comments. This study was carried out with funding by the PROMOTEO project of the Secretariat of Higher Education, Science, Technology and Innovations of Ecuador (SENESCYT). Revisions were completed at the Environmental Change Institute, Oxford University.

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