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The Connection of Vegetation with Tourism Development and Economic Growth: A Case Study for Aruba

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Abstract: Vegetation is an important ecosystem on earth. It influences the earth system in many ways. Any influences on this fragile variable should be investigated, especially in a changing climate. Humans can have a positive or a negative influence on plants. This paper investigates the possible impact of tourism development and economic growth on vegetation health using cointegration and causality for Aruba. The proposed framework contributes to a better understanding on the use of remote sensing of vegetation response to tourism development and economic growth. Thereby, provide opportunities for improving the overall strategy for achieving sustainable development on a small island state. The calculations showed that there were relationships between the tourism demand and economic growth on the vegetation health on Aruba for the western part of the island. On the other hand, for the central part of the island, no relationships were found.

Key words: Normalized difference vegetation index, tourism development, vector error correction model, vector autoregressive model, small island, Aruba.

1. Introduction

Human activities have a detrimental effect on the environment. The environment itself has limited resources comparing to the unlimited demands of society. Increased awareness on this has meant a re-evaluation of the methods of planning for future development, where a greater emphasis is put on the need to preserve these environmental resources for future generations, through the process of sustainable development [1, 2]. This can be viewed principally strongly in areas with a speedy increase in resources demand, such as in areas of high tourism activity. Tourism is one of the key factors in the increased urbanization and destruction of natural habitat in different coastal tourist destinations. Recent times have seen a significant increase in the numbers of tourists visiting the Caribbean regions, rising from 166 million stay-over visitors in 1970 to over 935 million during 2010 [3]. To accommodate for the increasing tourism demand, large stretches of coast have been developed for tourism activities, leading to concerns about their aesthetic and environmental condition and potential reductions in both quality of life for residents and economic potential for tourism [1]. The most pressing environmental concerns for Caribbean include biodiversity loss, urbanization, soil erosion, desertification, water conservation and climate change [4]. These effects may manifest in land cover changes, water shortages, soil erosion, air and water pollution, desertification and increased occurrences of forest fires leading to deforestation [4]. Consequently, any development, such as tourism, needs to be accomplished under the principles of sustainable

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development in order to minimize environmental damage [2]. Sustainable development is particularly an issue for small islands states, as they tend to have more fragile and limited natural resources. There is also an economic necessity to guard the environment, as its aesthetic appearance is a significant component of a regions' attractiveness to tourists [2]. A general strategy is necessary for designing schemes that can analyze the existing and past developments and therefore, be able to forecast an adequate sustainable development plan for upcoming generations. Increased knowledge of the state of the region's environment is studied, which is a prerequisite in order to make sure that development in that regions falls within sustainable strategies. The effective use of earth observation and satellite remote sensing data combined with a suitable blend of socio-economic data may aid in realizing not only a local specific direction to accomplish sustainable development of an area of interest, but similarly in monitoring the environmental effects of any developmental activities employed under various developmental plans [2].

The purpose of this paper is to examine remotely sensed data in order to find relationships between tourism demand and economic growth on Aruba, a small island state, and the environmental response, namely vegetation fluctuations. A common way to identify the response of vegetation to climate or human induced impacts is to use a satellite-derived vegetation index. A prevalent vegetation index is the Normalized Difference Vegetation Index (NDVI) [5]. Particularly, time series of NDVI data derived from the National Oceanic and Atmospheric Administration (NOAA) satellite have been broadly used to identify vegetation movement due to their relatively long coverage period [6]. Results from this study will gauge in the effective use of remotely sensed data for the achieving of sustainable tourism development on a small island state. The methodology involves using an Autoregressive Distributed Lag Model (ARDL) approach to test cointegration, with subsequent application of Vector Error Correction (VEC) or Vector Autoregressive (VAR) models to test causality among the three constructs. Literature review shows that only a few numbers of studies were conducted using the NDVI to monitor fluctuations in vegetation due to tourism growth on small island states. Therefore, there is a case for better understanding the response of the environment using remote sensing on small island states due to unsustainable tourism development. This study accesses a small island destination—Aruba, as the case study. Other studies has shown possible contributions of individual case studies to scientific generalizations through replication, where the mode is analytical generalization [7]. The goal is then to grow and generalize theories, and not to enumerate frequencies (statistical generalizations). Constructing theory from case studies is a research strategy that involves at least one case to create theoretical constructs, propositions, and/or mid-range theory from case-based empirical [8].

2. Material and Methods

2.1 Normalized Difference Vegetation Index (NDVI)

NDVI is a numerical value that makes use of the visible and near-infrared bands of the electromagnetic spectrum, and is adopted to analyze remote sensing measurements and assess whether the target being observed contains live green vegetation or not. NDVI is calculated as: NDVI = (NIR − VIS)/(NIR + VIS), where NIR is Near-Infrared Light and (VIS) is Visible Light [9]. Usually, healthy vegetation will absorb most of the visible light that falls on it, and reflects large portions of the near-infrared light. On the other hand, unhealthy or sparse vegetation reflects more visible light and less near-infrared light. Bare soils will reflect moderately in both the red and infrared portion of the electromagnetic spectrum [10]. Calculations of NDVI range from minus one (-1) to plus one (+1). No vegetation gives a value close to zero. Values close to +1 (0.8-0.9) indicate the highest possible density of green leaves [11]. NDVI has found a wide application in vegetative studies. Some studies have analyzed the relationship between the North Atlantic Oscillation (NAO) atmospheric mode and vegetation activity (NDVI) in southwest and northeast Europe [12]. They showed that the behavior of vegetation reflects the different response of surface climate to large-scale atmospheric variability associated to the NAO mode. Other authors have taken several cities in Guangdong Province, China as study areas to assess the long-term relationship between population growth and vegetation cover, using NDVI and the panel cointegrated regression method [9]. Their results indicated that there is a long-term inverted N-shaped curve relationship between population growth and vegetation cover in the region where there are numerous human activities and the influence of climate change on vegetation cover changes is relatively small. Their results further showed that not only will the consuming destruction effect and planting construction effect induced by the population growth have a great impact on vegetation cover changes, but vegetation cover fluctuations will also influence the population growth in the long term. NDVI was used also to analyze the vegetation response to rainfall supply in semi-arid regions of Africa [13]. The authors found that mean annual rain-use efficiency was the highest in Southern Africa. In both Southern, Eastern and Western Africa, the correlation between rainfall and NDVI regimes was found to be significantly high. Other scholars have looked into the causal relationship between NDVI and CO_2 [14]. The authors were able to identify regions where and months when disturbances to the terrestrial biota "granger cause" atmospheric CO_2. The authors were also able to find areas where and months when disturbances to the atmospheric concentration CO_2 generate changes in NDVI.

2.2 Case Study Aruba

Aruba is a small island located about 32 km from the Northern coast of Venezuela, and has an area of about 180 km^2. The island has a tropical steppe, semiarid hot climate with the wind coming for more than 95% of the time from the northeast and the southeast direction over Aruba, with an average speed of 7.3 m·s^{-1} at 10-meter distance (1981-2010) [15]. Aruba's average temperature is 27.9 ^{o}C while fluctuating from 19.0 ^{o}C to 36.5 ^{o}C. On average (1981-2010), Aruba receives 471.1 mm of rain [16]. The natural vegetation consists of scrubs bushes, scattered dividivi trees (caesalpinia coriaria) and xerophytes. The soil type of Aruba is generally shallow, except for pockets of deeper alluvium and high percentage of gravel and stones. Agriculture is underdeveloped and limited to a few small gardens for vegetables. Most fresh fruits, vegetables and other agriculture products are imported [17]. Aruba has a little more than half a century of experience with the tourism industry. In 1959, Aruba built its first 100-room hotels, modeled after similar ones in Florida and Puerto Rico [18]. In the early part, the tourism industry played only a small role in the overall economic development of the island, given the dominant position of an oil refinery, the Lago Oil and Transport Company, Ltd. [15]. This state changed drastically in 1985, when the oil refinery closed its doors, considerably shocking the Aruban economy [15]. This critical situation forced the government to search for a new source of economic activity. The most palpable way was to expand the tourism industry. The number of hotel rooms more than tripled, from 1986 to 2011, where the majority of visitors came by airplane [15]. The United States tourist, accounting on average for roughly 63.5% of all stay-over visitors among 1981-2011, makes the biggest market for Aruba. The Venezuelan market is the second largest for the island, accounting on average for about 13% of all stay-over visitors to the island [15].

2.3 Methodology

The basis for this study is the conceptual scheme depicted in Fig. 1, where causality will be investigated between, on one hand, vegetation, and both GDP and tourism demand, on the other hand.

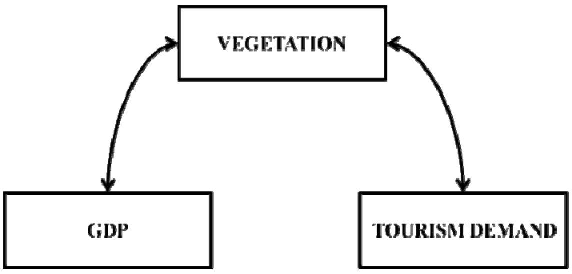

Fig. 1 Conceptual framework of the relationship among vegetation, GDP and tourism demand.

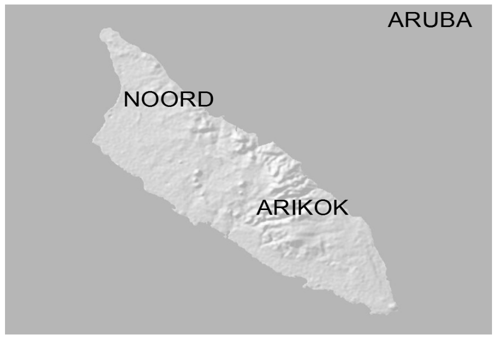

Fig. 2 Map of points of interest.

In order to investigate if the increase in tourism and GDP on Aruba had an influence on the vegetation, the authors selected two specific areas of the island (Fig. 2). Area 1 (ARIKOK) is located in the national park in the central part of the island. This area has restrictions on commercial and residential buildings and limited tourist activities and therefore, expected to have less influence of tourism and economic development. Area 2 (NOORD) is located at the western part of the island near the high-rise hotels. The western part of Aruba has experienced the highest tourism development and activities since 1986, with most of the available hotel rooms and restaurants located in that area.

NDVI time-series were collected from the Vegetation Index and Phenology (VIP) Lab at the University of Arizona [19]. Their vegetation indices are composed from global MODerate resolution Imaging Spectroradiometer (MODIS), Advantage Very High Resolution Spectroradiometer and Satellite Pour l'Observation de la Terre 4 (SPOT4). The VIP lab processed the data into a seamless and sensor independent record using a suite of community algorithms for data filtering, across-sensor continuity, Vegetation Index (NDVI and EVI2), land surface Phenology and spatial and temporal gap filling. The current version 3.0 is suitable for studies of land surface vegetation dynamics, long term change and trends, anomalies, and can aid various ecosystem and climate modeling [20].

Tourism development is proxied by the total number of stay-over visitors (TOUR) for 1981-2010. The economic growth is proxied as the value of all final goods and services produced in Aruba in one year given by the Gross Domestic Product value (GDP). Both TOUR and GDP data are from the Central Bank of Aruba for the period 1981-2010. The data were collected on an annual basis, whereby, the series were all transformed to standardize anomalies in order to work simultaneously groups of data that are related but not strictly comparable [21]. Having determined standardized anomalies, the next step is to assess whether these time-series are stationary. This study used the Augmented Dickey-Fuller test (ADF), Phillips-Perron test (PP) and the Kwiatkowski-Phillips-Schmidt-Shin test (KPSS) [22-24]. Studies done by other scholars showed that the KPSS test is often used as an added value of the ADF and PP tests, which in order to get more robust results [25, 26]. Separate from the standard unit root tests, the authors computed the Andrews and Zivot test and the Clemente, Montanes and Reyes test [27, 28]. Standard unit root test can confuse structural breaks and label a stationary variable as a non-stationary time-series. Andrews and Zivot provided a unit root test in the presence of one structural break. The Clemente, Montanes and Reyes test can handle two structural breaks and can distinguished between additive outliers and innovational outliers. Additive outliers captures sudden change, while innovational outliers allows for a gradual shift in the mean of the time-series [29].

The tests for stationarity are performed both on the levels and the first differences of the variables. Commonly, the assumption of stationary economic variables can be assumed to hold after differencing these series [30]. Following the test for stationarity, the authors proceeded with an Autoregressive Distributed Lag (ARDL) bounds testing procedure to assess the long run equilibrium relationship among the constructs. The ARDL model is a general specification, which makes use of the lags of the dependent variable and the lagged and contemporaneous values of the independent variable, through which short-run effects can be estimated directly and long-run equilibrium relationships can be estimated indirectly. The ARDL has several benefits over other methods of cointegration. First, it can be employed regardless of whether the underlying variables are I(0), I(1) or a combination of both. Second, the Error Correction Model (ECM) can be derived from ARDL through a simple linear transformation, which integrates short-run adjustments with long-run equilibrium without losing long-run information. Third, the ARDL approach is more robust and performs better for smaller sample sizes compared to other cointergration techniques [31]. The appropriate lags in the ARDL model are corrected for both serial correlation and endogeneity problems [32]. Fourth, the ARDL method can distinguish between dependent and explanatory variables. Dummy variables were used to simulate years that had structural breaks. The ARDL approach involves approximating the following Unrestricted Error Correction Model (UECM):

$$\Delta ARIKOK_t = \alpha_0 + \alpha_1 ARIKOK_{t-1} + \alpha_2 TOUR_{t-1} + \alpha_3 GDP_{t-1} + \sum_{i=1}^{n} \beta_1 ARIKOK_{t-i} + \sum_{i=1}^{n} \beta_1 TOUR_{t-1} + \sum_{i=1}^{n} \beta_1 GDP_{t-1} + \varepsilon_{1t} \quad (1)$$

$$\Delta NOORD_t = \alpha_0 + \alpha_1 NOORD_{t-1} + \alpha_2 TOUR_{t-1} + \alpha_3 GDP_{t-1} + \sum_{i=1}^{n} \beta_1 NOORD_{t-i} + \sum_{i=1}^{n} \beta_1 TOUR_{t-1} + \sum_{i=1}^{n} \beta_1 GDP_{t-1} + \varepsilon_{1t} \quad (2)$$

Where, Δ is the first difference operator, α and β are coefficients. The F-test is employed to examine whether a cointegrating relationship exists among the variable. The null hypothesis of no cointegration among the variables for Eq. (1) is $H_o = \alpha_1 = \alpha_2 = 0$, against $H_a = \alpha_1 \neq \alpha_2 \neq 0$, which is indicated as F_{ARIKOK}(ARIKOK│TOUR, GDP) for Eq. (1). Likewise for Eq. (2), the null hypothesis of no cointegration among the variables for Eq. (2) is $H_o = \alpha_1 = \alpha_2 = 0$, against $H_a = \alpha_1 \neq \alpha_2 \neq 0$, which is indicated as F_{NOORD}(NOORD│TOUR, GDP) and so on. The F-test has a non-standard distribution, which hinge upon whether variables included in the ARDL model are I(0) or I(1); the sum of the regressors, whether the ARDL model has an intercept or a trend and the sample size. Two sets of critical F values are provide for large samples [32, 33] while a special set has been calculated for a sample size ranging from 30-80 variables [34]. For all three sets, one assumes that all variable in ARDL model are of the type I(1) while the other assumption is that all variables are of the type I(0). If the calculated F-statistics falls beyond the upper critical value, the null hypothesis of no cointegration will be rejected irrespective of whether the values are I(0) or I(1). If the value is below the lower value, the null hypothesis of no cointegration cannot be rejected. If the value falls inside the critical value band, inference remains inconclusive and one should check other cointegration procedures such as the Johansen and Juselius [35]. The ARDL bound test requires prior knowledge of the stationarity of the data series used. The ARDL bound test can only be used for I(0) and I(1) variables. The presence of I(2) variables will invalidate the results of the computed F-Statistics, therefore,all variables need to be I(0) or I(1) [36].

Although the ARDL model tests for existence of or non-existence of long run relationships among the variables, it does not test for the direction of causality. Therefore, one needs to conduct a VEC to find the causality between the variables if they are integrated of order 1 (I(1)). If the variables are not integrated (I(0)), one can proceed with a simple VAR to find the causality among the variables. The Granger causality test will be applied to either the VEC or the VAR depending on the results of the cointegration [37].

3. Results and Discussion

All estimates were obtained using EVIEWS version 7.2, and Stata version 13. The authors determined the maximum number of lags for the stationarity calculations, following Eq. (3) [38]:

$$P_{max} = \text{int}\left[12 \text{ x} \left(\frac{T}{100}\right)^{\frac{1}{4}}\right] \quad (3)$$

Where, P_{max} indicates the maximum number of lags and T indicates the maximum number of observations. Here, T = 30 for all of the variables, and the maximum lag length was therefore, established at 8. Next, the optimal lag within that maximum was determined, based on the minimum of the SIC. For almost all the applied variables, the optimal lag length was between 1 and 6. The optimal lag lengths were subsequently applied in the ADF test. The KPSS and the PP test do not require setting an optimal lag length, and could be immediately calculated. Results for the non-structural break stationarity test (ADF, KPSS and PP) are shown in Table 1, results for the Clemente Montanes and Reyes test are shown in Table 2, and Table 3 gives the results for the Zivot-Andrews test. The summary of all the unit root test, and chosen integration are given in Table 4. Given these results, it can be concluded that the series are integrated at different orders, therefore, confirming the need of an ARDL bound test.

Since annual data is used, an initial maximum lag

Table 1 Unit root results.

Variables		ADF	PP	KPSS
	Level	-1.282661**	-1.348097**	0.430038*
ARIKOK	First diff.	-5.155952	-5.534691	0.500000**
	Integration	I(1)	I(1)	I(0)/I(1)
	Level	-2.856945	-2.863002	0.465649**
NOORD	First diff.	-8.323637	-10.03535	0.186016
	Integration	I(0)	I(0)	I(1)
	Level	-1.211595***	-0.984471***	0.618686**
GDP	First diff.	-3.062536	-3.062536	0.166244
	Integration	I(1)	I(1)	I(1)
	Level	-1.178587***	-0.892174***	0.656095**
TOUR	First diff.	-1.167435***	-3.043886	0.114761
	Integration	I(2)	I(1)	I(1)

* The symbols ***,** and * indicate the 1%, 5% and 10% levels respectively.

Table 2 Clemente-montanes-reyes unit root tests with two structural breaks.

	Innovative outliers				Additive outliers			
	t-stat SB1 SB2 decision							
ARIKOK	-7.01	1997	2002*	I(0)	-6.27	2001*	2005*	I(0)
NOORD	-6.19	1987	2003*	I(0)	-4.90	1985	2001*	I(1)
GDP	-3.33	1989*	1995*	I(1)	-4.23	1990*	1996*	I(1)
TOUR	-5.73	1987*	2002*	I(0)	-3.12	1991*	2005*	I(1)

* SB1 and SB2 denote the structural break dates suggested by the tests, * indicates that the structural break suggested by the respective test is significant at 5% level, critical value at 5% is -5.490.

Table 3 Zivot-Andrews unit root test.

	ARIKOK	NOORD	GDP	TOUR
Lags included*	0	0	1	1
Minimum t-statistics	-5.836	-5.367	-3.305	-4.055
At year	2004	1985	1993	1990
5% Critical value	-4.80	-4.80	-4.80	-4.80
Decision	I(0)	I(0)	I(1)	I(1)

* Lags for the difference of the series selected via t-test.

Table 4 Summaries of unit root tests.

Variables	ADF test	PP test	KPSS test	Zivot-andrews	Clemente et al. IO model	Clemente et al. AO model	Final decision
ARIKOK	I(1)	İ(1)	İ(0)/I(1)	I(0)	İ(0)	I(0)	I(0)
NOORD	I(0)	I(0)	I(1)	I(0)	I(0)	I(1)	I(0)
GDP	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
TOUR	I(2)	I(1)	I(1)	I(1)	I(0)	I(1)	I(1)

length of 2 m is used for the ARDL calculations [39]. The results of the bounds test for cointegration together with the critical values are reported in Table 5. The ARDL model was tested for lags 2 and 1. The model was subjected to a serial correlation test, and the lag model with the lowest AIC and SBC values were kept for calculation. The bounds test shows that no cointegration exists in the equation involving ARIKOK, GDP and TOUR.

On the other hand, the bound test showed that for NOORD as dependent variable, there is a long run relation with GDP and TOUR at 95%. Since the variable NOORD was cointegrated a granger causality test among the variables NOORD, GDP and TOUR, via a VEC model was used. The VEC model is defined as Eq. (4) [40]:

$$\Delta NOORD_t = \sum_{i=1}^{k}\gamma_{1i}\Delta NOORD_{t-k} + \sum_{i=1}^{l}\gamma_{1i}\Delta GDP_{t-l} + i=1m\gamma 1i\Delta TOURt-m + \pi ECTt-1+\varepsilon 1t+dummy \quad (4)$$

Where,

γ = coefficients;

ECT = error correction term;

ε_1 = residual term, the term is independently and normally distributed, with zero and mean and constant variance.

A VEC model will give you both long and short run causality information. The short-term is determined with a F-statistic (Wald test) on the coefficients of TOUR and GDP, and the long-run determined by the sign of the value of coefficient of the ECT and its significance. The VEC model showed long-term relationship running from tourism demand and GDP towards the NOORD variable. The model further showed that there exists short-run relationship between tourism demand and the variable NOORD (Table 6).

The long term causality could have been expected, since other studies such as in China, showed also a relationship between GDP and vegetation amount. As was shown in Chongqing City, China vegetation distribution and growth did not increase steadily nor rapidly like GDP and population with sustainable increasing trends from 1998 to 2005 [41]. Negative correlations were observed in relatively developed areas nearby the center of the city where rapid economic

Table 5 Bounds test for cointergration.

Dependent variable	Function			F-statistics
	F_{ARIKOK}(ARIKOK │ TOUR, GDP)			2.327787
	F_{NOORD} (NOORD │ TOUR, GDP)			4.549567
N = 2		**I(0)**	**I(1)**	
*F-critical at 5% level		2.695	3.837	

Table 6 Causality testing NOORD, GDP and TOUR.

Dependent variable	ΔNOORD(-1)	ΔNOORD(-2)	ΔGDP(-1)	ΔGDP(-2)	ΔTOUR(-1)	ΔTOUR(-2)	ECT_t
ΔNOORD	0.060790	-0.072507	-1.991593	-0.517388	2.158408 ←	2.254072 ←	-1.215154 ←
ΔGDP	0.000245	-9.20E-06	0.573032	-0.101618	-0.133755	-0.025764	0.018852
ΔTOUR	-0.024986	-0.017851	0.262928	0.119159	0.252303	-0.332673	0.055396

* Direction of significant (95%) causality ←, →.

development and urbanization made vegetation decrease both in distribution and productivity. For the short term, causality running from tourism to the vegetation in the NOORD area, other authors have seen this also in other places. For example, in Australia, direct impacts of recreation and tourism has been noticed due to clearing of vegetation for infrastructure or damage from trampling, horse riding, mountain biking and off road vehicles [42]. They further noticed that damages to the vegetation is not just restricted to the initial removal of vegetation. Some construction and use of roads and tracks can result in changes to hydrology and soils including erosion, sedimentation and pollutant runoff in adjacent areas. On Aruba, the causality is most probably explained by the increase in infrastructure and buildings near the hotel area due to tourism. Data from the Central Bureau of Statistics on Aruba shows a marked increase in population from 1991 through 2000 in the area selected as NOORD [43]. This probably has to do with the development related to tourism in that region. Therefore, one would expect more clearing of vegetation for the building of houses. It is mainly an island environment that is the attraction to tourists, but as a paradox the environmental consequences of what has happened in the name of tourist development has been destructive [1]. This is especially for islands that have enthusiastically embraced mass tourism and allowed unbridled bridled hotel development and resort construction. In, actuality, these places were the coastal and marine environments have suffered. Some scholars have indicated that inland mountainous interiors have escaped these severe effects, since most modern tourist development and infrastructure provision was a confined narrow coastal zone [1]. Small-island ecosystems, both in the Caribbean and the Pacific, appear to be very prone to overuse and can quickly become overwhelmed by the rapid and uncontrolled growth of tourism, tourism-related related activities, and the modernizing activities that accompany residential development, commercial growth, infrastructure structure expansions [1].

Since the variables ARIKOK, GDP and TOUR were not cointegrated, the authors proceeded with a VAR test in order to find possible short-term causalities. The VAR model is specified as:

$$ARIKOK_{xt} = \ a_1 ARIKOK_{t-1} \ldots. + a_p ARIKOK_{t-p} + b_1 GDP_{t-1} \ldots. + b_p GDP_{t-p} + c_p TOUR_{t-p} \ldots. c_p TOUR_{t-p} + \mu_t \quad (5)$$

Where,

a, b, c = coefficients;

μ_t = uncorrelated white-noise error term.

The VAR model is based on the Toda Yamamoto procedure for the test for granger causality [44]. Here, the authors test the null hypothesis on the absence of granger causality among ARIKOK, GDP and TOUR. The Toda Yamamota granger causality model for ARIKOK showed that there does not exist short-term causality among ARIKOK, TOUR and GDP (Table 7). So, the model showed that there is no relationship between the vegetation in the central part of Aruba and fluctuations in tourism demand and gross domestic product.

This is in contrast to the variable NOORD and other studies which showed that GDP and tourism could have an impact on the vegetation [45, 46]. These authors noticed that ecological damage due to tourism is not only limited to the initial removal of native vegetation, but other factors also. For example, the construction and use of roads can cause changes to

Table 7 Causality testing ARIKOK, GDP and TOUR.

Dependent	ARIKOK (-1)	ARIKOK (-2)	ARIKOK (-3)	GDP (-1)	GDP (-2)	GDP (-3)	TOUR (-1)	TOUR (-2)	TOUR (-3)
ARIKOK	0.619	-0.063	0.058	0.205	0.647	0.387	0.967	-2.291	0.3036
GDP	-0.058	0.110	-0.088	1.234	-0.689	0.037	0.270	-0.204	0.357
TOUR	-0.059	0.068	0.039	0.250	-0.204	-0.033	1.325	-0.560	0.183

hydrology and soils erosion and pollutant run-off. These studies also noticed that even at protected areas, such as ARIKOK, with no infracstructure change, the tourist practicing back country activities can cause vegetation to be crushed, sheared off and uprooted. These results will cause changes to the vegetation height, biomass, reduction in cover, reproductive structure [47].

Other studies on plants showed that features of plant morphology can make a plant more resistance to damage [42]. Therefore, communities dominated by more resistance plants types will be damage at higer use values compared to areas covered with more sensitive plants. Therefore, in some communities/areas, plants can recover faster from induced disturbances than in other. Climatic zone type was also shown to influence the response of vegetation to recreational and tourism use. Aruba has a tropical steppe, semiarid hot climate. It is windy and generally dry with only 65 days of rain more than 1 mm. Most of the rain falls mainly from October through January [16]. The climate is a factor in the types of plants on Aruba, where most have to be resistant to drought. Except for climate of an area, the soil type of the area will also influence the plant types [48]. The ABC island which includes Aruba have mainly soils consisting of basalt and limestone. The basalt type may contain minerals, but it will not hold water very well. The limestone on the other hand can hold water, but is poor in minerals. Another factor that influenced the vegetation on the ABC islands was the introduction of goats many years ago. Therefore, only plants that are capable of deterring the goats would survive and plants resistant to the harsh Aruban climate [48]. The area defined as ARIKOK is a protected area with limited development. Tourist can hike or drive vehicles at certain areas. The vegetation in the ARIKOK area would also be considered as a highly resistant vegetation that can recover fast. Therefore, the authors believe these limitations are the main reason for not seeing any causalities among ARIKOK, GDP and TOUR. The resistant type plants would recover fast from any damage from the tourist visiting the ARIKOK area. The ARIKOK area falls, also, within the national park zone, limited construction would be allowed, therefore, limiting the effect of economic development.

4. Conclusion

This study analysed the relationship between the vegetation index NDVI with tourism demand and economic growth on a small island. The idea was to gauge an insight between the island vegetation's health and the influence of tourism and economic growth of the island on the islands vegetation. Two areas were selected, one near the hotels and another in the central part of the island. The hotel area showed long-run causality from GDP and tourism towards the vegetation near the hotel areas, and short run causality from tourism to vegetation near the hotel area. The relationship was explained due to tourism-related related activities, and activities that accompany residential development, commercial growth, infrastructure structure expansions. On the other hand, for the vegetation on the central part, no causality was found between the parameters. This was explained due to the vegetation type, and lack of tourism development in this area. Most of the central part of Aruba falls within the protected national park area.

Some authors have reasoned that to approach a realistic future policy for small islands in the twenty-first century, both the public and private sectors must consider creating limits to tourism growth and expansion), where they suggest that small islands with limited natural resources and small terrestrial bases would do better targeting tourism niches and opting for quality over quantity [1]. Some highly capitalized tourist ventures, by their very size and scope, could threaten the fragility of small-island ecosystems in the Pacific and the Caribbean, in large part because their capital power could dominate the local governments, rendering the local government impotent and weakened in resolve to protect their societies landscapes and natural habitats [1]. On Aruba, the authors noticed that the areas with the main hotel developments have a relationship with the vegetation in that area. On the other hand, in 1995, the nature protection regulation ordinance became effective on Aruba, therefore, making the central part of Aruba a national park. The protection of this area paid off, since no relationship with tourism or GDP with vegetation amount in this area were found. Some limitations may apply to this study. Firstly, limitation is that the study was based solely on one destination, mainly Aruba. Secondly, there was no real-time measurements available on the amount of buildings built in the hotel areas, the amount was measured indirectly and assuming that more tourist would mean more housing and business development.

Future research should include a database based on aerial pictures and measurements of plant types. Since there might be a possibility that future NDVI measurements might be camouflaged by plants imported by the hotels and business development projects, while indigenous plants itself would be lost. Future research should also focus on the possibility that economic developments itself could have introduce harmful plant diseases and therefore, worsening the effect of plant loss.

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