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Assessing the potential for a payments for environmental services system in The Fond D'or Watershed, St. Lucia

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Abstract

A Payment for Environmental Services (PES) scheme is defined by Mayrand and Paquin (2004) as a tool "to support positive environmental externalities through the transfer of financial resources from beneficiaries of certain environmental services to those who provide these services or are fiduciaries of environmental resources." PES schemes can target water services, carbon sequestration and storage, biodiversity protection, watershed protection and landscape beauty. The case study area of the Fond D'or watershed in St. Lucia identifies and values existing watershed services. The Fond D'or watershed is the second largest, comprising of 10,230 acres with twenty-three per cent (23%) of the watershed in Government Forest Reserves. These Government forest reserves are located in the upper watershed while within the middle and lower watershed areas there are many activities including residential settlements, agricultural production (banana cultivation), forestry production, livestock production and ecotourism. This paper specifically focuses on the agricultural sector, mixed farming 24%, other intensive farming 32% and flatland intensive farming 8% which has significant environmental effects. Linking the valuation of these environmental services to a proposed PES scheme can be utilized to combat negative environmental practices and promote environmental sustainability. Further, this proposed PES scheme highlights the possible implications for farmers in terms of possible incomes, environmental practices and overall attitudes towards a change in practices.

JEL Classification: O13 (Agriculture; Natural Resources; Environment); Q51 (Valuation of Environment Effects); Q56 (Environment and Development); Q57 (Ecological Economics: Ecosystem Services; Biodiversity Conservation)

INTRODUCTION

This paper draws on a larger study undertaken by the Sustainable Economic Development Unit (SEDU) in 2008[1] for the National Authorizing Officer for the St. Lucia European Development Fund Operations,

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Ministry of Economic Affairs, Economic Planning, Investment and National Development.

The study has as its main objective: *"To explore options and opportunities for the establishment of a sustainable system to compensate natural resource users for the environmental services their management practices provide to society/community, using the Fond D'or watershed as a demonstration and case study site (and thereby contributing)… towards an improved quality of life through better and more sustainable management of the natural resources and the environment."*

The paper begins with a background to case study area Fond D'or in St. Lucia and then a brief description of the Ridge to Reef theoretical framework is provided. The next section details the methodology and approach of the study. Further, the results and discussion are detailed in the next section with the final section addressing the conclusion, implications of the study as well as the recommendations.

BACKGROUND

St. Lucia is an island situated between the Atlantic Ocean and the Caribbean Sea. It is part of the Lesser Antilles and is located north of the islands of Saint Vincent and the Grenadines, North West of Barbados and South of Martinique. In St. Lucia there are thirty-seven (37) major watershed areas with seven (7) being important in terms of water supply; Marquis, Roseau, Cul-de-Sac, Fond D'or, Troumasse, Canelles and Vieux Fort.

The Fond D'or watershed in the second largest, comprising of 10,230 acres with twenty-three per cent (23%) of the watershed in Government Forest Reserves. These forest reserves are located in the upper watershed while the middle and lower watershed areas are used for cultivation and livestock production. It should be noted that the Fond D'or watershed area(see map below) is not only a main source of water supply but it also a protected landscape.[2]

Saint Lucia's 2005 population was 164,791 (Central Statistical Office, St. Lucia[3]), up from a total of 157,779 in 2001. As individual settlement and community data are limited for the Fond D'or region, this section relies to a large extent on available aggregated population data for the entire Dennery district, as well as settlement and land use information for the Mabouya Valley. Census results of 2001 estimates that the population in the Dennery district was 12,767 which represents approximately 8.10% of St. Lucia's total population (as compared to 8% in 2005). Box 2 profiles a summary demographic profile of the Dennery region within which Fond D'or watershed is located.

Economic and Land Use Profile: Fond D'or Watershed

- **Agriculture:** The Fond D'or river drainage basin (watershed) covers an estimated 4,036 ha or 9,973 acres of land characterized by relatively flat lands. Agriculture is the dominant land use activity within the Mabouya Valley accounting for almost 777 ha or 1919 acres of land (MVDP, 2005).

  Currently, intensive commercial farming is being practiced in the lower valley on the flat to gentle slopes with cultivation becoming variable on the higher sloped lands to include mixed tree crops and vegetables.

  Mixed cultivation with bananas and tree

[2] As cited in the National Biodiversity Strategy and Action Plan for St. Lucia, NBSAP, undated. Government of St. Lucia.

[3] http://www.stats.gov.lc/

crops take place on the Glavier hillside lands south of the Castries-Vieux Fort Highway. Near the mouth of the river at Fond D'or Bay, there is a fairly extensive area of pasture under cattle grazing and approximately 10ha, or 25 acres, under coconuts. The areas outside of commercial production are dominated by subsistence cultivation combined with secondary woodland and scrub forest.

The northern ridge extending from Dennery Knob towards Au Leon has the most extensive area of natural forest, while extensive scrub forest and secondary woodland dominate the southern extents of the area along the Bois Jolie Ridge and Morne Vent (MVDP, 2005).

- **Livestock Production - Pigs***:* Pig farming is usually undertaken within sub-urban areas. This is as a result of the access to running water. The number of pigs increased by almost one hundred percent from 7,500 in 1986 to 14,658 in 1996 (Ministry of Agriculture, Forestry and Fisheries, Agricultural Census, 1996). Table 1 shows the distribution of Livestock in Dennery and St. Lucia as a whole.

Land Use Profile: Fond D'or Watershed

The main land uses in this watershed are shown in the table 2 below with an emphasis on agriculture. It can be send that agriculture is dominant (64%) in the Fond D'or area with 32% being other intensive farming, 24% being mixed farming and 8% being flatland intensive farming.

Water Profile

In the Fond D'or region, a survey[4] was undertaken of 8 pig farmers, 150 households, 10 upstream protectors by SEDU with respect to the main sources of water for households, overall satisfaction of water quantity and quality, willingness to pay for improved water quantity and quality, sources of water for pig farming and methods of waste disposal. The primary source of water for households is derived from the household tap or water supplied through private connections with WASCO (133 households, 89%). Further, Households responded that their second main source of water is that of bottled water (78 households, 52%) and the third source of water is that of rainwater (60 households, 40%). This is identified in the figure 1 below:

With respect to overall satisfaction with water quantity it can be seen that 46% of the sample were satisfied, 34% dissatisfied and 8% very dissatisfied as illustrated in the figure 2 below:

In terms of quality however, 60% were dissatisfied, 21% very dissatisfied and 8% satisfied. The figure 3 below illustrates the results of the water quality survey.

For the pig farmers, the main sources of water were from the water company WASCO (37.5%), the ravine (37.5%), the river (12.5%) and the stream (12.5%). This is illustrated in the

It was also identified that the methods of waste disposal by the pig farmers were impacting on water quality since 62.5% of the farmers identified that waste was washed into the drains. 12.5% of farmers identified that the waste was sold to other farmers, 12.5% indicated that the waste was used as manure and 12.5% indicated that the waste was disposed of by other

[4] Survey was undertaken by Dr. Thalia Esnard-Flavius, Lecturer, (Survey Coordination and Analysis Consultant, Department of Behavioural Sciences, University of the West Indies, St. Augustine Campus.

means. This is illustrated in the following figure 5:

THEORETICAL FRAMEWORK

Small islands have been described as existing all within the coastal zone, in that, whatever happens inland and upstream quickly finds its way to the coast. In other words, since watersheds flow from the 'Ridge to Reef' whatever happens in the uppermost tier would have a cascading impact downstream including, ultimately on the near shore and fringing reefs.

Viewed from the mountain or hillside ridge one can conceptualize small islands as made up of watersheds: each divisible into five main, integrated sub-regions. The upper watershed is followed by the middle and lower watersheds together with the coastal region comprising the near-shore and coast (including beaches in many instances) and, finally fringing coral reefs. In other words one can conceptualize a continuum from the Ridge to the Reef [5] in small islands. Figure 6 provides an illustration of such a typical watershed in the Caribbean and, in fact, in many other such islands.

What is a Payment for Environmental Services (PES) System?

Mayrand and Paquin (2004) define a PES scheme as an approach that seeks: *"to support positive environmental externalities through the transfer of financial resources from beneficiaries of certain environmental services to those who provide these services or are fiduciaries of environmental resources."* According to Wunder (2005) a Payment for Environmental Services scheme is a voluntary transaction where:

- a well-defined Environment Services (ES): or a land-use likely to secure that service
- is being 'bought' by a (minimum one) ES buyer
- from a (minimum one) ES provider
- if and only if the ES provider secures ES provision (conditionality).

The logic of a PES scheme lies in the fact that there are few direct benefits to be derived from land uses such as land conservation. Further, the benefits tend to be less than other options for land uses such as conversion to cropland or pasture. However, **the costs on downstream users may be high where deforestation occurs**[6] since benefits such as water filtration, water stability and reduced carbon emissions would no longer be received as well as carbon storage and biodiversity for the global community. As a result, payments from beneficiaries can offer an incentive for ecosystem managers to undertake conservation. Pagiola and Platais (2007) argue that "*PES thus seeks to internalise what would otherwise be and externality."* Engel, Pagiola and Wunder (2008) also point out that the PES schemes tend to utilize the Coase theorem whereby problems of external effects can, under certain conditions, be overcome via private negotiation between affected parties.

[5] Ridge to Reef' was the title of a watershed project in Jamaica, borrowed here since it so aptly captures the reality of small islands. See Associates in Rural Development (2002) for more details on this project.

[6] Applied in terms of the estimated value of assets at risk in the Fond D'or Watershed.

Steps to Developing a Successful Market for Environmental Services

The key steps to developing a successful market for environmental services according to Landell-Mills and Porras (2002) include:

1. *"Identify benefits provided by a specific service and by determination of (forestry) activities that deliver this service;*
2. *Establish willingness to pay;*
3. *Formalize property rights;*
4. *Establish payment mechanisms and supporting institutions;*
5. *Undertake pilot activities and feedback to market design."*
6. *Undertake a feasibility study.*

METHODOLOGY/APPROACH

Consistent with the above R2R approach one can identify the upper and middle watersheds (and to some extent the lower watersheds) providing a range of eco-system functions including:

1. Water quality;
2. Flow regulation;
3. Soil erosion control and soil fertility/health;
4. Ecosystem integrity, biodiversity, and landscape beauty.
5. Carbon sequestration (and hence a positive carbon sink function).

Each of these five functions represents economic values. In what follows, an economic valuation will be placed on directly on (1), partially on (4) and indirectly on (2) and (3). These two latter indirect values – of flow regulation and soil erosion control and soil fertility/health- will be estimated by valuing agricultural output and land/housing and infrastructure all of which would indirectly reflect the degree of protection provided. To explain, the Fond D'or watershed can be considered to be providing water quality and quantity flow regulation, ecotourism benefits together with carbon sequestration.

The extent of the benefit of Water Flow Regulation together with soil erosion control and soil fertility/health will be reflected in terms of the costs foregone(saved) by those engaged in agriculture, settlement and utilisation of public infrastructure downstream. In other words, if the upper and middle watersheds become substantially degraded there will be an increase in water and soil/sedimentation flow downstream with concomitant negative impacts on agricultural production via flooding.

An estimate follows below as the contribution of the eco-system services in the Fond D'or watershed. To contextualise this estimation, a review is now provided below of the main issues that are identified in the literature in undertaking such an economic valuation exercise.

Economic Valuation Methodology

In terms of the valuation of environmental resources the literature seeks to measure total economic value which itself is made up of the following:

- **Direct use values**: those economic values derived directly from use by society.
- **Indirect use values**: those values derived from the indirect support and protection provided to economic activity and property by functions of nature, or regulatory environmental services.
- **Non-use values:** those values derived neither from current direct or indirect use of the watershed. Related to use values are **option value**, which can be direct or indirect, and arise because individuals value the option to use an

environmental good or service in the future. A special category of option values is **bequest values**, which result form individuals placing a high value on the conservation of environmental goods and services for future generations to use. People may also gain satisfaction from the knowledge that certain environmental goods and services exist and therefore may be willing to pay for their continued existence. This component of the non-use value is known as the **existence value**.

The Total Economic Value (TEV) of an environmental good or service comprises use and/or non-use values. From this perspective, we can see that: **TEV = direct use values + indirect use values + non-use values.**

RESULTS AND DISCUSSION

Application of Steps to Developing a PES System[7] to the Fond D'or Watershed, St. Lucia

STEP 1: Identify benefits provided by a specific service and by determination of (forestry) activities that deliver this service

The valuation approach and methods will now be applied, in a modified[8] form, to the specific case of the Fond D'or watershed. First, are the direct use values contributed by the watershed. As table 3 shows the two direct use values identified are water abstraction and eco-tourism[9].

This is followed by the estimation of two indirect use values[10]: The first being carbon sequestration and the second, flood and erosion control. The latter value estimated in terms of the assets protected by the current degree of watershed protection upstream. These assets include agricultural production, settlement and public infrastructure: all of which benefit from the existing level of watershed protection upstream and would be negatively impacted by any significant downstream deterioration.

The following economic valuation methodologies were used:

The following table 4 for summarizes the specific values of ecosystem services in the Fond D'or watershed:

Indirect use Value: Carbon Sequestration[11]

The estimate of the value of carbon sequestration is based on the benefit transfer methodology. The area under forest as shown earlier (in Table 2 of the preceding chapter) was 1198 ha. Pearce and Pearce in 2001, estimated that conservative values of US$2000/ha were available in the carbon trading markets. This same value is retained but converted to EC$ i.e. a total value of EC$6.5 million.
Two caveats are needed. First, is on the critique of the legitimacy of benefit transfer procedures from one tropical site to

[7] As identified byLandell-Mills and Porras, 2002 as cited earlier

[8] Due to limited timeframe, modification is necessary given the collection and estimation of data.

[9] For details on how these direct use values and the other values described were estimated see SEDU (2008).

[10] Non-use values are acknowledged but not estimated

[11] For the purpose for this paper we will only look at the indirect use values of carbon sequestration and agriculture, the details of all the other values estimated can be found in SEDU (2008).

another[12]. Second, as both Pearce (2001) and Adger et. al. (2002), also note carbon storage is a benefit external to the economy itself and is extremely difficult to internalise although there is a fledgling carbon trading market already in existence.

Indirect Use Values: Flood and Erosion Control: What is at Risk and Hence Protected?

- **Agriculture - Value of Agricultural Land**

The following table 4 shows the estimated value of agricultural lands as categorized by areas under banana production and areas under mixed cultivation.

- **Fair Trade Bananas in the Fond D'or Region.**

Fair trade banana production is dominant in the watershed with 95% or 1140 acres of 1200 acres of banana production by 323 farms. The Fair trade price as compared to the market price of bananas provides an incentive of almost EC$10 extra per box in Fond D'or watershed region.

The estimated value of fair trade banana production is used as the total annual value of banana production in the watershed: i.e. 11,000 boxes/week x 50 weeks x US$23 =**US$12,650,000 or EC$$34,155,000**.

- **Pig Farming In Fond D'or**

Presently, there are 33 piggeries[13] along the Fond D'or River. The numbers of pigs vary from 1 to several hundreds per farmer. The process for estimating the number of pigs for the Fond D'or Watershed included deriving the total number of pigs from the sample of eight pig farmers.

The lower value: EC$ 1.3 million was used to take into account that not all of the pigs would be slaughtered in the same year. Moreover, these prices are from 2002: six years ago.

- **Other Agriculture**

Other agriculture was assumed to have a residual worth of EC$1,300,000 per annum. In other words, no specific estimate was made but a very conservative assumption was used to cover the undoubted existence of agricultural production other than bananas and piggeries in the watershed.

Estimate of annual costs foregone

Table 4 also estimates the damage costs foregone. By this is meant that if there were significant deterioration in the watershed then the assets and income flows at risk would suffer a cost in terms of either loss of earnings (agriculture). The annual estimated damage cost foregone has been assumed to be 10%.

Step 2: Establish Willingness to pay

PIG FARMERS

The pig farmers' survey (SEDU, 2008) also assessed the willingness of those pig farmers who engaged in improper waste disposal to undertake sustainable land management practices. In that regard, pig farmers were asked whether they were willing to shift to either using the pig waste for manure or selling it to other farmers or persons in the community. All five (5) pig farmers who engaged in improper waste disposal were willing to change their practice but stressed on the need for needed assistance in the form of technical assistance (one [1] pig farmer), labour (one

[12] See Adger et al, (2002), pp.331 for a discussion on this score.
[13] Information provided by The St. Lucia Pig Farmers Co-operative Ltd. (2008)

[1] pig farmer), and financial assistance (five [5] pig farmers).

HOUSEHOLDS

The survey instrument used by SEDU (2008) also presented a hypothetical case to the participants where they were asked whether they would be willing to pay for changes in the water situation for their household if WASCO was to:

- Make water available in the tap for at least 12 hours per day
- Provide good water quality that was always odourless and colourless and
- Establish private water connections to their house if it was not already established.

The responses revealed that one hundred and forty (140) or 93.33% of the participants were willing to pay for these stated changes. Ten (10) persons or 6.7% of the sample were not willing to pay.

STEP 3: Formalize property rights;

It can be noted that WASCO water intakes lies within the protected forest reserves with the remaining two lies on private lands. A feasibility study would need to detail the willingness to be compensated of the upstream private property owners for appropriate land uses. It should be noted that the survey[14] of upstream users with 'good practices' can provide a model to be used for estimating the net benefits of good practices across all such private property owners.

STEP 4: Establish payment mechanisms and supporting institutions

Water and Sewerage Company (WASCO) of St. Lucia is an available, existing operational entity which can function as a source of sustainable financing through the water tariff.

RECOMMENDATIONS/CONCLUSION

STEP 5: Undertake pilot activities and feedback to market design.

- **Rainwater Harvesting Programme**

It is proposed that the existing rainwater harvesting programme (RWH) be used as the pilot within the larger water abstraction pilot, but linking this to Fair Trade banana production and pig rearing. Some further details follow below.

The rationale for proposing that the RWH be used is that it is already an operational pilot on which, therefore, there already is some empirical base for learning. The Rainwater harvesting programme in the Fond D'or watershed has as its main objective to "*demonstrate a strategic approach to participatory watershed management, which would integrate principles relating to sustainable natural resource and environmental management."*[1]

The Rainwater Harvesting (RWH) Project seeks to provide a method to alleviate the water shortage and water quality issues through the collection and storage of rain water for domestic household use. The **overall objective** is "*to contribute towards improved quality of life, health, and sanitation through better management, capture, and distribution of available water resources*." The **specific objective** is to "*demonstrate RWH as a simple and low-*

[14] SEDU (2008)

[1] Ministry of Agriculture, Forestry and Fisheries (2007)

cost water supply technology which can provide water at an acceptable quality standard."

The project costing can also be broken up into the following:

In other words, the cost per installation was EC$8,206.00.

- **Link to Fair Trade Banana Farming and Pig Rearing**

It is further proposed to link the Rainwater harvesting Programme with that of fair trade bananas and pig rearing. The main proposal is to provide a variant of the RWH systems (average costs: EC$8206)[2] to the 33 piggeries in the watershed: either without cost ($270,798), or at a subsidised cost. The condition for such access would be that the pig farmers would now shift as far as is feasible (that is particularly in the rainy season) to use of rain water as opposed to WASCO water). The survey revealed, for example, that 38% of the sample used the tap water provided by WASCO. Although the actual quantum of WASCO water utilised is not available one can reasonably infer that such a saving would be readily re-allocated and welcomed by the water deficient householders who would then pay for such water.

The second proviso for access to the RWH systems by the pig farmers would be their agreeing to store their pig waste and either use on their own lands and/or sell to other farmers: of whom the fair trade bananas would be an obvious and proximate choice. As noted in the survey one pig farmer, with 120 pigs, earns about EC$1200 from selling manure in excess of his own needs.

STEP 6: Undertake a feasibility study

A feasibility study was not possible within the scope of this study but the information provided in this report suggests that the main planks for such a feasibility study are already in place.

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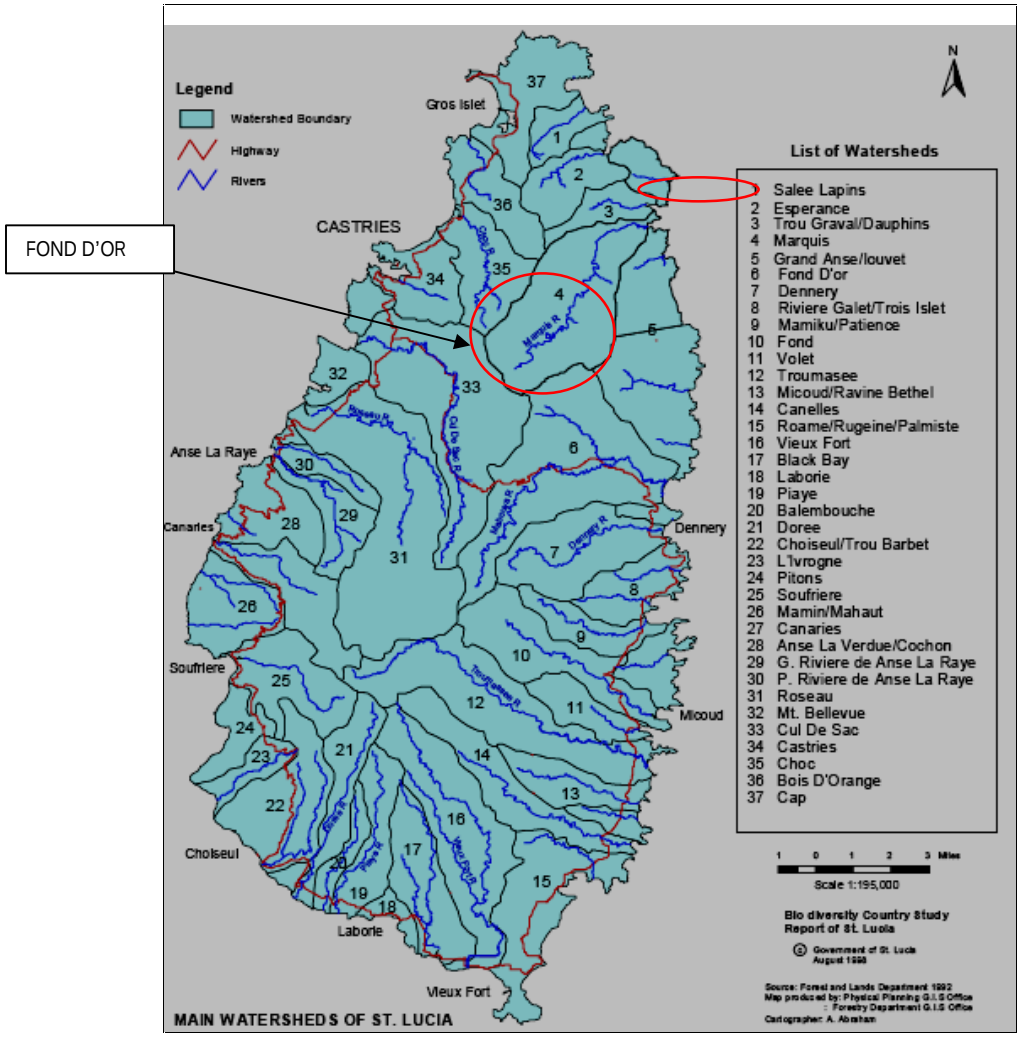
Map 1: Main Watersheds of St. Lucia



Source: Saint Lucia Natural Resources and Agricultural Development Project -Studies and Proposals for the Implementation of a Land Registration Programme. (1986).

Demographic Profile: Fond D'or Watershed

Box 1: Summary Demographic Profile of Dennery

- Location: East Coast, Population: 12,710
- Gender ratio: 49.1 percent (male) and 50.9 percent (female)
- Population aged under 15 years: 33.2 percent
- Population aged over 60 years: 11.1 percent
- Female-headed households: 59.3 percent
- % of population covered by any type of insurance:39.7
- % with primary school as the highest level of education: 49.2
- % with no certification: 78.2
- % Employed: 30.2
- Ownership of dwellings: 80.4
- % with concrete as outer wall: 30.5
- % of households with no toilet facilities: 18.1

Sources: Population census and report interviews from Henry-Lee (2004)

Table 1: Distribution of Livestock in St. Lucia by Type and Administrative District

Administrative Districts	Cattle	Pigs	Poultry	Sheep	Goats	Rabbits	Horses	Other Animals
Dennery	**357**	**556**	**1,730**	**626**	**796**	**41**	**-**	**23**
Total	7,064	14,658	100,436	12,480	9,718	1,552	246	1,396

Source: The Planning and Statistics Unit, Ministry of Agriculture, Forestry and Fisheries and the Environment 1996-97 as cited in the Biodiversity Country Study Report of St. Lucia (1998)

Table 2: The Main Land Uses in the Fond D'or Watershed in St. Lucia.

DESCRIPTION	**Squared Metres ($M^{2)}$**	**Hectares (Ha)**	**Acres**	**%**
Natural Tropical Forest	9,721,450	972	2,402	24.57
Plantation Forest	678,951	68	168	1.72
Scrub Forest	1,584,020	158	391	4.00
Rock and Exposed Soil	18,589	2	5	0.05
Flatland Intensive Farming	**2,967,692**	**297**	**733**	**7.50**
Mixed Farming	**9,643,701**	**964**	**2,383**	**24.37**
Rural Settlement	1,735,486	174	429	4.39
Urban Settlement	536,771	54	133	1.36
Other Intensive Farming	**12,640,498**	**1,264**	**3,124**	**31.94**
Mangrove	45,990	5	11	0.12
TOTAL	**39,573,147**	**3,957**	**9,779**	**100.0**

Source: IWCAM (2008)

Table 3: Economic Valuation Methodologies Used

Market Price	Directly for: Water Abstraction, Ecotourism
Market Price	Indirectly for: Carbon Sequestration
Damage Cost Avoided	For water and soil flow regulation

Table 4: Specific Values of Ecosystem Services in the Fond D'or Watershed

	Asset Values (EC$MN)	**Annual Income Yield (EC$ MN)**	**Damage Cost Foregone (EC$MN)**
1. Direct Use Values			
A. Water Abstraction		1.0	-
B. Sustainable Timber	0.42		
C. Non-Timber Forest Products (NTFP)	0.16		
D. Eco-Tourism		0.30	0.15
2. Indirect Use Value			
A. Carbon Sequestration	6.47		-
Protection of Assets			
3. Agriculture		36.76-37.06	
A. Bananas	1.51-1.82	34.16	3.42
B. Piggeries		1.30-1.60	0.13
C. Other Agriculture		1.30	0.13
4. Settlement	2,549.00		254.90
5. Public Infrastructure	1,000		100.00

Source: SEDU (2008)

Table 5: Estimated Value of Agricultural Lands in the Fond D'or Region

Areas predominantly under Banana Production (flatland agricultural lands)	Area (acre)	Cost/acre (EC$)	Value (EC$)
Bosquet D'Or	29.4	10,000	294,000
Grande Ravine	29.4	15,000	44,1000
Montrose	6.2	8,000	49,600
La Pelle	18.4	12,000	220,800
Valley Farms	42.1	12,000	505,200
Total value of lands under banana production			$1,510,600
Areas under Mixed Cultivation (hillside farms)	Area(acre)	Cost /acre ($EC)	Value (EC$)
Bara1	30.1	6,000	180,600
Bara 2	41	5,000	205,000
Compere	101.8	6,000	610,800
Glavier 1	225.5	2,000 to 3,500	451,000 to 789,250
Glavier 2	62	6,000	372,000
Total value of lands under mixed cultivation			$1,819,400

Source: Compiled by Author from MVDP (2005)

Table 6: Estimated Value of Pigs in Fond D'or Watershed

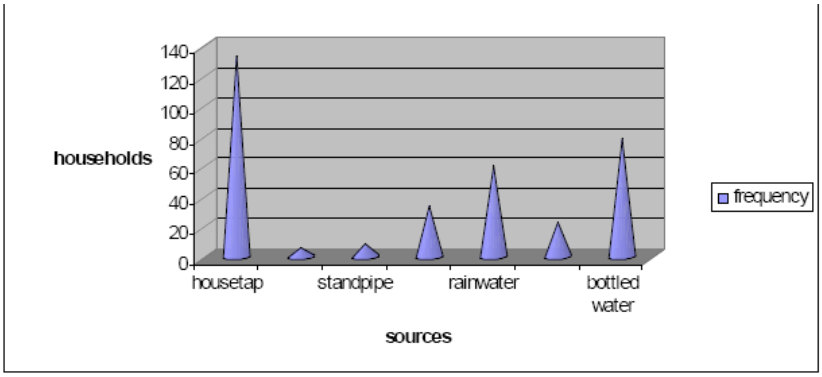
Number of pigs in Fond D'or	Estimated Value $EC (Live Weight)[3]	Estimated Value $EC (Dead Weight)[4]
2,317	1,133,013 - 1,320,690	1,320,690 - 1,584,828

Table 7: Rainwater Harvesting Costing

Item (31 systems)	**ECD$**
Study Design	18,375
Supervisory Consultancy	25,000
Procurement & Installation	211,000
Total	**254,375**

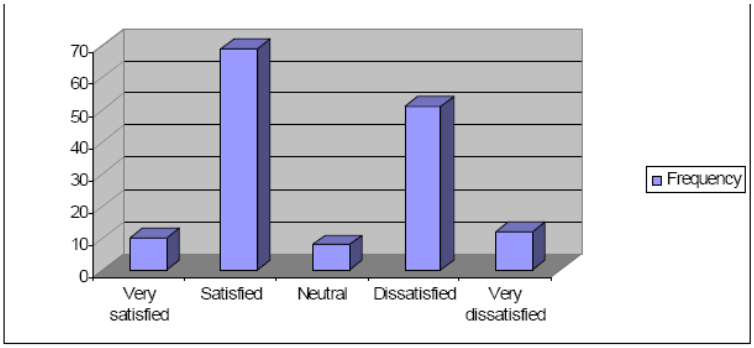
Source: IWCAM 2008

[3] Using Std. live weight (lbs) for pigs
[4] Using Std. Carcass Weight (lbs) for pigs



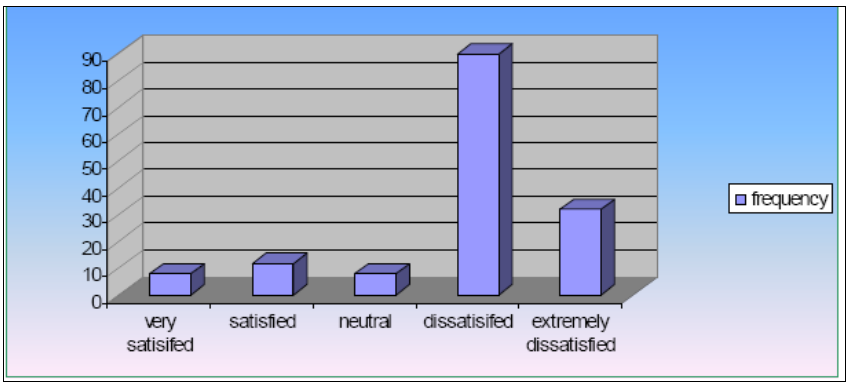
Source: SEDU (2008)

Figure 1: Sources of Water - Households



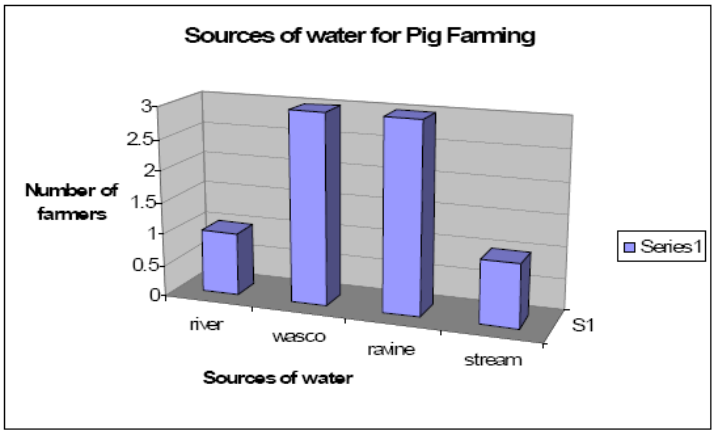
Source: SEDU (2008)

Figure 2: Satisfaction with Water Quantity – Households



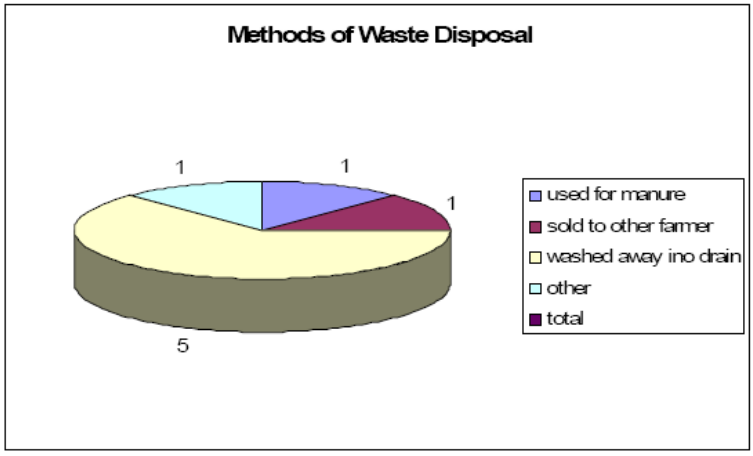
Source: SEDU (2008)

Figure 3: Overall Satisfaction with Water Quality - Households



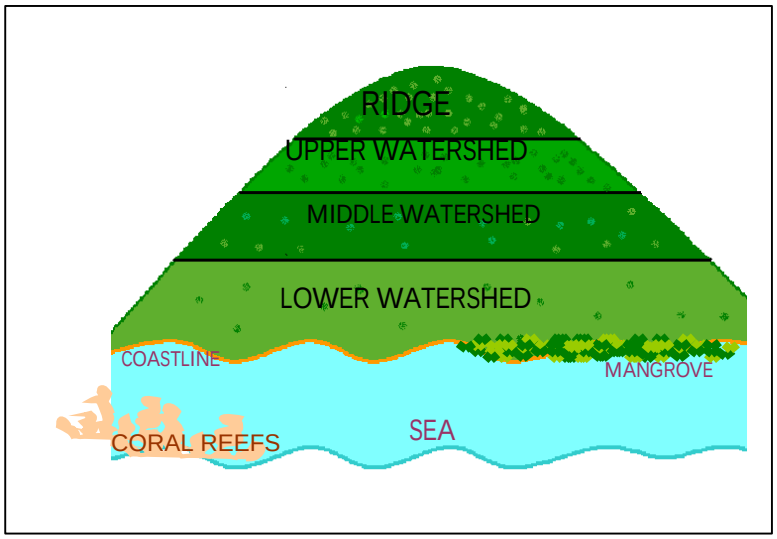
Source: SEDU (2008)

Figure 4: Sources of Water for Pig Farming



Source: SEDU (2008)

Figure 5: Methods of Waste Disposal – Pig Farmers



Source: Pantin, D., Attzs, M., Ram, J., and W. Rennie, (2008).

Figure 6: Sub-Regional Breakdown of Illustrative Ridge To Reef (R2r) Watershed In SIDS