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DIFFERENCES IN NONMONETARY VALUE OF ECOSYSTEM GOODS AND SERVICES AMONG KALINAGO AND AFRO-CREOLE PEOPLES OF THE COMMONWEALTH OF DOMINICA, WEST INDIES

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ABSTRACT

Through time, interactions between physical and biotic factors contribute to emerging landscape patterns. The dynamics among social and cultural groups influence the human-mediated contribution to this process. This paper explores the cultural, historical, and socioeconomic differences among peoples as it could affect their recognition of the contribution of ecosystem goods and services provided by alternative land covers to the local well-being. Here, we present the results of a field study developed in the Commonwealth of Dominica among the native Kalinago and the Afro-Creole inhabitants. The results suggest that the two groups do not differ in their valuation of specific land covers but differ regarding ecosystem goods and services. Over the course of time, differences in preferences will have implications for the ecological trajectory of the island, according to the respective empowerment of the groups. Differences in the value of these services and their relationships with land covers are discussed based on predominant economic activities and constraints that categorize both groups.
Keywords: Afro-Creole, Dominica, Kalinago, land cover, valuation.

1 INTRODUCTION

Through time, interactions between physical and biotic factors contribute to emerging landscape patterns. The dynamics among social and cultural groups influence the human-mediated contribution to this process [1]. Shifts in power dynamics among groups can precipitate changes to the dominant land use regime, leading to profound changes in land cover, associated biotic processes, and often declines in ecological health [2]. Assigning values to landscapes, documenting their shifts, and problem-solving when losses or conflicts arise are all intrinsically political processes [3]. Locally, these are mediated by implicit social rules, values and dynamics among cultural groups which are difficult for outsiders to discern. Quantified differences in nonmonetary values can be especially useful in understanding the forceful contribution of social dynamics to landscape change over time.

Culturally inherited perceptions of needs and wants differ among human societies and are important drivers for the use and management of natural resources, generating distinct environmental impacts at different temporal and spatial scales [4]. The recognition of the value of ecosystem goods and services to well-being depends largely on the environmental literacy [5] of the involved agents. Over a certain level of literacy, it is expected that most ecosystem functions would be perceived directly or indirectly to benefit humankind [6].

Land use decisions made by individuals and public agencies can have a significant impact on the speed and direction of environmental change. These decisions, particularly in developing countries, may be influenced by causes such as population increase, growing landlessness, inequalities in access to land and the loss of traditional systems of resources management and community control [7]. Land use activities such as agriculture, forestry or industry remove vegetation cover, modify hydrology, and decay soil productivity, thus altering the structure and function of natural systems. In this stressed condition, the capability of ecosystems to maintain a certain flow of goods and services greatly decreases, thus affecting human well-being [8].

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We hypothesize that cultural, historical and socioeconomic differences among peoples could affect their environmental literacy and their recognition of the contribution of ecosystem goods and services provided by alternative land covers to the local well-being. Dominica, a small Eastern Caribbean island containing two different isolated cultural groups, namely, native Kalinago and Afro-Creole, and very diverse natural systems is an ideal place to test this hypothesis. In this paper, we explore the perception of the value of ecosystem goods and services and the importance of different land use alternatives for the well-being of both Kalinago and Afro-Creole, based on a fieldwork performed in 2001.

The paper proceeds as follows. Section 2 provides a brief overview and background of the Commonwealth of Dominica and the Kalinago and Afro-Creole peoples. Section 3 describes the fieldwork methodology, including a brief description of the situation of the addressed ecosystem goods and services in Dominica. Section 4 presents the results of the field study. Section 5 includes a short discussion and conclusions from the study.

2 BACKGROUND

The Commonwealth of Dominica with an extension of 754 km^2 and 71,183 habitants is the most northerly and largest of the Eastern Caribbean's Windward Islands. The island surface is characterized by very rugged and steep terrains covered by the most extensive and finest rainforest in the Caribbean. The rugged topography constitutes a major constraint to the development of human settlements and agriculture because approximately 70% of the island surface is unsuitable due to erosion risk, waterlogging, or poor soil quality. Nevertheless, agriculture is the foremost sector of the economy and deforestation of both public and private land for agricultural expansion and timber harvesting is a crucial problem, resulting in soil erosion and localized shortages of fuel wood, charcoal, poles, and other utility timber [9].

Dominica, like other West Indian islands, was occupied by the Kalinago people – Carib Indians who fiercely opposed European settlements. After initial domination by France, the island was ruled by the British who displaced French Creole timbermen and farmers to the interior and the Caribs to the mountains and the more exposed Atlantic coast. The Carib Territory was officially established in 1903 and included 1480 hectares on the mountainside of the central eastern coast under the authority of the Carib chief. The territory maintains a system of communal land tenure, which had existed since pre-Columbian times and is probably the only substantial remnant of communal land in the region today [10]. The island, like other plantation-based colonial societies, was initially dependent on inexpensive African slave labor, and developed a socioeconomic system which did not end until 1834, when the former slaves were granted their freedom. Since independence in 1978, the large estates outside the Carib Territory have been divided and sold, and the increasing demand for land has resulted in the government distribution of crown lands to farmers. Nevertheless, this allotment has not prevented further encroachment into neighboring forested areas [11]. The lack of well-defined property rights and the fragmentation of the land among the members of a given family unit have generated conditions that make peasants less ready to carry out improvements and undertake investment projects on their farms, resulting in inadequate control of soil erosion and other forms of land degradation [10, 12].

Compared with other Caribbean countries, Dominica still retains much of its traditions, culture, and knowledge, which largely rest with the Carib people who are recognized as a distinct culture that is afforded some protection through the establishment of the Carib Territory and the Carib Council [9]. Although much of the original Carib and the African cultures have not persisted through centuries of European domination, we consider the Commonwealth of Dominica as one country made up of two groups of peoples with different histories, cultural heritages and socioeconomic profiles that could have distinct perceptions of the value of ecosystem goods and services as well as the importance of alternative land uses to their well-being.

3 METHODS AND DESCRIPTION OF ECOSYSTEM GOODS AND SERVICES

Based on focus group meetings with Dominican stakeholders, ten ecosystem services and nine ecosystem goods provided by five alternative land covers – forestlands, croplands, urban, rivers, and the ocean – were selected for the study (Table 1). A short survey explored households' perceptions of the value of alternative land covers and the importance of the addressed ecosystem goods and services to their well-being, using a Likert scale from 1 to 7 (1= least important/valuable and 7 = most important/valuable) similar to the method described by Schaberg *et al*. [13]. In order to identify relationships among land uses, ecosystem services and ecosystem goods that could be useful to explain the responses of Kalinago and Afro-Creole inhabitants, the values obtained in the survey were used to create correlation matrixes that were transformed into distance matrixes and submitted to multidimensional scaling (MDS) analysis [14]. A total of 26 Kalinago and Afro-Creole households were considered in the study.

A synthesis of the state of the ecosystem goods and services considered and their importance for the island's economy was developed based on field observations, focus group meetings, interviews with local stakeholders and published literature. Some relevant issues for each good and service are briefly developed in this section.

3.1 Ecosystem services

3.1.1 Erosion control

Around 37% of Dominica's total land is classified as land with high erosion risk and 20% as moderately high erosion risk. Deforestation for agricultural expansion and the development of coffee and sugarcane estates has resulted in severe erosion. Rapid removal of natural vegetation on both private and public lands for cultures and timber activities has resulted in at least 2% of the total land area of Dominica being disturbed by landslides. The largest recent landslide occurred in the Layou River which affected the Dominica Hydroelectric Expansion and had a significant socioeconomic impact. Other extractive activities such as illegal sand mining alter the nature of the coast and predispose the coastline to erosion from wave action thereby resulting in sedimentation on coral reefs.

Table 1: Ecosystem goods and services considered in the study.

Ecosystem goods	Ecosystem services
Timber products	Erosion control
Nontimber products	Water supply
Fish from the ocean	Water quality
Freshwater resources	Biodiversity
Crops	Clean air
Herbs and medicinal plants	Climate regulation
Hunting of game	Soil fertility
Potable water	Protection against storms and hurricanes
Housing	Appreciation of landscape
	Recreation activities

3.1.2 Water Supply

Dominica has seven major watersheds found mainly in the central region of the island. Almost all of them are located in privately owned lands where there are no effective controls on land use activities. These include the Layou, Roseau, Castle Bruce and Hampstead river basins. Most of the rivers originate on the slopes of the central mountain ranges, whilst a few originate as outcrops of underground springs along low-lying valleys. The largest of the water systems has a supply capacity of over 4.3 million gallons per day (4.3 mgd) for the capital Roseau and its environs. This system serves a population of about 25,000 people. Two other systems have a supply capacity of about 1.4 mgd, whilst the other systems are much smaller and serve communities with populations of usually less than 1000. However, at some periods during the dry season, intermittent shortages can be experienced in a few of the systems. This is associated with the observation that in some streams dry weather flows are estimated to drop as low as 30% of the average wet weather flows. The period from January to June is considered to be the drier half of the year, although this distinction is less pronounced in some years through the interior and the east coast than along the west coast.

3.1.3 Water quality

Fragmentation of natural vegetation and reduction of forest cover generate adverse effects on water quality and quantity. Inappropriate land use activities such as banana culture in stepper slopes have caused soil erosion and silting of rivers and streams. Dominica Water and Sewerage Company (DOWASCO) currently extracts water from about 47 independent river intakes, which are not devoid of high levels of pesticides and fertilizers. Nevertheless, the high levels of private land ownership within catchment areas carries with it serious risks of water supply contamination. The Stewart Hall Water Catchment, which serves the highest number of persons, constitutes the country's only protected forest source as provided for under the 1958 Forest Ordinance. Based on the 1989 Water and Sewage Act, DOWASCO has recommended that all the island's catchment areas be declared 'Water Quality Control Areas'. Water catchment areas (for domestic and hydro uses) located within the boundaries of national parks and forest reserves receive full legal protection and normally remain under natural vegetation cover.

3.1.4 Biodiversity

Dominica exhibits a rich flora classified in 155 families, 672 genera and 1226 species of vascular plants including 11 endemic species such as *Sabinea carinalis*, the national flower of the island. Dominica is host to the most diverse assemblage of wildlife remaining in the smaller Eastern Caribbean islands. All faunal groups are present with birds and bats species being particularly abundant. Two endemic parrot species, the imperial parrot or 'Sisserou' (*Amazona imperialis*) and the red-neck parrot 'Jaco' (*Amazona arausiaca*) are both considered threatened and are specially protected under Dominican law. Fragmentation of natural vegetation and reduction of forest area generate adverse effects on wildlife habitat, and water quality and quantity. Loss of biodiversity and environmental damage are more evident in areas of high concentration of human activity such as estuaries and near shore areas.

3.1.5 Clean air

Dominica's climate is characterized by strong and steady trade winds. These winds blow in a westward direction and their speed is dependent on the season and the altitude. Dominica's air quality is good due to its ventilation conditions and the lack of heavy contaminant industries.

3.1.6 Climate regulation

The mountainous topography of the island allows the existence of microclimates within very short distances. These unique microclimates are extremely sensitive and any change in their conditions

will therefore have an impact upon individual species of flora and fauna. At the same time, variations in distribution, abundance and composition of natural vegetation are likely to result in local change of climatic and hydrological conditions. Reports from Dominica's Forestry Division indicate that the Loubiere River had experienced dead crayfish as a result of increased temperatures owing to the discharge of heated effluents from some manufacturing entities. More drastic global anthropogenic effects have resulted in the rising of the Caribbean Sea level at a rate of 2.5 mm per year, changes in local and regional temperature, alterations of rainfall patterns, and intensification of storm frequency [15].

3.1.7 Soil fertility

Maintenance of productivity on agricultural land is associated with the role of biota in the cycling of nutrients and adequate management practices. Declining soil fertility is associated with decline in soil organic matter, loss of soil structure, lower water infiltration, soil compaction, and increasing erodibility and leaching, leading to a decrease in nutrient holding capacities. In Dominica, external pressures have led to a more intensive transfer of water and nutrients from forest to agricultural plots. During the late 1980s and early 1990s Dominica's natural vegetation was cleared at an increasing rate mainly for banana farming. Much of this land was, however, unsuitable for this purpose. Farming on these steep slopes and the clearance of river buffer belts and windbreaks have caused erosion and nutrient loss through runoff, generating the need for external fertilizer inputs which in some areas are land-based sources of pollution and eutrophication. Banana plants require high humidity and temperature and the soil is rapidly depleted of nutrients such as calcium, iron, magnesium, nitrogen, phosphorus, potassium and zinc. If banana plants are cultivated without rotation, the soil fertility sharply declines after the first 2 years. This is one of the reasons which has pushed companies to continuously expand plantations by deforestation.

3.1.8 Protection against storms and hurricanes

The most common and historically most significant natural hazards in Dominica are tropical storms and hurricanes due to the island's location in the Atlantic hurricane belt. During hurricane David in 1979, three-quarters of the total population was left homeless and the economy was almost destroyed resulting in disastrous social and economic effects. Hurricanes can cause accelerated erosion of coastlines, damaging physical structures that have amenity values such as beaches and reefs, as has been well documented for hurricanes Hugo and Lenny. All agricultural subsectors are potentially vulnerable to hurricanes and tropical storms as well as associated flooding and waterlogging; the dominant crop; banana, being especially sensitive to damage. On the other hand, some studies report that Dominica's forests are relatively resilient if they are maintained undisturbed. Changes in forest structure and species composition increase forest gap sizes, and logging damage contributes to vulnerability by diminishing the forest's capability for windbreak.

3.1.9 Appreciation of landscape

The progressive expansion of the tourism sector in Dominica has been focused on the exploitation of the island's natural beauty. The primary resource base in Dominica is its pristine natural environment. The volcanic landscape with its lush rain forest supports a rich diversity of flora and fauna which are of great interest for tourism activities. The tourism policy of 1988 considers the conservation of the physical environment and animal and plant lives with the objective of obtaining benefits derived from the development of tourism activities. However, over the years fundamental changes in the landscape have occurred as a result of the construction of buildings and roads and urbanization, thus leading to the deterioration of aesthetic values [9].

3.2 Ecosystem goods

3.2.1 Timber products

Forests cover around 65% of the land surface of the island. Dominica's forests are relatively rich in timber and uniform in composition and have a large total utilization volume; gommier (*Dacroydes excelsa*), carapite (*Amanoa caribaea*) and bois cote (*Tapura latifolia*) are the most abundant species and represent over 50% of all trees [16]. Timber resources have been continuously exploited since early Kalinago times for canoe construction and during European domination for wood export without significant impact. During the 20th century, several attempts to develop the industry failed as a result of the high costs associated with timber extraction in a difficult topography [17–19]. Currently, up to 65% of the domestic primary products is generated by small sawyers, who can work in areas that are inaccessible to mechanized operators. Although these exploitations may contribute to land cleaning by illegal tree cutting and charcoal production in some locations, the main problem is associated with the effect of selected timber, which can alter the species composition, affecting the structure and function of forest systems.

3.2.2 Nontimber products

Dominica's rich forests provide its inhabitants with traditionally useful species such as Larouman reed (*Ischinosiphon arouma*), maho bark and boia canon (*Cecropia peltata*) which are used as raw materials for the manufacture of baskets, ropes and canoe equipment by the Kalinago people. Pounded leaves of Nivwage *(Clibadium sylvestre)* are used to poison rocky river pools for fishing, although this practice is disappearing. Some species such as Roucou (*Annato* sp) and Genipa (*Genipa americana*) are still used as a source of dyes.

3.2.3 Fish from the ocean

The island of Dominica has a 153 km coastline that adjoins a 715 km coastal shelf, providing different types of habitat for many different species of fish and crustaceans. Landing reports are estimated to be above 1100 metric tons per year showing capture of lobster, many species of groupers and snappers, squirrel fish, shrimps, goatfish, grunts, many species of wrasse, parrot fish and file fish. Reef fisheries are currently declining in terms of catches and size of individuals, maybe due to the negative impact of land-based sources of pollution, although, on the other hand, other fisheries such as coastal pelagic are showing an increasing trend. Migratory pelagic fisheries have the greatest potential for development although they are constrained by the small size of boats and the lack of navigational aids.

3.2.4 Freshwater resources

Freshwater fisheries of Dominica have not been thoroughly studied; nevertheless, the most abundant species have been identified as *Scydium* spp. and *Eloris pisonis* locally named 'Lòsh', mountain mullet (*Agonostomus monticola*), and striped mullet (*Mugil cephalus*). The majority of freshwater species in Dominica migrate between freshwater and salt water, while some spawn in the sea, e.g. several species of the genus *Centropomus* and the introduced *Oreochromis* sp. The anthropocentric effect on estuaries and wetlands of developments such as the drainage of the Cabrits freshwater wetland for hotel infrastructure has changed the ecology of the area, varying the salinity and affecting nursery and refuge sites for several species. Some introduced species such as *Tilapia mossambrica* occur in the Freshwater Lake while *T. nilotica* and *T. aurea* are reared in ponds and on aquaculture farms.

3.2.5 Crops

Agricultural output averaged 19.8% per annum of Dominica's GDP. The history of Dominican agriculture has been one of dependence on single crops. The first was coffee during the 17th and early

18th centuries Sugar increased in prominence toward the end of the 18th and 19th centuries. After the abolition of slavery, cocoa and lime were the most important crops and by 1920 the island became the world's largest producer of lime, but changes in the market forces caused a slump in the industry. Since 1950, banana production has been the main economic activity on the island although it has been decreasing since the early 1990s due to crop diversification efforts.

3.2.6 Herbs and medicinal plants

Attempts to harness the knowledge about medicinal plants have been made by nongovernment organizations such as the Movement for Cultural Awareness and the Small Projects Assistance Team. A total of 62 plants found in Dominica have been identified as a source of traditional medicines, among them Palmiste (*Enterpe dominicana*), Bwa Bande (*Richeria grandis*), Okra (*Abelmoschus esculentus*), Turnip (*Brassica rapa*), and Thyme (*Thymus vulgaris*) are the more commonly used species. There is no information available on the extent of overexploitation of these plants and their relative abundance [20].

3.2.7 Hunting of game

The Forestry and Wildlife Act (1976) specifies seasons for hunting and fishing, both of which usually last 6 months. Legislation is inadequate and fines and fees are low. Little is known about exploitation levels. The current socioeconomic situation has resulted in increased exploitation of wildlife resources such as agouti, iguana and mountain chicken frog (*Leptodactyllus fallax*), although this latter species is protected by law [9].

3.2.8 Potable water

In Dominica the major competing uses of water are for agriculture, industry and domestic supply. In this regard, the main users of Dominica's abundant water resources include DOWASCO for supplying potable domestic and export water supply and the Dominica Electricity Services (DOMLEC) for hydropower generation. The drinking water supplied to domestic, commercial and industrial users are given priority over all others in catchments where competing demands exist. Around 77.5% of households have direct access to piped water supply from the national system although some Carib Territory areas depend on other sources.

3.2.9 Housing

The island's rugged topography represents a major constraint to the development of human settlements due to the little flat land available. Most existing communities have no room for expansion except on hillsides. As a consequence, conversion of agricultural land to housing has increased in the last 50 years. Portsmouth is the only major settlement with a substantial amount of reasonably flat land available for expansion. The Roseau area is under strong development pressure and is expanding in a lineal pattern along the coastline and on scarce pockets of flat land on hilly areas around the city. Increased urbanization has witnessed a change in the composition and volume of solid and liquid wastes with negative impacts on the natural environment. Modern waste collection, treatment and disposal systems are being established but have not yet significantly reduced the impact of human waste especially in coastal areas.

4 RESULTS

The results of the field study did not show statistically significant differences in the value of alternative land covers – forestland, cropland, urban, ocean and rivers – to the Kalinago or Afro Creole inhabitants of the Commonwealth of Dominica, nor differences in the value of each land use between both groups (Table 2).

Table 2: Kalinago and Afro-Creole Likert scale values per land cover type.

	Kalinago Mean ± SD	Afro-Creole Mean ± SD	Level of significance p
Forestland	6.2 ± 1.78	6 ± 0.81	0.28
Cropland	6.4 ± 0.89	6.25 ± 0.95	0.78
Urban land	4.2 ± 3.03	5.25 ± 1.70	0.7
Ocean	5.4 ± 2.60	6.75 ± 0.5	0.46
Rivers	5.8 ± 2.68	4.25 ± 2.75	0.22

Table 3: Kalinago and Afro-Creole Likert scale values per ecosystem service.

	Kalinago		Afro-Creole		Level of
	Mean	SD	Mean	SD	significance p
Erosion control	5.2	± 2.68	6.25	± 0.95	0.78
Water quality	7	0	7	0	
Biodiversity	5.8	± 2.16	5.75	± 1.25	0.51
Clean air	5.6	± 2.60	4.5	1	0.12
Water supply	6.6	± 0.89	4.25	± 1.70	**0.02**
Climate regulation	5.4	± 1.81	3.75	± 1.5	0.17
Soil fertility	7	0	5.5	± 1.29	**0.02**
Protection against hurricanes	4.4	± 3.13	1	0	**0.07**
Appreciation of landscape	6.6	± 0.54	4.5	± 2.38	0.15
Recreation activity	3	± 2	4.75	± 1.70	0.25

Nevertheless, the study revealed differences in the valuation of different ecosystem services by Kalinago and Afro-Creole groups. Among the Kalinago, the value for water quality and soil fertility is statistically higher than the value for recreation ($p < 0.05$), while among the Afro-Creole, the values for the services of erosion control, water quality, biodiversity and soil fertility are statistically higher than the service of protection against storms and hurricanes ($p < 0.01$). The result of comparing the value of each ecosystem service between the two groups shows that the Kalinago assign statistically higher values to water supply ($p < 0.02$), soil fertility ($p < 0.02$), and protection against storms and hurricanes ($p < 0.07$) (values in bold in Table 3).

Regarding the value for the different ecosystem goods, the data analysis did not evince significant differences among the Kalinago, but some differences are significant among the Afro-Creole group. Fish from the ocean, fresh water resources, crops and potable water exhibit higher values than hunting of game ($p < 0.01$ in all the cases). Between-groups comparison shows differences in the value of ecosystem goods. Thus, the value assigned by the Kalinago to hunting of game is statistically higher than that assigned by the Afro-Creole group ($p < 0.08$), and the value assigned by the Afro-Creole to fish from the ocean is higher than that assigned by the Kalinago group (values in bold in Table 4).

For the Kalinago, the MDS analysis of land covers and ecosystem goods shows three clusters: (i) forest and cropland; (ii) timber, herbs and hunting; (iii) ocean, rivers and freshwater resources (Fig. 1). The same analysis for land covers and ecosystem services shows three clusters: (i) forest, climate regulation, biodiversity, water supply and cropland; (ii) oceans and rivers; (iii) appreciation

Table 4: Kalinago and Afro-Creole Likert scale values per ecosystem good.

	Kalinago		Afro-Creole		Level of
	Mean	SD	Mean	SD	significance p
Timber products	4	± 2.54	5	± 1.8	0.53
Nontimber products	4.8	± 2.68	4.5	± 1.29	0.61
Fish from the ocean	4.2	± 2.94	7	0	**0.03**
Fresh water resources	6.2	± 1.78	5.75	± 2.5	0.73
Crops	6.8	± 0.44	6.25	± 1.5	0.73
Herbs and other medicinal plants	5.4	± 2.60	4.5	± 2.08	0.44
Hunting of game	3	± 2.54	1	0	**0.08**
Potable water	3.6	± 3.13	5	± 2.82	0.60
Housing	7	0	6.5	1	0.26

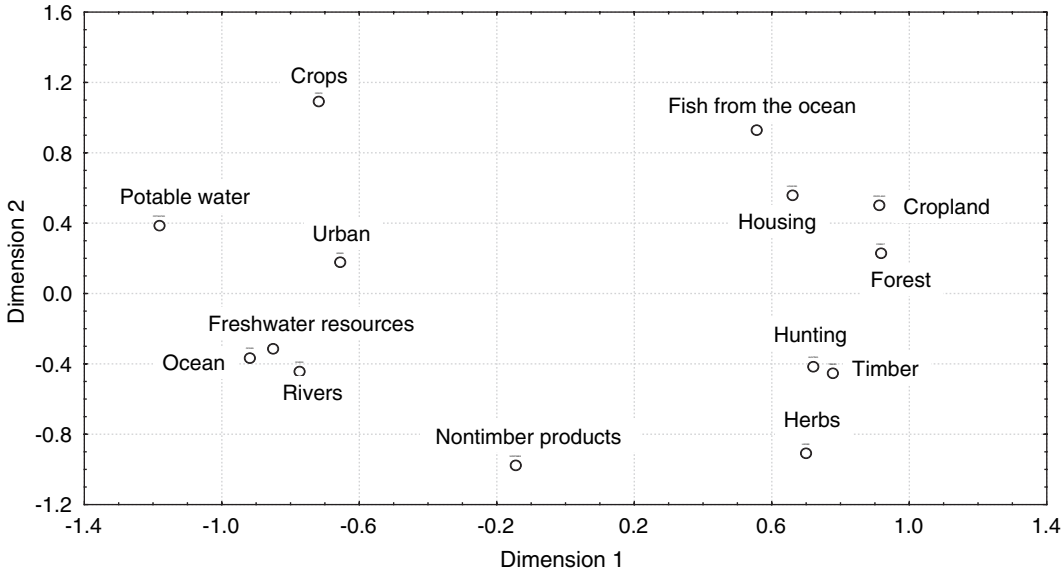

Figure 1: MDS analysis for the Kalinago regarding land covers and ecosystem goods.

of landscape and protection against storms and hurricanes (Fig. 2). Finally, the MDS analysis for ecosystem goods and services shows associations between (i) biodiversity, water supply and climate regulation and (ii) crops, appreciation of landscape and protection against storms and hurricanes (Fig. 3).

The Afro-Creole group shows different patterns. Regarding the analysis of and covers land ecosystem goods, the MDS analysis reveals a clear association between: (i) crops and croplands, and a great cluster formed by (ii) forest, timber and nontimber products; rivers, freshwater resources, potable water and urban land (Fig. 4). The result of the MDS analysis for land covers and ecosystem services

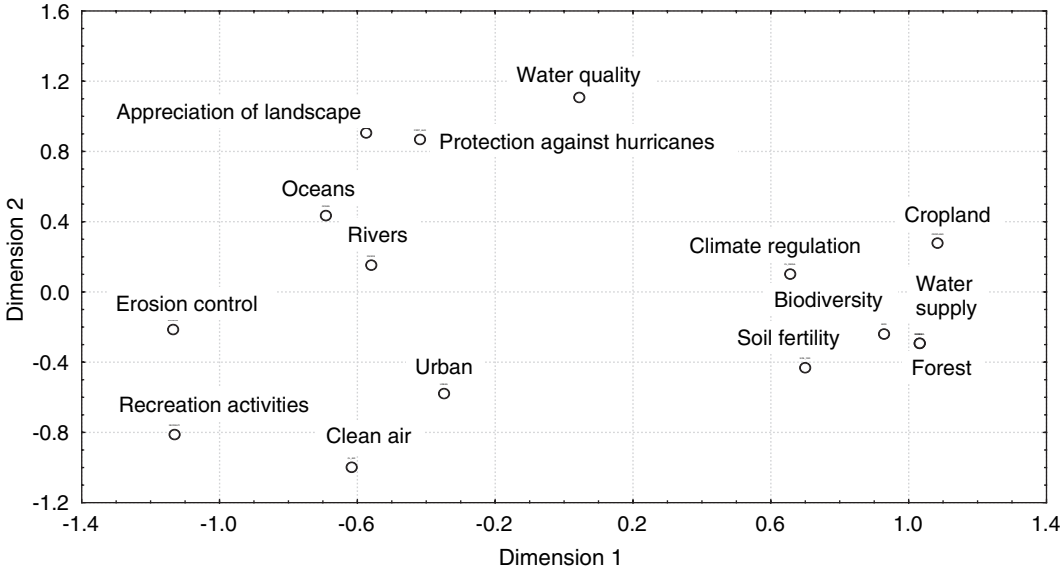

Figure 2: MDS analysis for the Kalinago regarding land covers and ecosystem services.

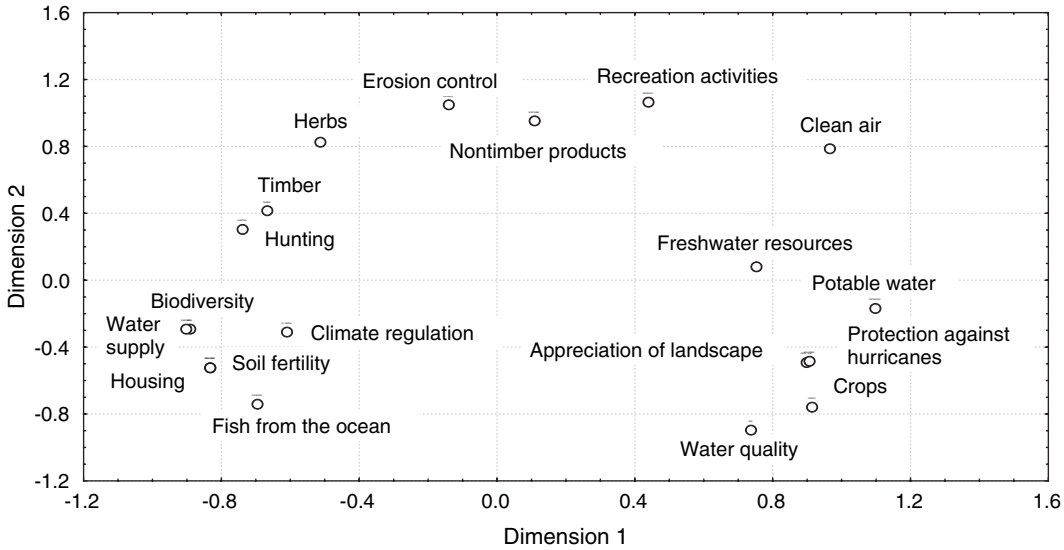

Figure 3: MDS analysis for the Kalinago regarding ecosystem goods and ecosystem services.

shows a strong association between urban land, erosion and soil fertility (Fig. 5). Finally, the MDS analysis of ecosystem services and ecosystem goods shows two main clusters: (i) timber and nontimber products, soil fertility and erosion control, fish from the ocean, freshwater resources and potable water; (ii) water quality, water supply and housing (Fig. 6).

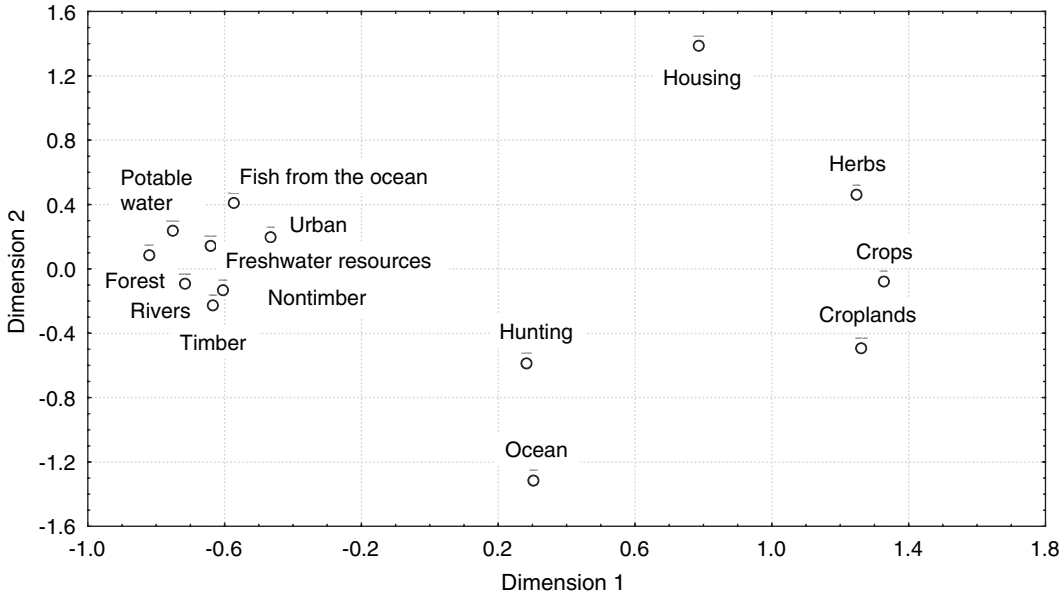

Figure 4: MDS analysis for the Afro-Creole regarding land covers and ecosystem goods.

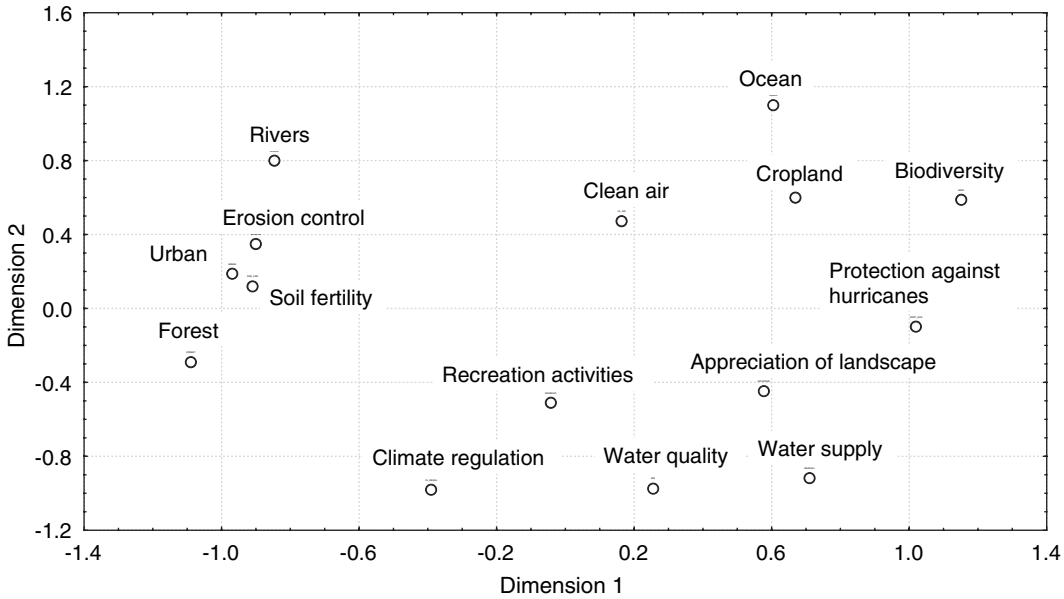

Figure 5: MDS analysis for the Afro-Creole regarding land covers and ecosystem services.

5 DISCUSSION

Human judgment and actions are influenced by a set of conditions that through time, guide people to assign importance and necessity to actions, goals and objectives. The term ‘value’ represents the contribution of something to goals, objectives or conditions. Often this term is used in a static rather

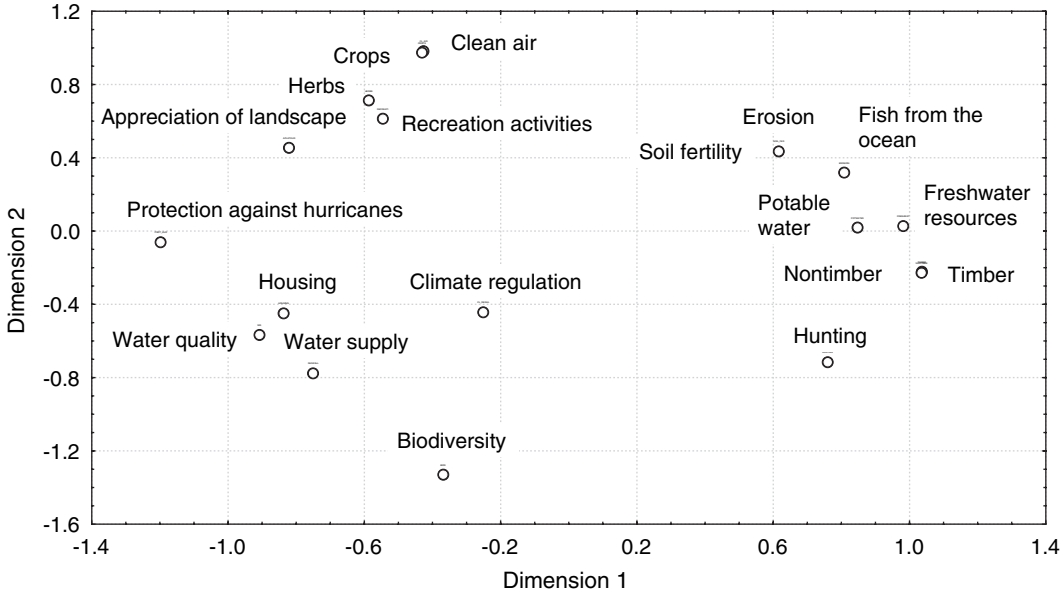

Figure 6: MDS analysis for Afro-Creole regarding ecosystem goods and ecosystem services.

than a dynamic sense and this obscures attention to underlying shifts in individuals' priorities, or cultural and social changes.

An anthropocentric point of view suggests that 'value' refers to the contribution of something to human goals, such as economic well-being. Valuation of natural systems and their services is generally undertaken (i) to show that natural systems are linked to human welfare even when they are priced zero, (ii) to describe the relative importance of various ecosystem types, or (iii) to justify or criticize a particular decision in a particular place [21]. In this context, our work was designed to obtain a nonmonetary value of different land covers and the associated ecosystem goods and services as a measure of their importance to the well-being of the Kalinago and the Afro-Creole inhabitants of Dominica.

The fieldwork results suggest that the lack of statistically significant differences among alternative land covers and between the Kalinago and the Afro-Creole should be explained by a widespread feature of Dominican rural households: multiactivity, i.e. the multiplication of the income sources. In that sense, for both groups, the relative contributions of forestland, cropland and urban land as well as oceans and rivers seem to be equally important to their livelihoods.

Within-group differences in the value of ecosystem services show the low importance of recreation services for the Kalinago and the service of protection against storms and hurricanes for the Afro-Creole. These low valuations could be explained in terms of recent history. The Afro-Creole are mainly settled in the west coast, an area best protected from winds and storms which always appear from the east. However, in 1999, Hurricane Lenny unprecedentedly impacted the island from the west, damaging the best agricultural lands, which had been cleared a long time ago. That land is currently being used for growing bananas, a cash crop which is extremely sensitive to wind and storm damage. The extensive damage caused by the hurricane increased the perception among the Afro-Creole that the service of protection against storms and hurricanes is negligible. The low value of recreation services among the Kalinago may be explained by the fact that current and past tourism

policies in Dominica have been focused on the Carib Territory, and their Kalinago habitants are seen as tourist attractions themselves and there are no compensations for the discomfort caused by visitants. Furthermore, most revenues from tourism are obtained by people outside the Carib Territory and not by the Kalinago stakeholders [22].

The results of between-group analyses of ecosystem services show a higher value for the service of protection against storms and hurricanes for the Kalinago than the Afro-Creole. This is not surprising since the Kalinago are settled in the east coast, which is more exposed to winds and is locally referred to as *au vent* and their inhabitants as *gens au vent*. [19]. The Kalinago value the ecosystem service of water supply and soil fertility significantly higher than the Afro-Creole. It is likely that the values for those ecosystem services mainly provided by the forests reflect the lack of presence of DOWASCO in many areas of the Carib Territory as well as the increasing importance of water supply services for the islanders, because over the years deforestation has generated a change in the flow of Dominican rivers such as Castle Comfort, Roseau, Layou and Geneva, and resulted in the incidence of droughts like that which occurred in 1994 and increase of runoffs and nutrient loss, thereby diminishing soil fertility [23].

The lack of evincible differences in the valuation of ecosystem goods among the Kalinago, highlights the multiactivity of that group and the permanent or seasonal use of a broad range of resources. The Afro-Creole show differences in the valuation of ecosystem goods such as the lower value assessed for the hunting of game compared with crops or fish from the ocean. These differences, when viewed between groups, could be easily explained based on the economic activities and constraints that categorize the Kalinago and the Afro-Creole. The east coast is less appropriate for fishing. The Carib Territory lacks convenient landing sites due to its shoreline characteristics, and the only two available places, Salibia and the Church of St. Mary, are useful only for small canoes [19]. Given these restrictions for fishing, it is not surprising that fish from the ocean does not extensively contribute to the Kalinago well-being compared with other more available ecosystem goods. The same argument could be employed to explain the low valuation by the Afro-Creole for the hunting of game, a resource associated with forest areas. Afro-Creole people are more involved in agricultural and fishing activities, so the relative contribution of hunting to their well-being should be low.

The MDS analysis of land covers and ecosystem goods for the Kalinago exhibits a cluster conformed by forest and croplands, which suggests a strong association between these land covers and their importance in a multiactivity economy. The same analysis also shows the relationship between timber products, herbs and hunting of game, all of these being resources associated with forestlands. This association could be explained by the fact that, while going to the forest to obtain timber products, the Kalinago collect herbs and hunt profitable prey. On the other hand, the availability of nontimber products is extremely seasonal and specific parties are organized when the abundance of these products is high enough to justify the collection effort, hence it is not surprising that nontimber products are not included in the previous cluster. The association between rivers, freshwater resources and the ocean suggests a good knowledge of the life history of prey. Most freshwater fish species in Dominica migrate between freshwater and salt water, spawning in the sea. The Kalinago scoop up tiny 'titiwee' and *Centropomus* species on their seasonal run upriver from the sea [9].

For the Afro Creole, the MDS analysis of land covers and ecosystem goods presents two clusters, the first one consisting of croplands and crops. The expected association emphasizes the importance of agriculture for their well-being. The second cluster consists of three land covers (forestland, rivers and urban) and four products (timber and nontimber products, freshwater resources and potable water). The association inside the cluster can be easily explained in terms of product provision: forests provide timber and nontimber products, rivers provide freshwater resources, and potable water is provided by rivers and is available in urban areas via DOWASCO, which covers the demand

of Afro-Creole households. The exclusion of herbs and medicinal plants in the forest cluster, which includes timber and nontimber products, suggests an incomplete knowledge of the goods provided by the forest. Imperfect ecological knowledge is also evinced in the relationship between freshwater resources and rivers, which excludes the ocean, which is essential for the nursery and early stages of most of Dominica's freshwater species [9].

The MDS analysis of land covers and ecosystem services for the Kalinago presents an association between appreciation of landscape and protection against hurricanes. Dominica's tourist industry strategy has been developed with the idea of promoting the island's pristine natural environment. In this sense, the value of landscape appreciation is strongly linked to the level of conservancy of forests. Increasing disturbance of forested areas decreases their scenic beauty value and at the same time decreases their capability for windbreak. Some reports indicate that Dominica's disturbed forests and forests adjoining gaps are more susceptible to damage from hurricanes and storms [24]. The association between oceans and rivers in a cluster may be explained based on the pertinence of both biomes to the same cultural domain related with water. The MDS analysis shows a third cluster conformed by forest, climate regulation, biodiversity, water supply and crops. The topography of Dominica allows the existence of microclimates depending on the altitude and the vegetation cover provided by forests. These microclimates provide different habitats which maintain a high number of vegetal and animal species. Variations in distribution, abundance and composition of natural vegetation are likely to result in local change of climatic and hydrological conditions. Increasing pressure for agricultural expansion of cash crops and the production of charcoal, posts and firewood has resulted in deforestation and wildlife habitat reduction. Deforestation has generated a change in the water supply services, diminishing the flow of some Dominican rivers and increasing the incidence of droughts affecting sensible sectors such as cash crop agriculture [23]. The relationships between forest and protection against winds, floods and landslides, protection of biodiversity, and maintenance of water supplies are explicit in the objectives for the creation of Dominica's protected forest such as Morne Trois Piton which was declared a World Heritage Site and is currently a popular tourist destination.

The MDS analysis of land cover and ecosystem service for the Afro-Creole group exhibits a sole cluster formed by urban area, erosion and soil fertility. This association suggests that the Afro-Creole are conscious of the land degradation caused by the conversion of forest or agricultural land to housing development, which is a common occurrence in Roseau Valley, Canefield, Belfast, Wallhouse, Morne Daniel and Grand Savanne [22].

The MDS analysis of ecosystem services and ecosystem goods for both the Kalinago and the Afro-Creole shows some expected associations based on the analysis of the previous results for land covers and ecosystem goods as well as for land covers and ecosystem services. The analysis shows that the clusters found in the Kalinago group are preferentially formed by ecosystem services: a main cluster formed by biodiversity, water supply, climate regulation and soil fertility, and a smaller one conformed by appreciation of landscape and protection against storms and hurricanes. On the other hand, Afro-Creole clusters are mainly conformed by ecosystem goods: fish from the ocean, freshwater resources, potable water, and timber and nontimber products. We consider that the great difference in cluster composition does not deny the existence of common and cross-cutting interests between the Kalinago and the Afro-Creole. We suggest that perceptions and values differ because both peoples differ in their interests, benefits and costs of land use. Basically, our results suggest that between the Kalinago and the Afro-Creole sufficient differences still remain in the perception of the world that the groups cannot consider homogeneous, with a single common interest.

Environmental literacy is still higher among the Kalinago than their Afro-Creole counterparts [25]. Differences in environmental literacy levels between ethnic groups have been previously reported

[26, 27] and usually minorities express higher level of concern about nature. We consider that in Dominica, the differences in environmental literacy are based on the high traditional knowledge of natural resources and natural landscape present among the Kalinago group. Dominica's government recognizes the great importance of this knowledge, with special reference to the conservation of biodiversity and the management of agricultural systems. However, the lack of appreciation of traditional values, rural and regional migration, and the associated breakdown of mechanisms that have historically been utilized for transmitting such knowledge through the community have combined to create a situation whereby access to traditional practices, culture and knowledge could be lost. Hence, policies that reform the current configuration of indigenous and governmental institutions, improving the capacity of the Carib chief and the Carib Council to deal with problems facing the Kalinago, and conserve their cultural and natural patrimony are still needed.

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