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THE IMPACT OF CLIMATE CHANGE IN THE LOCAL DEVELOPMENT OF SIDS

I declare in lieu of oath, that I wrote this thesis myself. All information derived from the work of others has been acknowledged in the text and the list of references is given.

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Zásady pro vypracování

Small Island Developing States (SIDS) do not follow a specific or determinate track of evolution, instead they present unique geographic, economic, political and cultural characteristics that creates in them a specific case with its own challenges to implement strategies for sustainable development. These territories tend to suffer excessive consequences from the decisions taken by the develop countries, specially with the results of over-consumption, large quantities of greenhouse gases generated, and the evolution and deterioration of the environment, creating an increasing and uncontrollable posture of vulnerability, that in SIDS according to the Organisation for Economic Co-operation and Development (OECD) results in at least 73 percent more vulnerable than other upper middle income developing countries. Consequently, it results important to go further into the examination of the impact of this state of susceptibility to climate change that affect not only the local conditions for development within each of the islands but also on the perception of the international community towards different kinds of aids that are key factors to ensure a long run sustainable development and the environmental conservation.

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OECD 2018. Making Development Co operation Work for SIDS. Organisation for Economic Co operation and Development OECD.

UNEP 2014. Emerging issues for Small Island Developing States. Results of the UNEP Foresight Process. United Nations Environment Programme UNEP, Nairobi, Kenya.

Pelling M, Uitto. J 2001, Small island developing states natural disaster vulnerability and global change, Global Environmental Change Part B Environmental Hazards, Vol 3 1

Sutton, P, Payne, A. 1993. Lilliput under Threat The Security Problems of Small Island and Enclave Developing States. Political Studies, 41 4, 579 593.

ANDERSON, A. 2012. Climate Change Education for Mitigation and Adaptation. UNESCO Special Section on the ESD Response to the Three Rio Conventions, Vol 6 191 206

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ABSTRACT

The Small Island Developing States (SIDS) are a group of nations that constantly faced climate hazards due to the irresponsible and constant greenhouse gasses (GHG) emissions, creating a disproportionate imbalance of consequences and responsibilities between significant and small issuers. The possibility of implementing a mitigation and adaptation project considers a certain amount of financial aid, but it does not study the challenges behind building an effective network between new technology and the local community.

The path that delineates the number of emissions of GHG gives a clear panorama on the amount of carbon dioxide (CO2) that will be emitted on different socio-economic scenarios with different consumption and production behaviors and the implementation of climate public policies.

Finally, the proper inclusion of the local community into decisions related to climate change adaptation, resilience strategies and economic growth create a synergy between the international community expectations on how a strategy should be implemented and what the local community needs.

Key Words: SIDS, Climate Change, CO2 emissions, Human Development Index, Local Strategies, Adaptation.

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List of abbreviations

SIDS – Small Islands Developing States

UN – United Nations

UNEP – UN Environment Programme

GHG – Greenhouse gasses

CO2 – Carbon Dioxide

RCP – Representative Consumption Pathways

ODA – Official Development Aid

HDI – Human Development Index

COP – Conference of the Parties

CGE – Computable General Equilibrium

IPCC – Intergovernmental Panel on Climate Change

SRES – Special Reports on Emission Scenarios

CARICOM – Caribbean Community

AOSIS – Alliance of Small Island States

OECD – Organization for Economic Cooperation and Development

OECS – Organization of Eastern Caribbean States

BPoA – Barbados Programme of Action

UN-OHRLLS - UN Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States

CCCCC - Caribbean Community Climate Change Center

EVI – Economic Vulnerability Index

LSCI – Linear Shipping Connectivity Index

CVI – Coastal Vulnerability Index

1 Introduction

While the convergence on the definition of SIDS is accomplished, the political and scientific world has not reached a general consensus, which has created a constant evolution of its classification, starting from a limit of the population size in each of the nations, to the geographical area that each of them occupies, including their length in coastal area, as well as the isolation and remoteness. This makes an emphasis in one of the main aspects that create a specific characteristic that each of the 52 countries (38 United Nations [UN] members and 14 Non-UN members) have. All the islands that belong to this group have faced singular and specific problems: insularity, remoteness, lack of diversification in productive processes, high dependence on tourism and low exportation of agricultural goods, high costs in transportation, and extreme vulnerability to external shocks (UN Environment Programme [UNEP], 2014); this has made any the nation-island vulnerable to the slightness change in climate, which creates a disproportionate consequence in the imbalance of the economic and social structures of the territories.

Local development in small islands continually suffers the ravages of strong climatic events that each year turn more violent, largely because around 90 % of the islands are located in the tropics and most of their territories result to be in their extent coastal. Meanwhile, the international community has been slowly recognizing the fact that a drastic change is needed in the contaminating production processes, with the main aspect of high emissions of greenhouse gases as the main characteristic of the economic activities. That results in the need to slow down the warming process that the Earth is suffering; this, as a measure to reassure a healthy future and release the stress that climate change represents for small and local economies that are not able to adapt fast enough to guarantee their sustainability, growth and existence. How will the radiative force path that the world is modeling right now affect developing islands in the long run?

Is it possible to understand and estimate the impact of GHG emissions in the near future when the era comes to an end? While it is impossible to answer this question with a 100 % of certainty under the available information provided, it is plausible to estimate some consumption paths, focusing on the trajectories of radiative forces, land use and socio-economic scenarios that have been called representative consumption pathways (RCP). Van Vuuren et al. (2011a) remarked that "the representative consumption pathways (RCP) are the product of an innovative collaboration between integrated assessment modelers, climate modelers, terrestrial ecosystem modelers and emission inventory experts" (p. 5). Therefore, the human behavior of production and the emission of GHG that comes with it will guide the radiative forces to a specific path and, with it, predict on a certain level the security that societies and countries will develop.

It should be noticed that the impact of GHG emissions continues to be unpredictable, but there is an assurance that, to keep following the path of a behavior characterized by "business as usual", the amount of these harmful gasses that constantly raise the temperature of the Earth surface will have an impact. The

questions are: how will it impact small communities? Or, more precise, how the growing emission of CO2 and other toxic gasses will impact the local development of SIDS? And therefore, Why SIDS? SIDS are one of the most vulnerable groups of nations that will suffer the more of the consequences of climate change, as their emission of CO2 per capita its minimum compared to developed countries', but the impact becomes 10 times larger in these small developing states than in countries that bear much more of the responsibility.

Moreover, how does the imbalance in the environment affect the local economies, health and education of small communities in SIDS? This is a question that highlights that not every country is held responsible on equal share for their emissions and consumption behavior that peculiarly trespassed the Earth's boundaries, bringing more developed countries to the corner on how they should interfere into helping to cope with the devastation of global warming. A plausible path of emissions of GHG –as literature mentioned– is the RCP 4.5, which stabilizes radiative forcing at the same level (Thomson et al., 2011) and presents a peak of the emissions just before 2100, but continuously creates a series of disproportions and a predicted increase of the temperature of 2.4 degrees at the end of the era, in comparison to pre-industrial times. How will an increment in the temperature, measured in CO2 emissions during the following years until the end of the era, affect directly and indirectly the capacity of developing SIDS?

In the following work, the specification and definition of RCP are shown. The following section contains a detailed literature review and the gaps on how SIDS are hardly included on climate literature and on the lack of responsibility from developed countries regarding past and present emissions, as well as the help provided for the mitigation and adaptation in the form of official development assistance (ODA). Next, there is an explanation and a justification on why RCP are viable or not to predict a possible future, which continue with a detail explanation of a study case that considers six SIDS from different global regions. This, after analyzing economic and social indexes as pre-existent conditions, and how the constant increase of CO2 affects its human and economic developments while making a comparison of the consequences between SIDS and their regions with the possible scenario of RCP 4.5 radiative force and how it will affect the development of SIDS. Also, the study case will allow to determine how a change on the emissions affects directly the HDI under a panel data model, considering the possible and predicted values for emissions at the end of the era, and a discussion of local interventions for global problems to reduce mitigation and adaptation problems in the islands at the same time than the maximization of international aid and last conclusions.

2 Literature review

SIDS faced a modest notoriety and participation in global decision-making and on the effects of the events that occurred or may occur in these territories; therefore, the inclusion, availability and further exploration of the academic sphere on SIDS-related topics have not been extensively explored until recent years in the same way as other sovereign nations that influence markets, diplomacy and global politics more strongly.

Likewise, the role of the environment in local communities belonging to SIDS its characterized by the use of centuries of traditional knowledge and methods for coping with changes in their ecosystem during their whole existence, as communities passed from generation to generation by myths and oral traditions how to endure the sustainability of their economic activities while adapting to external changes. Eventually, with the apparition and growth of international markets and a more globalize world, a perceivable increase of energy demand, the exhaustion of natural resources and the surpass of planet boundaries, conditions that have put in check the ancestral methods of adaptation and have made necessary mitigation systems in hand with more technological and suitable adjusting programs to ensure economic growth have faced modern solutions. The new necessity to research and give policy makers a clearer picture on how to intervene to ensure a long-lasting and sustainable development in SIDS creates a new and emerging path to scientist, economist and politicians to build adequate research programs to intervene efficiently and, thus, ensure the continuity of communities and environments across the globe.

Departing from theories and methods on how the future of the Earth is going to look like, there are different possibilities and hypotheses about the behavior of relations between countries and humans, as well as the environment and the economic activities that will prevail or disappear. That's why most of the literature available works on possible futures, predicting temperatures and the raise of the oceans, considering the past and present behavior of societies, comparing with pre-industrial times, and the possible changes that should be made in their consumption behavior and their way of producing, leading to paths and patrons of the climate.

2.1 Local development and climate change in SIDS

The impact of climate change has been a trend topic for the last decades, relentless focusing on how more developed nations would be affected or on the incidence of more violet climate hazards that could affect indirectly their production means or travel schedules. Meanwhile, the focusing point on developing countries has been slowly reaching notoriety, as these nations do present not only higher vulnerability, but they continue to face several challenges of development and, at the same time, they deal with unexpected and stronger environmental events. For SIDS, the recognition of international spheres for development as nations and communities in danger has created a strong base to motivate exhaustive and detailed research and consideration

of the impact of climate change in countries that present an economic, social, historical and environmental differentiation as SIDS result to have.

For now, the consequences of climate change in SIDS have much left to been said, literature gaps are still present, and the analysis is mostly focused on an economic or governmental generalized panorama, where local or community level adaptation or mitigation strategies and projects do not receive much attention because of the believe that they are short-range strategies.

As discussed by Wade & Jennings (2015), it results undeniable that the effect of climate changes is perceived differently between developed and developing countries. In a series of analysis, they included the dependence on different economic activities that each of the countries relies their economy on, in which there is a large acknowledgement and emphasis that countries that heavily relied on climate sensitive sectors as agriculture, forestry and tourism are the ones to suffer negatively the continued effects of global warming, being the activities mentioned above the main economic areas of SIDS. This, while adding to the mix a political consideration: "The aftermath of natural disasters often falls on authorities who are forced to spend vast amounts on clear-up operations and healthcare costs that come with experiencing extreme weather" (Wade & Jennings, 2015, par. 8). This way, a storyline about how the productive areas of SIDS is created; these represent a large part of economic machinery of the islands, those that face the consequences of climate and expose vulnerability and lack of diversification, bringing up-front an economic problem and poverty issues for native people that, besides of presenting a full dependency for natural resources, their economic behavior is characterized by survival production without generating a surplus.

On the other hand, Mendelsohn, Dinar & Williams (2006) created a clear path that concludes that a raise in the temperature of the Earth does have a distributional impact across countries. This gap becomes larger between "rich" and "poor" countries, where not only a higher temperature could benefit regions that are characterized to be cold or with seasons; the fact that they encounter with adaptation as a survival and coping strategy implies higher monetary costs that most of developing countries cannot face in terms of financing the project or having enough specialized human capital. While the study presents two main scenarios where a) all countries face identical climate change, and b) all countries face same initial climate, the results do reach a consensus in which poor countries feel global warming more deeply as one of the main sectors affected is agriculture. This activity plays an important role in the economic sphere of non-industrialized nations.

Although the results also highlight the sensitivity that some developed countries achieve with an increase in temperatures, it acknowledges that, for some countries with seasons, an increase in temperature is even beneficial and it does not imply a large damage in comparison to nations that are located on the tropical areas of the planet. Local communities will need to cope and adapt on a faster pace to global warming conditions, but considering the under financial capacities compared with the level of impact, global measures are needed

to be taken, as suggested by the authors. Also, it is necessary to consider cross-national compensation, having in mind that most of the developing countries "will bear the brunt of the damages from climate change even though they made only a small contribution to cumulative emissions" (Mendelsohn et al., 2006, p. 175). SIDS face not only the adaptation costs of climate change, but they also have to deal with the lack of aid and adequate international cooperation; these target projects of adjustment where the aim is to help with unexpected and expected climate hazards at the same time, in order to cover local necessities that should include the community participation.

Similarly, Hallagatte, Dumas & Hourcade (2010) accentuated that the uncertainty that global warming brings can be segmented into three spheres: "the change in climate itself, the change´s impacts at the sector level, and their macroeconomic costs" (p. 1), with the consequence that it could be translated into an unknown path to obtain several outcomes that guarantee the achievement of sustain growth of any economy, especially to the ones developing as in SIDS. At the same time, it also put through its pace the adaptation capacity of each of the nations that face directly and indirectly any increase in atmospheric or oceanic temperatures. As these adaptation processes put into test how governments respond to the sudden increase in costs, they also created a noticeable panorama of the time gap of response and mitigation of each of the affected developing and developed nations, with an exponential increase of risk, due to high temperatures in low-income countries, as well as the capacity to successfully respond and deal with the same situations in high-income nations.

The above delineates a clear path, but also a different one to each of the societies that face a disruption of their economies due to the interference in their productive activities and to unpredictable natural events, with a direct link to specific and non-diversified economies with special characteristics, as presented in most of SIDS. An increase in temperature greater than 2° C that continuously alters the coping mechanisms of ecosystems across the globe will also "create a possibility of rapid increase in economic costs at a sector o regional scale due to climate change impacts who pace and magnitude may exceed the uncertain ability of societies to manage changing risks" (Hallagatte et at., 2010, p. 2).

The UNEP has made a meticulous study about the characteristics of each one of the SIDS, but also about the several issues and impacts that they face in their last report released in 2014. The report confirms that the impact of climate change to which SIDS are exposed is totally disproportionate to the carbon emissions they produce during their economic processes, where local communities rely on the surrounding environment and the natural resources availability to extraction, and take advantage of goods for subsistence, generating employment and stablishing a small exportation market. The devastation of the environment impacts directly the capacity to obtain natural resources to meet the needs of the population and, as the consensus of the authors on UNEP (2014) latest report considered:

> It will magnify the vulnerability of SIDS owing to their relatively small land mass; the concentrations of population, infrastructure, and economic activities in coastal areas; and their high dependence on coastal ecosystems for food and livelihood security and protection from extreme events. (p. 43)

The absence of financing means does not only put at risk the regenerative capacity in terms of the physical structure of the islands strongly affected by climatic events, but it also puts at risk the social structure and increases the possibility that these communities fall into conditions of poverty, creating or worsening inequity conditions, limiting the access to quality education and health system, forcing communities to cope through migration or re-location in different territories. This could mean the loss of traditions and ancestral knowledge and, at the same time, the community feeling, which could create an unnecessary diaspora.

While Nurse & Moore (2010) called for an urgent adaptation as "changes are expected to trigger a series of bio geophysical, socio-economic and health impacts" (p. 100), in hand with the fact that a delimitated land size creates a concerning situation in SIDS, their own capacity for adaptation is limited and their resources are scarce, while the environment continue to evolve and get altered by humans. Therefore, the analysis of the international relations between SIDS and continental countries could serve as a response for global warming, in order to help mitigation and adaptation in every region, especially SIDS, with the creation of the Conference of the Parties (COP), as "economic and financial costs of adaptation will be difficult if not impossible for many island state to meet" (Nurse & Moore, 2010, p. 105). The presence of the international community in terms of ODA could follow an important and significant role on how SIDS successfully manage to deal and ensure economic growth in the presence of environmental hazards. The participation of the global community on projects and programs in SIDS, focusing on adaptation or even mitigation, also presents strategies to achieve them; but these imported strategies have left aside the local conception and relationship of nature and humans.

2.2 On global interlinkage with SIDS and climate change

Being part of a globalized world also means that every process or action, despite the place where it occurs, does have a repercussion all over the Earth. The climate vulnerability that SIDS have been dealing with is a truthful example of the disproportionate effect of contamination and high emissions of GHG that are diffused in heavy industrialized countries, which affect nations as SIDS, that are not responsible for any kind of significant emissions through time. The relationship of islands governments and societies with continental institutions is a net of aid, commerce and tourism that counts on financial and technological knowledge interventions for development; some of those are infrastructure or educational projects, climate change mitigation and adaptation, which have become issues and topics of importance towards SIDS. Therefore, there are necessary actions to take, in order to ensure sustainable socio-economic growth.

Moreover, Pelling & Uitto (2001) explored the direct influence of the changing economic scene, political institutional and environmental situation of the global system with the susceptibility and exposure of SIDS, different structures and their capability to react. The high dependence of international markets, especially on tourism and small participation in exportations of raw material of SIDS, creates a constant hazard and accentuates a condition of vulnerability towards the rapid evolution of international industries, that not only pile the market but mostly contribute to the global warming and to the rise of the seas; thus, obtaining a problematic duo for the island territories. Along with the susceptibility, Pelling & Uitto (2001) showed that strategies that lead to keep-up with the globalization way of consumption will conduce to a local environmental degradation, as there will be a combination of local pressure to produce at high rhythms with the global environment change, resulting to place additional stress on local ecologies, a constant cycle of degradation with an intensive industrial production that SIDS do not constitute.

On the other hand, the effect of climate change measure by a computable general equilibrium (CGE) tends to be a standard tool for policy analysis and forecast of economic growth, as mentioned by Kompas, Pham & Chen (2018). Also, the inclusion of change in temperature as an indicator of global warming is a variable needed in every prediction of GDP and price variability, as it represents a major determinant and influence on the production processes, the service deliveries and the generation and transformation of natural resources to human consumption. Every nation can choose either to adopt measures to adapt to climate change or to start rethinking consumption pathways and divert manufacturing means to reduce the environmental impact and prevent higher rises in temperature. The authors acknowledge that the adoption and compliance in a general way by all countries to treaties such as the Kyoto and the Paris agreement are necessary to avoid damage, not only economically, but, quoting an important principle belonging to Kyoto Protocol, "common but differentiated responsibilities" that clearly holds developed nations responsible to take more drastic measures to reduce the impact within and outside national borders, as well as a responsible role on leading the necessary technological knowledge to developing countries in need of it.

Continuing to portrait a global panorama on climate change, since its instauration in 1988, the Intergovernmental Panel on Climate Change (IPCC) has worked arduously to create, collect, analyze and produce objective scientific information about the environmental conditions of the Earth and the importance to tackle down climate change with political and economic strategies to reduce the impact of the resulting environmental phenomena in the societies across the globe. At the same time, there are possible and plausible actions to be taken in the present to reduce risks and havoc in the future. While the evolution of the reports of the organization has been hand to hand with the innovation of technology and the increasing precision on the available data, the situation that we face as human beings has also transformed for better or worse. The anthropogenic impact over the environment is a fact and it has been discussed and studied in the five reports that the IPCC has published after an extensive review of experts and governments. The fourth and fifth reports

produced and released to the pubic included story-lines, each of them with specific social, politic and production characteristics that would mold a possible future for small islands; this, as a part of an extensive analysis that, with their singularity, face the consequences of climate change with different tools. The third report (AR3) presents four scenarios A1, A2, B1 and B2, and these are called Special Reports on Emission Scenarios (SRES), in which are shown future levels of economic activity and demographic growth or de-growth in hand with social behavior regarding climate policies and production practices.

The fourth report compiles a more complete description of the scenarios that us, as humans, can lead to the Earth. These are classified and titled y four RCP, where each represents a behavioral way of the society that will lead to a track of emission and concentration of GHG and an estimate mean of the Earth's temperature in 2100. The first one is RCP 2.6 and it describes a radical change at the production processes of every economic activity, so each of them becomes a "zero emission" activity; this way, the Earth´s temperature is kept under 2° C. The second one, and the most plausible one, is RCP 4.5, in which emissions peak around the year 2040 and then decline with a mean temperature on 2100 of 4.5° C. Likewise, the RCP 6 also has a peak and decline of the emissions, but this one occurs in 2080, with a respective temperature of 6° C. The last one is the RCP 8.5, that is called "business as usual", and it describes an energy path focused on carbon that would lead to increase emissions without any peak, as they continue over the years.

2.3 RCP as a response research to climate change

The unification of SIDS has brought up the acknowledgement of these territories thanks to the apparition of some of them in organizations by groups like the Caribbean community (Caricom) or the Alliance of Small Island States (AOSIS), which gives SIDS a more visible position in negotiation fields, in matters to advocate for human rights, cooperation for the fulfillment of the sustainable development goals or international financing to help with the mechanisms of adaptation and mitigation of the impacts of environmental hazards and climate change. Furthermore, the importance of analyzing the impact of climate change on the sustainability for the development in SIDS has slowly taken part into the international scientific community, as these present highly vulnerability to environmental changes as a heterogenic group.

Nevertheless, the slow recognition of the differences in the impact between regions and the level of development of each of the nations determine the advantages and disadvantages that many countries face, due to the high level of uncertainty that revolves around the precision of the climate change impact or how the capacity of adaptation and mitigation will induce to higher or lower growth. Therefore, the importance on how the sustainable development mechanisms of the regions across the globe will have to adopt new or improve measures to be part of the growth process becomes a particular issue for developing countries, which could bring upfront social and economic inequalities that come along with more risk, as the capacity of adaptation decreases to the presence of an unequal and unstable society, in which more emissions not only increment the

impact on the capacity of mitigation, but it also creates a certain inertia beyond the limits of production and the availability of resources, jointly putting more pressure on the capacity of resilience and recovery of each of the societies.

Therefore, organisms like the IPCC have been working exhaustively to recognize that climate change is an anthropogenic phenomenon, but also to create a vast and wide data collection over the years to conclude and advise policy makers, governments and scientists on how to approach and mitigate the economic and social problems that come along as a visible threat that causes climate imbalance and alters ecosystems, resources and territories, leading to vast problems of unprecedented migrations, lack of resources and more poverty and inequality across nations.

Furthermore, the IPCC has been promoting several reasons, like the impact on biodiversity and the adjustments needed to be done to social policies and mitigation strategies, to discuss and perform an extent analysis of the evolution of climate and how anthropogenic activities surpass beyond the defined nine planetary boundaries and continuously delineate the consequences of human-environment interaction. As a result, in the last two assessment reports released (2007 and 2013), the IPCC has used different literature about possible paths to be taken depending in consumption, production, use of energy of different sources and demographic transitions around regions. Frequently, the qualitative analysis in hand with evolving quantitative approaches through the years, has led to the complex creation of theories and possible future panoramas that show an overview of the industrial consumption and social path; this, since humans are leading the global change of the environment.

Each of the RCP developed by several scientist contains information about the GHG emission, energy consumption and use, land use and population growth that facilitate the prediction of the radiative forcing levels to which van Vuuren et al. (2011b) remarked: "more precisely, the information contained in these scenarios on emissions and concentration and land use" (p. 96). After an extended analysis by the IPCC about the scientific community research and papers, it concluded the convenience of using four RCP, being the following: 2.6 W/m^2, 4.5W/m^2, 6$W/m^2$and 8.5 W/m^2 (Intergovernmental Panel on Climate Change [IPCC], 2007). Each of them presented different use of land and energy, GHG emission and growth of the population. For SIDS, any of the pathways implies a threat, as any violent change in the environment is translated into ocean acidification, bleach of the corals and damage of the mangroves between others; these are ecosystems that support the economic and social activities of these small nations. More clearly, Davidson (2012) declared and used RCPs on his own work as "examples of a range of scenarios of internally consistent future projections of the major greenhouse gas emissions […]. There are many combinations of cultural and technological scenarios that could be consistent with each of these RCPs" (p. 2). Continuing, Baek et al. (2013) explained:

> The global average warming, and precipitation increases for the last 20 years of the 21st century relative to the period 1986-2005 are +1.1C/+2.1 % for RCP 2.6, +2.4 C/+4.0 % for RCP4.5, +2.5º C/+3.3 % for RCP 6.0 and +4.1C/+4.6 % for RCP 8.5, respectively […]. As standards scenarios that include time paths for emissions and concentrations of greenhouse gasses and aerosols, and land use/land cover. (p. 602)

This clearly states that, for any increment of emissions in comparison to the pre-industrial levels, there will be eventually an imbalance in temperature and precipitations all over the Earth, in some places with more incidence than in others. For SIDS, any scenario means a stressful situation for their economy and communities, as their capacity to adapt or implement any kind of mitigation plan is limited due to the lack of different kinds of resources, as monetary, technological or knowledge absence. The lack of capacity to follow one of the first principles of adaptation: "[…] hoping and working for the best while preparing for the worst, serves as a useful first principle of adaptation planning" (UNDP, 2017); it creates at SIDS a disadvantage position to counteract against any climate occurrence.

The first RCP with the most ambitious target is the RCP 2.6 W/m^2, which at the end of the era means an estimate emission of CO_2 of around 490ppm, and while it does not represent a defined set of climate policies, it does represent, to a certain level, the Copenhagen Accord (2009). This last urged to continue with the agreed in Kyoto Protocol and to try to portrait for a less contaminated future, applying correct and strict climate policies to follow "the scientific view that the increase in global temperature should be below 2 degrees Celsius", as mentioned in the drafted final document, in which each big polluting nation (as China with 6.51 %, and the U.S.A. with 14.65 %, according to the World Bank Data for 2017 of CO_2 emissions per capita) starts to reduce their GHG emissions to less than 60 % for 2020. In order to be successful and reach the proposed goal of reducing emissions, the change in the production parameters of most industries around the world had to be rapid and forceful; nonetheless, as it was expected, the change never came, and the target of reducing emissions and promoting a "green" path was just a utopia.

In contrast to the cleaner and greener RCP, the 8.5 is characterized by the "business as usual" and it is based on the A2 scenario of the second report of the IPCC, which describes an industrial behavior characterized to be high in intensity at fossil fuels, energy use and consumption, especially coal. Also, as it was mentioned by Riahi et al. (2011), this pathway could tell and assume a storyline about high population growth, altogether with a relatively slow income growth, modest rates of technology change, almost zero energy intensity improvement, and a noticeable absence of climate policies that lead to a high emission of GHG. While this RCP results as an almost impossible scenario to be followed by any kind of society or nation, professor Justin Ritchie reinforced that difficulty, thanks to the acknowledgement of the utilization of coal, which needs to increase from 28 % in

2011 to 51 % in 2100 as a primary energy supply, with the reduction of natural gas (from 24 % to 15 % on the same period), as well as oil (reducing its participation as a major source of energy, from 33 % to 11 %).

On the other hand, the supply/demand of energy sources of the main consumers of energy and industrial production, like U.S.A., China or India, has transformed the needs into more efficient forms of energy, exploring new and more productive sources, as nuclear; or intensifying oil use, even if the prices continue to grow and reserves reduce. Therefore, the emissions of GHG tend to increase proportionally to where economic activity is accelerating (Ritchie & Dowlatabadi, 2018); RCP 8.5 is, consequently, extreme.

In comparison to the two extremes of the RCPs, the ones in the middle, RCP 4.5 and RCP 6, represent a more realistic path that describes several conceivable lines of consumption and production that reflect and predict, under a normal distribution, CO_2 emissions per capita of the world. These two paths represent a certain introduction of climate policies with degrees of restriction in GHG emissions besides CO_2, considering also sulfur dioxide (SO_2), methane (CH_4) and nitrous oxide (N_2O), among others, that reduce their emissions but do not eliminate them completely. Additionally, for these two representative pathways, one of the main characteristics is that emissions before or after 2100 ascend and, then, decline; the only difference between RCP 4.5 and RCP 6 is the time when they start to decline. The anthropogenic emissions of GHG, depending on the development scenarios, determine a level of CO2 concentration that falls into a global temperature change that does not a have a specific number of Celsius degrees related to change temperature, but it's a fact that an alteration and the warming of the environment will happen and will be reflected in the climate of every region, especially at SIDS.

While RCPs are not a socioeconomic parameter and do not represent specific behaviors of production, consumption or even climate policies, they do present a panorama within how societies tend to produce and consume, as well as an insight on how emissions are generated and how the global future is modeled. The intervention of actual policy makers and the severeness of the climate policies are not only taken into account, but also the availability of biodiversity and the development of future generations. These show a clear vision about how radioactive forces are going to model the temperature, pollution and precipitations of the Earth; and, at the same time, these affect the human-environment relationship.

3 Methodology

This was developed through the data mining from the respective statistical bureau of each of the countries to be analyzed, and from international organizations, like the World Bank, the Organization for Economic Cooperation and Development (OECD), the Organization of Eastern Caribbean States (OECS), Caricom and AOSIS. This, with the participation of several assessments and some detailed information gathered from international programs and institutions that have been meticulous while studying several situations, which have

been globally and locally affecting SIDS at economic, social and political levels. These last include the UNEP, the Barbados Programme of Action (BPoA), the UN Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States (UN-OHRLLS), the Caribbean Community Climate Change Center (CCCCC), the South-Pacific Regional Environmental Programme, and the Pacific community. All of these create a trustful and vast network of data collection and veracity.

There is some data needed to develop a dynamic model over time since 1990, in order to estimate the effect of an increase of emissions of CO_2 (as independent variable) to the local development of two islands as representatives of each of the regions. This, taking into account a level of heterogeneity from economic activity to the way they are vulnerable from their exposure to a large coastal area: from the Caribbean region, the two representatives are Belize and Grenada; two from the Asian Pacific Region, Fiji and Papua New Guinea; and, from the Africa region, two more islands, Mauritius and Seychelles. The data collected from the agencies mentioned above used to specify the model and to define the econometric model are the following:

- Human Development Index (HDI): will be used as the dependent variable, as a measure of not only economic growth, but also of social development, considering education and health as important factors, like the economy. Why using HDI instead of GDP or percentual growth of GDP? As HDI as a proxy for well-being captures and emphasizes social welfare as an important component of sustainable development, considering that economic activities are not the only factor that results affected by the emissions of CO_2, equally health and education suffer the consequences of climate change.
- Population growth (population total): it changes from island to island and becomes an issue, as some birth rates tend to be high, creating an over-population issue or, on the other side, some really slow growth rates that could put in danger the survival of the native people. Population growth also pressures the capacity of the government to supply the necessary basic needs as quality education and health services, that covers the complete population. On one side, population growth with quality education and health, represents a growing and qualified labor force that influence the production of goods with aggregate value and therefore a grow of the economy. On the other hand, as mentioned by Todaro (1989) if population growth is rapid and do not come with a state of well-being it could be one of the causes of under-development, authors like Ahmed and Beldona (2006) argue that the relationship of population growth on HDI do have a negative impact on GDP and education as it can have an adverse effect on the economic performance if "if such growth puts an undue demand to reduce savings and increase consumption" and on education it can signifies highly costs that most of SIDS governments cannot face. The expected effect of population on HDI depends on how this growth is managed by the pre-existent conditions of society.

- ODA: net received as a percentage of GDP, which involves international flow of monetary aid that covers adaptation projects to combat ravages of climate change. There are two view of points on how aid impacts development, the moral argument that implies that more developed countries should provide aid to developing countries to eradicate extreme poverty having a positive impact on the macroeconomic level of the country that receives it. On the other side, the argument that aid do not provide a solution on the long-run and creates a dependency on nations that receive this kind of intervention, as it doesn't consider the local communities. Hammarstrand (2013) found that in aggregate terms of aid, ODA excluding debt, has a positive impact on HDI and it had a significant positive effect three years after it was received. Alternately, found that technical cooperation had a significant negative effect three years after it was received. ODA is a variable that can behave depending on how it interacts with SIDS environment and on how its used.
- CO2 emissions metric tons per capita, as these are one of the main GHG that induce a change in the oceanic and the Earth's surface and produce an imbalance on the environment. As mentioned by Jeroen et al (2018) the relationship of GHG emissions with health it's a direct contribution with deaths due to climate-related disasters, while GDP has an insignificant correlation, and for the education part the connection is not very clear, but education can be a way to prepare people and provide them the necessary information and knowledge for proper adaptation strategies. GDP defined it's just a monetary measure, it doesn't capture other social status or conditions as inequity or the depletion of natural resources, that is why utilizing GDP as a measure of development do not capture a more complete and social level of the society. Carbon dioxide emissions on SIDS are quite low in comparison to the consequences they faced related to climate change, CO2 emissions also represent the presence of industrial processes that drive the economic sectors, increasing the growth of GDP at the same time of the possibility to improve the social welfare of the islands, on the other hand the emissions do have a negative impact on health and ecosystems, decreasing the HDI. Consequently, CO2 (Hammarstrand, 2013)emissions and HDI could have also an indeterminate relation depending on the country, the characteristics of the industries or the consumption behavior of the society and the complete effects depends on how strong is either the positive or the negative impact.
- Foreign Direct Investment (FDI): it shows the establishment of international investment in the islands that normally comes for tourism-related inversions to build a strong hotel infrastructure. FDI are effective on HDI when a strong and well plan policies are present in the nation, FDI inflows are more strongly positively related to improvement in human development when FDI policy restricts foreign investors from entering some economic sectors and when it discriminates against foreign investors relative to domestic investors (Reiter and Steensma, 2010). The openness to receive investment from other nations has been a recurrent practice in developing countries between them SIDS, again Reiter

and Steensma (2010) argue that the effects of FDI are "developing countries benefit directly from FDI through an inflow of capital, tax revenues, and employment, and indirectly through spillover of the foreign investor's technology and knowledge to local enterprises and workers, and through access to foreign markets". SIDS benefit from it to finance their more important sectors of the economy as tourism with the construction of adequate infrastructure, or agriculture with the import of knowledge and implementation of new technology.

The IPCC, with the prognostics and the pathways of CO2 emissions in hand with the RCP data base, created an estimation of radiative forces until 2100, and these declared the clarification of how the extensive data is managed "and has undergone several procedures to assure quality and consistency, to harmonize regional base year emissions to recent inventories, and to downscale the projections to 0.5 x 0.5 degree". That creates consistency on the collection and usage of the data, in order to have, at the same time, statistical validity. Why are CO2 emissions over other GHG? As van Vuuren et al. (2011b) mentioned, "by far the most important contribution to increased radiative forcing compared to pre-industrial levels comes from CO_2" (p. 106). Regarding the relationship with sea-level rise (SLR), where the surface's and air temperature increases, it is directly linked to a rise in the emissions and levels of CO2. At the same time, these emissions could affect negatively the economic growth of each of the islands.

A dynamic panel data, considering the six islands and the respective values from 1990 to 2018 with predicted CO_2 from 2030 to 2100 every 10 years, is going to be used in a way in which the strict exogeneity assumption is relaxed in comparison to other panel data models visible. The effect of the regressors and the individual effects, as well as the expected value of the variable of interest, only depends on contemporary values of regressors and unobserved heterogeneity; in this case, having an observable effect of the emissions over the HDI until the end of the era. While it is expected for the CO2 emissions to slow down and negatively affect the economic and social development of communities in the islands, mitigation and adaptation programs financed by ODA or other monetary flow from international institutions could work as a net to endure and assure sustainable development on the long run.

To use a statistical valid dynamic panel data model, the Hausmann test its applied, in order to re-assure the best way to determine and observe the effects of the variables, or if it should be a dynamic or fixed model. The null hypothesis stated that the preferred effects behave randomly, and the alternative hypothesis states that the effects are fixed, with a result of not rejecting the null hypothesis, applying this way a dynamic panel data model, only limited by the fact that any variable can't be static during the time of the panel data and it is required for it to vary over time. In the meantime, problems of heteroscedasticity will be detected and solved under the White test, which involves returning the squared residuals of Ordinary Least Squares (OLS) to the fitted values,

and on the squares of the fitted values, in order to have validity in the regressors. The model to explain the effect of CO2 to the development of islands is the following.

$$HDI_{it} = \beta_0 + \beta_1 CO2Emissinsmetrictonsper Ca + \beta_2 FDInetinflowsGDP + \beta_3 Populationtotal + \beta_4 AyudaOficialDesarrolloODA$$

The expected behavior of the parameters has a statical significance for a 5 %; as for β_1 and β_3, it is expected a value lower than zero ($\beta_1, \beta_3 < 0$). This implies that to increase the emissions and the population in any of the islands, the expected value of the HDI will decrease; and, as for β_2 and β_4, the expected value is greater than zero ($\beta_2, \beta_4 > 0$). Finally, a FDI inflow and more ODA received the HDI, and these will increase as a beneficial condition in the economic and social panorama, which can be achieved thanks to a monetary increase.

4 Study case

4.1 Country profiles and backgrounds

Most of SIDS show a level of heterogeneity within their regional localization and their spread across the globe. While some of the island relay heavily on tourism (as Fiji or Barbados), others have fishing and agriculture as main economic activities. Each of the SIDS are considerable different between them, from the location that the geo-position of territories creates into their environment, to their past. This last could have been colonial or not, along with their political organization or their main economic activities, but what they have in common is an unmeasurable vulnerability to climate hazards. Taking into consideration each of the special characteristics that every small island presents, each of the nations is put into consideration by using different indexes to analyze how severe would be the impact in local development; this, with an increase of CO2 until the end of the era.

The following indexes are relevant to choose a set of countries that, in their own differences, could present a general panorama of how climate change impact SIDS from the main regions: Pacific, Caribbean and Atlantic; Indian ocean and South China sea (AIS). Each of the indexes mentioned and analyzed creates a delimited panorama on the social and economic conditions that six countries have been dealing with since 1990, and these also have shaped their development status now days.

For each of the SIDS regions, there are two representative islands that show diverse panoramas, particular characteristics and economic positions; this, including the dependency to volatile markets as tourism, location that could improve or diminish the economic openness, or their capacity to adapt to a coastal area situation. Belize, Fiji, Grenada, Mauritius, Papua New Guinea and Seychelles are part of the group defined by the UN as SIDS, a complete heterogenous set of independent islands which face the same problems and consequences of climate change in different ways.

4.1.1 HDI

The gross domestic product (GDP) is a macroeconomic comparable measure that shows the monetary value in the production of goods and services of a country during a limited period. The GDP has been used for decades, but it has completely left behind the social part of development, creating a misconception of growth that is purely based on the interaction between supply and demand of markets. Finally, the HDI was created by the UN Development Programme (UNDP) to "emphasize that people and their capabilities should be the ultimate criteria for assessing the development of a country, not economic growth alone" (European Comission, 2021, par. 1).

Meanwhile, SIDS show characteristics that traditional measures that the GDP or even the HDI leave behind, as they don't manage to capture social, political and cultural behaviors that create a level of development; nor these offer wellness or turn to be relevant to their sustainability, without mentioning the vulnerability factor or the inequity at different socio-economic levels. It has to be added to the list the enormous heterogeneity that can be perceived between regional groups of SIDS and within islands of the same geographic region. However, HDI results to be a measure that shows the evolution under specific and mostly adverse circumstances of small islands development in comparison to more industrialized and geo-position benefited countries. These nations have been growing with remoteness from markets, low supply of fossil fuels and climate events that not only created an economic shock, they also grew the possibility to become more resilient, adapt and come together to mitigate the effects of natural disasters with associations as AOSIS or Caricom, based on mutual learning.

The average HDI for the SIDS group is that of 0.684 for 2017, locating the group above the average for developing countries (about 0.681), but that continues to place them below the global average for HDI: 0.728 (UNDP, 2018). While SIDS are above the mean, if inequality is considered into the mix, HDI considerably shrinks in about 25 %, making visible the governance and distributional problems that most of the island countries present. Therefore, there is an income inequality, followed by education and health. Also, each of the SIDS analyzed showed an increase in their HDI over the past 30 years, which not only shows a path that includes the directly influential factors to the growth and development of communities and economies on SIDS, but it does present a standardized indicator that creates a comparable scenario on how SIDS are doing, and how these are expected to improve. As mentioned by UNDP (2019) on their human development report, Belize´s HDI has been increasing, putting the country in a category of high human development, presenting a steady increase in life expectancy, and education on a less steep path.

4.1.2 Economic Vulnerability Index (EVI)

SIDS are the most environmentally vulnerable of all developing countries, according to the EVI (Organisation for Economic Co-operation and Development [OECD], 2018). This last is an index that

measures the structural vulnerability of developing countries to economic and environmental shocks, as well as the determinants of exposure to shocks (OECD, 2018). Barriers that are part of global markets go further than remoteness; also, the heavily dependence of SIDS on imports, from basic goods as food, to complex ones as oil, and different kind of fuels, creates an extreme situation of vulnerability of SIDS regarding the changes of these articles at international markets. SIDS also focus their economic activities in no more than three sectors: agriculture, fishery and tourism; and the financial situation of SIDS, that is characterized by highly indebt governments, deteriorate even more the possibility of a fast and effective response to external shocks of the environment or markets in general.

The index includes not only economic aspects of vulnerability, it also considers the environmental factors that may affect somehow the productive activities performed in each of the economies. As part of the economic side, the sub-indexes, defined by the UN Committee for Development Policy (2008), are: a) share of agriculture, fishing, forestry and hunting in GDP; b) remoteness and landlocked; c) merchandise export concentration; and d) instability of the exportation of goods and services. Regarding the environmental vulnerability sub-indexes, considered by the UN Committee for Development Policy, there are the following: a) share of population in low elevated coast zones; b) share of population living in drylands; c) victims of disasters; and d) instability in agricultural production. A significant part of sustainability in SIDS comes hand to hand with the level of their vulnerability; and, as Assa & Meddeb (2021) mentioned, "vulnerability index reflects SIDS' environmental as well as socio-economic vulnerabilities and will allow policymakers, creditors and investors to more accurately understand the context of SIDS and address their structural constraint" (p. 14).

Moreover, "SIDS are estimated to be 34 % economically more vulnerable than other developing countries" (Developing a Vulnerability Index for SIDS, 2002, par. 4),as mentioned by the UNDP, which clearly creates a path that not only shows the level of adaptation and how it is affected by external shocks, but it also creates a regression to the process of becoming sustainable, as well as a local development that ensures economic growth, social equity and a responsible use of the natural resources available.

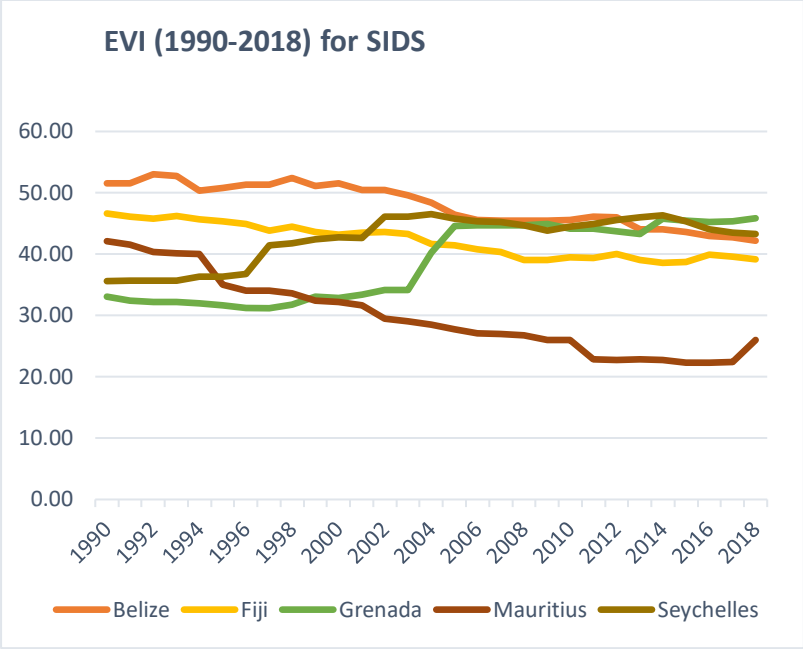

Figure 1. EVI (1990-2018) for SIDS. Data OECD

Therefore, while the behavior of the index results differently for each of the countries, it is noticeable that they are tending to convert into a range of 40 % to 50 %. That proves that SIDS have main economic sectors highly susceptible to external shocks or dependent on third part component, as foreign investors and climate disasters or variances.

Mauritius performance on reducing their level of susceptibility has shown a slowdown though the years, decreasing almost 20 % over the years until 2017, following with a small increase; but, again, strengthening and diversifying their economic sector, trying not to depend heavily on the sugar crops. These changes are part of a governmental strategy ever since the 80's, in order to create variety in markets and assure a more stable growth, while becoming attractive to investors. Mauritius represents a visible improvement by reducing their vulnerability by approaching their weak points and focusing on diversification and efficacy of their advantages, and countries like Belize and Fiji are slowly converging into an index smaller than 40 %, but their specialization and reliance in tourism are two of the main sources of labor and economic prosperity; this creates a dependence of an extremely volatile industry, as tourism appears.

4.1.3 Linear Shipping Connectivity Index (LSCI)

The LSCI aims to capture the integration level into the existing liner shipping network by measuring liner shipping connectivity. As mentioned by Notteboom, Pallis & Rodríguez (2021), LSCI can be considered as a

proxy of the accessibility to global trade through its shipping network. A higher index reveals more engagement in international trade, frequent maritime economic activities and accessibility to ports and transportation networks. The index considers six components for its calculation: a) schedule ship calls, b) deployed capacity, c) number of shipping companies and liner services, d) average and vessel size, and e) directly connected ports (UNCTAD, 2006 cited by Notteboom et al., 2021).

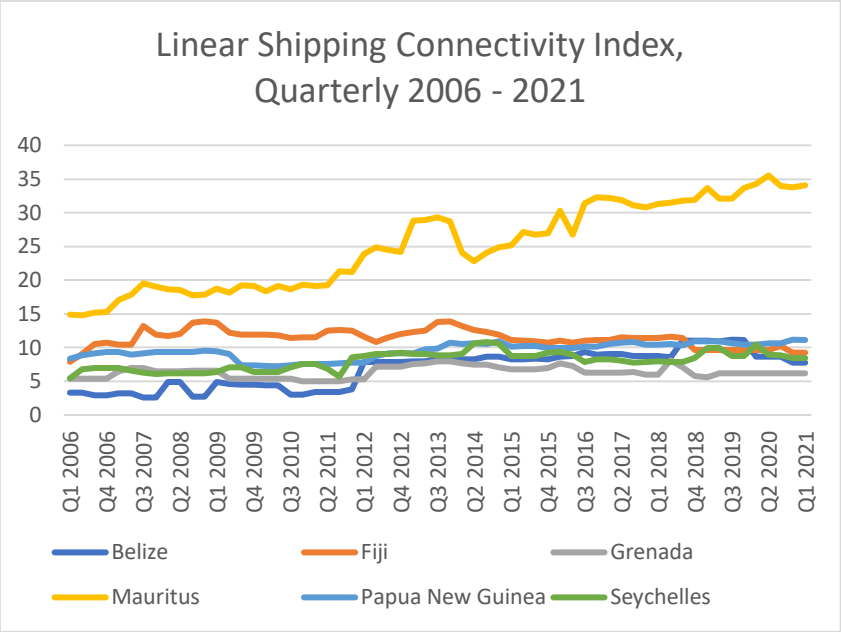

Figure 2. Linear Shipping Connectivity Index, Quarterly 2006-2021. Data UNCTAD

Under the LSCI, it is possible to clarify even more the condition of remoteness that affects most of SIDS, not only because of the distance between islands (center and periphery) and other nations, but because it also highlights the absence of a high flow of ships that show the intercommunication of the markets, leaving aside SIDS and their products. Consequently, not only the exposure of SIDS local markets to compete and be part of a global and interlinked trade results undermined by their remoteness and the size of their ports, but the supply of basic goods, as energy and fuel, cannot be generated in the islands. This is an obstacle in terms of availability and price, as transportation costs tend to be higher; therefore, connectivity issues in SIDS also create a barrier to build economies of scale that magnify a series of trade issues but conclude in an inability to improve the provision of services dedicated to trade, as they are discouraged by high transportation costs, reducing the connectivity and competitivity.

Moreover, the creation and development of connectivity links have been an issue for every nation, which requires to plan a complete, efficient and well-designed plan that considers the logistics and the infrastructure behind it, as well as to face the financial costs for ports, roads constructions, labor hand training and bringing knowledge to the islands.

As it can be perceived, 5 out of the 6 island nations analyzed count with an index below 10, which not only shows the weak panorama of interlinkage and participation on the global market of the island nations, but it also leaves a desirable and necessary path to expand and engage to a globalize market. Fiji and Grenada, for the last 15 years, have maintained a stability in their respective index, which has been between 5 and 10, showing that the evolution and construction of ports; the presence of shipping companies and the arrival of ships have not been a matter of development or importance in the institutional planning, or part of the governmental project. Meanwhile, Belize and Papua New Guinea do show a slight improvement due to the increase in scheduled ship calls, which are directly connected to ports. The exceptional case of the group is Mauritius, that evolved and doubled its connectivity not by building more ports, but by taking advantage of their attractive landscape of white beaches to increase the arrival of any kind of ships, from people transportation to articles of first necessity. At the same time, Mauritius looks forward to supply the demand of those who come to the island.

Consequently, maritime connectivity issues, either from lack of necessary infrastructure, transportation costs or even remoteness, do create a vulnerability and incapacity of adaptation at the same rhythm of globalization. On the other hand, SIDS relay on sectors that do not bring a surplus that enables a fast and sustainable economic growth. Simultaneously, islands had also accustomed theirselves to remoteness, and these behave on a basis of non-improvement, as it can be observed in the almost inexistent and unconsidered path to development.

4.1.4 Contribution of tourism to GDP and travel and tourism jobs

While tourism is a growing sector all over the world that generates jobs and creates infrastructure to provide different services, SIDS, because of their relative unexplored ecosystem, do present a major differentiation and advantage, but it depends on how this industry is exposed and sold to the world. In contrast, their remoteness and transportation costs constantly are displayed as disadvantages. Regarding SIDS, seven have at least ¼ of their GDP generated by tourism; therefore, the weight of an economic view oriented to tourism represents an important sphere and activity, as it generates employment and becomes an appealing mean for economic growth.

As for travel and tourism jobs, this industry generates at least 10.2 % of the world GDP (World Bank, 2019), since SIDS represent an important source of employment for native people. That is translated not only into a raise in the occupation rate, but it is also part of an education network to increase the literacy rate for professional education. As the education and labor rates increase, the development of each of the nations is expected to also improve, which results in a stronger local community, more present in the decision making of the government and, therefore, in more cohesive and sustainable development projects.

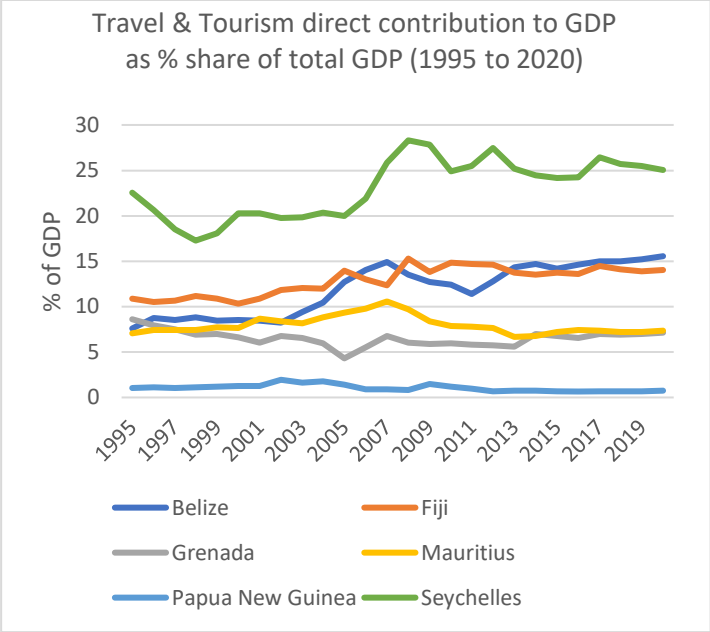

Figure 3. Travel and tourism direct contribution to GDP as % share of total GDP (1995 to 2020). Data world Bank

As it can be perceived, Seychelles has a major dependency on tourism as a main economic activity, since the values of contribution go from 18 % to almost 28 %, keeping its participation on the GDP between 23 % to 28 %, stable from 2006 to 2020, where the exploitation of its image as a paradise for the relaxation of people all over the world, the improvement of security and the increase of adequate infrastructure increase the arrival and overstay of tourists. This turns the island into a growing sector and assures a strong industry and the participation of the community in the labor force. Meanwhile, Fiji and Belize do count with a strong tourism industry, but it represents a maximum of 15 % of the GDP; nevertheless, it is predicted to continue to grow, as international travelers still prefer island destinations, and these countries show not only a safe environment for tourism, but a financial attraction for investors. At last, Papua New Guinea, Mauritius and Grenada have shown a trend of less dependency on tourism as a productive sector of GDP, and the behavior is not expected to increase in the next years.

Tourism at SIDS has been changing into a more environmentally friendly and sustainable development economic activity; even if the complete flow of US dollars does not stay in the islands, it could bring an added differentiation with other touristic destinations at the same time, in order to counter-balance topics related to remoteness, size and climate vulnerability. The economic and social impact of tourism not only seems reflected in the arrival of tourists and the construction of hotels, but these also create underemployment and a lack of

diversification in the education, which is only focused on tourism. Therefore, vulnerability in SIDS not only depends on climate change, but also on the lack of possibilities to diversify and create a safety net.

4.1.5 Coastal Vulnerability Index (CVI) as an indicator of climate vulnerability

The CVI is one of the most commonly used and simplest methods to assess coastal vulnerability to sea level rise; particularly, because of the erosion and/or inundation (Climate Adapt, 2011, par. 1). SIDS are territories that have been surrounded by the ocean, not only an important source of natural resources to supply food and transportation for the community; these are masses of salted water that have relevant influence in the access to fresh water, land sedimentation and erosion, and transportation means. The index considers the following variables: geomorphology, shoreline change rates, coastal slope, relative sea level rate, mean significant wave height and mean tidal range.

- Considering the variables, the climate impact on Belize treats especially the coastal infrastructure dedicated to tourism through the decrease of water quality, the reduction of space dedicated to recreational beaches, coral reef bleaching and fishing activities. In addition, damage to any of the coastal infrastructure coming from a climate hazard could represent a deceleration of the country's marine-based tourism sector.
- Following Belize, Fiji is composed of 332 islands. It can be attributed to the vast land characterized to be coastal, which puts under enormous risk, because of the climate change, complete populations, infrastructure and towns located around the coast. Meanwhile, the tourism industry also reflects damages resulting from storms or other climate occurrences, like beaches dedicated to tourism. Not only tourism areas show damage, but the ones near the Navua river present floods damaging livestock and different kinds of crops.
- For Grenada, there are some risks which are faced at different levels: climate change affects fisheries, agriculture and tourism; and settlements and beaches near the coast are territories that suffer from SLR, where at least 73 % of Grenada´s major tourism resorts infrastructures are at risk (Caribsave, 2012).
- As for Mauritius, the intensity of cyclones and the increase of sea-level create stress in the nation´s economy and human resources. Also, the flooding and the erosion of coastal territories continue to the degradation of the ecosystem; hence, it is necessary to implement more strategies and reduce risks, like the building of hard protection since the 1960's (Duvat, Anisimov, & Magnan, 2020).
- Papua New Guinea has a great dependency on their coast, as fishery is one the most important economic activities of the country and a major food supply. Inland flooding, coastal flooding and draughts are constant threats that need to be put first when it comes to risk knowledge and fast

planning. This, in order to face more violent climate hazards time and the surface heating due to the oceans.

- At last, Seychelles also shows high levels of dependency on the tourism sector, since a significant part of this economic activity is performed by the coast, along with fishery and small markets. The shoreline change rates prove an increase in the sea-level, despite the intervention of the government and the loss of coastal land; this could continue to increase the change rate to more than 0.5 % yearly (World Bank, 2019).

"SIDS are particularly vulnerable to the climate crisis and will continue to be among the earliest and most impacted countries" (UN-OHRLLS, 2015, p. 6). While adaptation processes and projects continue to be characterized by high costs, not as efficiently on the long-run, SIDS present an unmeasurable vulnerability to changes in their ecosystem, especially the ones occurred by increases of the temperature.

> Their climate is influenced by large ocean-atmosphere interactions such as trade winds, El Niño, monsoons and tropical cyclones. With populations, agricultural lands and infrastructures tending to be concentrated in the coastal zone, any rise in sea level will have significant and profound effects on settlements, living conditions and island economies. (UN-OHRLLS, 2015, p. 6)

Therefore, development and sustainability on SIDS depend on the capacity to reduce the condition of vulnerability for each of the islands, while strengthening the economy and social relationships with their means of production and the environment.

Finally, the islands of Belize, Fiji, Grenade, Mauritius, Papua New Guinea and Seychelles are examples of how heterogeneity is part of the characteristics of SIDS and, at the same time, they face similar problems, from misconception about the development of important factors that do not fit into different global standard measures, to transportation issues due to remoteness, or even the dilemma regarding the improvement of their infrastructure and tourism. Nevertheless, this last is a sustainable activity that protects and endures the natural environment while improving the competitiveness in the tourism international market. SIDS can adapt and cope with climate change, but they constantly struggle with the path that is needed to be taken to assure an economic growth, along with the damaging of the necessary environment, or while the geography is compromised.

4.2 Regression and results

4.2.1 STATA regression

The following study case aims to predict the effects of the CO2 emissions over the HDI, under the construction of a panel data dynamic model with fixed effects, while analyzing the data for Belize, Fiji, Grenada, Mauritius, Papua New Guinea and Seychelles from 1990 to 2018, using STATA as the main software. After a detailed recollection and analysis of the data considered relevant to determine a valid result from the variables' behavior, the outcome of the model is the following:

```
Fixed-effects (within) regression               Number of obs      =       147
Group variable: INDIVIDUO                       Number of groups   =         6

R-sq:                                           Obs per group:
     within  = 0.6734                                         min =        18
     between = 0.7334                                         avg =      24.5
     overall = 0.3417                                         max =        30

                                                F(4,137)           =     70.61
corr(u_i, Xb)  = -0.8352                        Prob > F           =    0.0000
```

HDI	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
CO2EmissionsmetrictonsPerCa	.0100796	.0028225	3.57	0.000	.0044983	.015661
FDInetinflowsGDP	.0011401	.0003655	3.12	0.002	.0004175	.0018628
Populationtotal	3.06e-08	3.83e-09	7.99	0.000	2.30e-08	3.82e-08
AyudaOficialalDesarrolloODA	-.0067315	.0008977	-7.50	0.000	-.0085066	-.0049563
_cons	.6219884	.0130897	47.52	0.000	.5961045	.6478724
sigma_u	.16290118					
sigma_e	.02344676					
rho	.97970393	(fraction of variance due to u_i)				

```
F test that all u_i=0: F(5, 137) = 109.03                     Prob > F = 0.0000
```

Regression1

Results

$$HDI_{it} = 0.621 + 0.01CO2EmissinsmetrictonsperCa + 0.001FDInetinflowsGDP + 0.000000003Populationtotal - 0.0067AyudaOficialDesarrolloODA$$

Each of the variables results to be statistically significant under a level of significance equal to 5 %, and the effects shown are small but perceivable:

- To an increment of 1 metric ton per capita, it will be an increase on the HDI of 0.01 points, leaving all variables constant.
- As for the FDI net inflow, to an increase in 1 unit of FDI it will reflect an increase of 0.001 points in the HDI, maintaining all variables constant.

- The growth of the population shows even smaller effect; as for an increase in 1 unit of the total population, the HDI will have a positive change of 0.000000003 while the rest of the variables are unchanged.
- ODA, on the other hand, has a negative impact over the HDI, as an increase in the ODA received by the country of 1 monetary unit, it will represent a decrease of the HDI in 0.0067, ceteris paribus.

These results do not follow the first assumptions made under the theorical frame that the impact of CO2 emissions could represent a reduction on the development of the islands, as it threatens the capacity to perform the main economic activities of SIDS. Also, an increase of CO2 emissions represents a risk of infrastructure related to tourism. On the other hand, environmental degradation also serves as a tourist attractiveness and, at the same time, brings basic goods to the natives and provides them the capacity to carry out activities related to fishery and recreation. This is also perceived as a barrier to economic and social well-being, where the positive sign reflects and reassures that SIDS are special cases of development and their behavior on relationship to aspects of climate change are distant to follow a predetermined path from other countries.

An explanation for this phenomenon could be the "vulnerability paradox" stated by Hallegatte et al. (2010), which stated that a healthy economy with a high growth seems more vulnerable to any kind of disasters than a less developed economy. This, since the last ones react to this event and, most of the time, bring out a "stimulus effect" that incentives the reconstruction capacity and makes use of possible unused resources, getting productivity on the long run. Moreover, it is reflected in the GDP as an adequate investment in infrastructure that impacts positively the economic growth with the creation of jobs, the investment and the use of adequate technology to encounter climate hazards while reducing the vulnerability of the society and improving the capacity of adaptation.

Consequently, the vulnerability paradox could be the reason why social and economic levels at SIDS do not respond negatively to CO2 emissions, due to the possible adaptation and mitigation programs that induce economic growth through the participation of the community in building infrastructure and, at the same time, transform capital into useful public expenditure. Also, it is important to consider that the reconstructive capacity is limited not only by the availability of capital and expenditure needed to rebuild, but on the recurrence and intensity of the climate events: if they turn out to be frequent, the reconstruction could not be possible, or it may not have the quality necessary to endure stronger or more violent climate events.

Additionally, the positive sign that belongs to the effect of the population is minimum, but it is still a direct effect over the HDI, in where an increment in the population could imply that the economy has more productive workers or a stronger base for economic development. Further, HDI for islands tends to be quite high, considering that these nations are classified as developing countries, so an increase in the population comes together with a social environment and education and health for all the native people.

The other unexpected value for the parameter belongs to the variable ODA with a negative sign, since an increase in the development aid should be represented like an improvement regarding the conditions for the sustainable development; despite this, what the regression showed was the opposite effect. While authors like Klōck (2015) or Mertz et al. (2009) advocated for the presence and implementation of climate adaptation programs for developing countries and measures used in more developed countries that have been successful when combating the impact of climate change, it is shown that some parts of the project have a certain bias on considering the whole environmental scenarios and conditions of the islands. This was mentioned by Leal et al. (2020) through a study case of the Solomon Islands, where a reactionary type of adaptation, implying international intervention without considering the local context, led to the implementation of ocean walls to avoid the intrusion of seawater on the coast and, thus, the sedimentation of the land didn't translate into a durable option to combat the arrival of future storms or to control seawater intrusion.

At the same time, Nuun & Kumar (2018) stated that the climate-human interaction in SIDS have long-run implications for a sustainable livelihood; but, before anything, programs should consider a vast panorama regarding the specific challenges that each of the islands encounter, differentiating unique forms of vulnerability, sensitivity and resilience aspects: "island societies and cultural practices have often high degrees of resilience to external shocks" (Nuun & Kumar, 2018, p. 246). The conception that sometimes is normalized concerning to islands that aid interventions should focus on the core or at specific areas, without considering the vulnerability in these; therefore, the aid that enters to the islands does not present the expected impact on sustainable development, and it can even slow down the process of adaptation and mitigation.

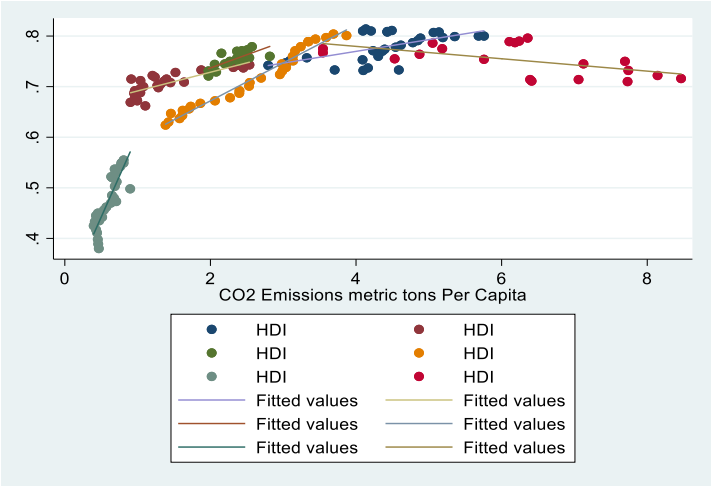

Figure 4. CO2 emissions metric tons per capita

The only parameter that follows the predicted value is the one belonging to the FDI net inflow, as this type on investment represents a boost on the economic sector, providing the financial capacity to build or improve tourism infrastructure that is not only hotels, it is also reflected into better roads, more employment possibilities

and the appearance of new markets that supply a demand of those who travel to the islands; and the enlargement of existing markets that come to benefit from more consumption. An inflow of investment represents economic growth, even if part of the revenues generated do not stay in national territory, so SIDS have a certain benefit on the presence of foreign investment on the long run. Into a more specific view, from country to country, about the impact of CO2 emissions to the HDI, the following graphic can show how the variable CO2 emissions metric tons per capita behaves and follows a relationship with the index.

The HDI for 5 out of the 6 individuals (Belize, Fiji, Grenada, Mauritius and Papua New Guinea) and its positive relationship with the CO2 emissions can be seen in the graphic, on the doted lines on the upper part of the illustration; meanwhile, the only country that shows a negative relation between the two variables is Seychelles, that is located on the lower left side of the graphic. While the exact reasons on why only one country does not show the same behavior related to the changes on HDI due to GHG emissions, the assumption or justification of this result could lay under the specific characteristics of the coastal area and the high dependency of Seychelles on tourism, which also relies on the presence of beaches and marine biodiversity that are highly susceptible to a SLR, which is a direct consequence of the air and ocean heating.

All considered, strategies to perform long lasting and sustainable economic activities can be put into risk due to SLR, coral bleaching and loss of available fishes or land deterioration; but a useful public spending, especially the one dedicated to reducing or adapting to climate change events, brings the improvement or apparition of more efficient and adequate infrastructure and technology. At the same time, an unplanned aid could undermine the effects of the same to boost development and expose the continuity of traditions and community cohesion with the surrounding environment. SIDS have a long way to go between assuring their coping capacity with climate change and creating synergic strategies between more developed nations and themselves; that endures a sustainable economic growth regarding its ancient traditions, which could adapt to the special conditions of the islands.

5 Discussion and conclusion

5.1 Discussion - SIDS and climate change interventions

While most discussions are focused on interventions that worked on coastal areas in continental nations that do not consider the peculiar characteristics of the economic, social and environmental areas of SIDS, a different angle targeting the participation of local communities and institutions will create a strategic and efficient coalition between heritage and new technologies, preserving historical knowledge and, at the same time, bringing and providing the necessary tools to adapt to climate change on an efficient way.

It's imperative that SIDS start to advocate for international aid, but in a form that contemplates the needs of local communities, based on their heritage and their relationship with the environment. Financial aid given

as ODA tends to intervene with projects that do present a short-run solution, but do not consider the geology and geography of SIDS and how these factors create an economic and social disbalance of local communities around their own biodiversity and heritage. The intervention of organization and governments of SIDS should follow learning projects with key factors as the following: improving the diffusion of local cultural knowledge, as it contributes with the mobilization and the cohesion of the community to team-work; planning every project to be implemented, and these also should be inclusive for the participation of representatives figures of the community; and, finally, building durable and long-lasting alliances that create sustainable projects which look for local level adaptation and continue to be beneficial on the long-run for communities. "The need for more locally-appropriate and effective interventions but also for further investigations into weather international adaptation finance is fit-for-purpose and meeting recipient needs and priorities" (Robinson, 2020, pp. 14-15). This clearly looks up to a new path for international cooperation, where the importance to understand how local societies behave and share with their ecosystem is a major advantage that must be considered for the implementation of any kind of adaptation plan.

The interaction of SIDS with their habitat affects their economic sector, their relationship with global markets and the competitivity of their main export goods. At the same time, SIDS present a social and development dilemma of intervention, while trying to maintain community and local wisdom, since the efficiency and quality of international technologies could perform faster and with more protection when dealing with climate hazards, guaranteeing the economic growth. This way, there could be clashes on the interaction of villages and their natural environment and the way they deal with the same disaster, but they could also stay truthful to their roots. Therefore, while climate mitigation is a problem that deserves a collective action and a local intervention from all sides of the community, a strong focus on climate policies by the competent institutions, making emphasis on adaptation and mitigation strategies and considering international approaches that could be applied in regional or local contexts, could guarantee a sustainable and constant economic growth and, at the same time, provide and cover the basic needs of SIDS population; this could create an important anticipatory, integrated and holistic adaptation (Robinson, 2020).

Additionally, considering investment in infrastructure and appropriate water markets, as mentioned by Collier et al. (2009), could enable a proper development of social intervention while providing new skills to the young population, bringing modern and ancestral knowledge together as a heuristic tool that simplifies the convergence of development and infrastructure information to help cope and mitigate present and future climate hazards. The knowledge transference will also need the intervention of governmental institutions in form of adaptation policies, and the support of exhaustive risk assessments by region and necessities, widely understanding the prevalence and regularity of climate hazards.

Besides, SIDS administrations should encourage production and economic models based on "the blue economy" in SIDS economic spheres, creating economic exclusion zones that bring together a competitive advantage to emerging sectors related to the ocean as the main provider of basic goods and resources either as food provider, as a communication and transportation method, or as a significant local and social distinction of unity within the community. Considering a different economic model based on the ocean, the assessments related to mitigate or adapt as coastal vulnerability or the product concentration related to the diversity of production of SIDS economy are also necessary; this way, the measures to pledge with climate change could be created and assured.

Concerning to the illustration process, the education will bring the trust and the improvement of the quality of gathered data to fully understand how the climate change and the raise of temperature could impact ecosystems around the territories of SIDS and, in the same way, how local solutions in hand with advanced technology could reduce the impact of ocean rising, coral bleaching and coastal degradation on local economies. A strengthening resilience economy in SIDS will help with the rehabilitation processes for the mangroves, the creation of coral gardens and the replanting all over the coast to improve the natural wall against storms and hurricanes. This way, the community governance could do better while it prepares for any climate disaster at the same time that supports a coastal area conservation. Also, it should be good to create a safety net to fight back the long-term consequences of decisions from the past and present from developed countries without compromising SIDS economic and social growth reducing inertia, as well as the uncertainty and the local environmental degradation.

"Adaptation to climate change is not merely a question of technological solutions but also a social challenge, as it is framed by various socio-political and economic settings, coping capacities and national-international relations" (Petzold & Ratter, 2019, p. 5). Additionally, understanding how climate-human interaction and relationship in SIDS works will improve the implementation of long-term solutions of adaptation that will translate into a joint mechanism of evolution and cultural transformation, always considering and respecting ancestral knowledge and heritage to prevent the disintegration of island societies. Full consideration of educational needs of SIDS is a first line necessity to ensure the application of methods that entirely follow and understand the biodiversity and social context that each of the islands faces, altogether with new and efficient technologies that could be adapted to perform and fulfill climate mitigation and adaptation programs successfully, which are translated as a benefit for different aspects of life in community.

5.2 Conclusion

The importance of climate change and how it impacts the life of millions around the world has been a study subject from the past decades, as its influence and conditionality to sustainable development has gained relevance. This way, it has become a decisive factor that can be considered as a barrier or a lift for economic

and social condition of nations and communities. On the other hand, SIDS have suffered an excessive impact from the consequences of climate change, since their vulnerability and dependence on the natural resources that surround them are in susceptible conditions, creating an environment where the application of coping mechanisms result hard and specific strategies cannot be implemented as monetary of technological barriers are present in the community.

However, several theories have shown that while the effects of climate change aggravate the strength and frequency of environmental hazards, they also expose the capacity to develop without facing much defiance or slowing down the process. Analyzing and generalizing that all SIDS are vulnerable, without considering the complete background, characteristics and specific challenges of an individual island, also limit and misconduct the purpose and the focus that this should have on the territory, as the perception of how the monetary or technological resources should be employed. That's one of the main reasons why ODA does not have the expected effect on HDI improvements; nevertheless, for SIDS it implies a constant struggle between denying or not applying traditional knowledge that has been helping to cope with climate change for most of the existence of communities, and the implementation of new technologies that could not perform as expected.

Consequently, GHG emissions of CO2 from the industrialized world have an effect on the Earth's surface, oceans and air temperature, which causes a constant warming of the environment, affecting the health conditions of humans and deteriorating the environment. As for the economic impact, the results show that an increase in CO2 emissions could promote the improvement of economy, as appropriate infrastructure needs to be built, in order to be useful for public expenditure, and apply the proper adaptation and mitigation projects. Therefore, an increase of CO2 emissions could have an improvement of the economic sector of SIDS with a greater effect than the impact that this GHG could have under the educational or health structures and institutions.

SIDS continue to be endangered zones; whose specific characteristics create a vulnerability to extreme changes. In that sense, these could be seen as a disadvantage for commerce or transportation issues, but these are also what makes them unique territories, where their uncommon landscapes, historical circumstances and rich cultural background calls for the attention of international communities intrigue the scientists, inspire the coexistence of new technology with ancient knowledge, and back up the cohesion of technological improvement along with the community, which brings effective and coherent environment conditions.

6 Bibliography

Anderson, A. (2012). Climate Change Education for Mitigation and Adaptation. *UNESCO Special Section on the ESD Response to the Three Rio Conventions, 6*(2), 191 - 206.

UN Environment Programme [UNEP]. (2014). *Emerging issues for Small Island Developing States.* United Nations Environment Programme (UNEP). Nairobi, Kenia: Results of the UNEP Foresight Process.

Thomson, A. M., Calvin, K., Smith, S. J., Kyle, G. P., Volke, A., Patel, P., . . . Edmonds, J. A. (2011). RCP4.5: A pathway for stabilization of radiative forcing by 2100. *Climatic Change, 109*(77), 77-94. doi:https://doi.org/10.1007/s10584-011-0151-4

Wade, K., & Jennings, M. (2015). *Climate change & the global economy: Regional effects.* (Schroders, Ed.) Retrieved from Schroders: https://www.schroders.com/en/ch/asset-management/insights/economics/climate-change-and-the-global-economy-regional-effects/

Mendelsohn, R., Dinar, A., & Williams, L. (2006). The Distributional Impact of Climate Change on Rich and Poor Countries. *Environment and Development Economics, 11*(2), 159-178.

Hallegatte, S., Dumas, P., & Hourcade, J. C. (2010). A Note on the Economic Cost of Climate Change and the Rationale to Limit it Below 2°C. *World Bank Policy Research Working Paper*, 1-17.

Nurse, L., & Moore, R. (2005). Adaptation to Global Climate Change: An Urgent Requirement for Small Island Developing States. *Review of European Community & International Environmental Law, 14*(2), 100-107. doi:https://doi.org/10.1111/j.1467-9388.2005.00430.x

Pelling, M., & Uitto, J. I. (2001). Small island developing states: Natural disaster vulnerability and global change. *Global Environmental Change Part B: Environmental Hazards, 3*(2), 49-62.

Kompas, T., Pham, V. H., & Che, T. N. (2018). The effects of climate change on GDP by country and the global economic gains from complying with the Paris Climate Accord. *Earth's Future, 6*(8), 1153 - 1173. doi:https://doi.org/10.1029/2018EF000922

van Vuuren, D. P., Stehfest, E., den Elzen, M. G., Kram, T., van Vliet, J., Deetman, S., . . . van Ruijven, B. (2011b). RCP2.6: Exploring the possibility to keep global mean temperature increase below 2°C. *Climatic Change, 109*(95), 95-116. doi:10.1007/s10584-011-0152-3

van Vuuren, D. P., Edmonds, J., Kainuma, M., Riahi, K., Thomson, A., Hibbard, K., . . . Rose, S. K. (2011a). The representative concentration pathways: an overview. *Climatic Change, 109*(5), 5-31.

Davidson, E. A. (2012). Representative concentration pathways and mitigation scenarios for nitrous oxide. *Environmental Research Letters, 7*(2), 1-7. doi:http://dx.doi.org/10.1088/1748-9326/7/2/024005

Baek, H. J., Lee, J., Lee, H. S., Hyun, Y. K., Cho, C., Kwon, W. T., . . . Byun, Y. H. (2013). Climate Change in the 21st Century Simulated by HadGEM2-AO under Representative Concentration Pathways. *Asia-Pacific Journal of Atmospheric Sciences, 49*, 602-618. doi:https://doi.org/10.1007/s13143-013-0053-7

United Nations [UN]. (2009). *Copenhagen Climate Change Conference.* UN.

Riahi, K., Rao, S., Krey, V., Cho, C., Chirkov, V., Fischer, G., . . . Rafaj, P. (2011). A scenario of comparatively high greenhouse gas emissions. *Climatic Change, 109*(33), 33-57. doi:https://doi.org/10.1007/s10584-011-0149-y

Ritchie, J., & Dowlatabadi, H. (2018). Defining climate change scenario characteristics with a phase space of cumulative primary energy and carbon intensity. *Environmental Research Letters, 13*(2), 1-11. doi:https://doi.org/10.1088/1748-9326/aaa494

van Vuuren, D. P., Kriegler, E., O'Neill, B. C., Ebi, K. L., Riahi, K., Carter, T. R., . . . Winkler, H. (2014). A new scenario framework for Climate Change Research: Scenario matrix architecture. *Climatic Change, 122*, 373-386. doi:https://doi.org/10.1007/s10584-013-0906-1

European Comission. (2021). *Human Development Index (HDI).* Retrieved from European Comission: https://knowledge4policy.ec.europa.eu/dataset/ds00071_en

United Nations Development Programme [UNDP]. (2019). *Local Solutions - Adapting to Climate Change in Small Island Developing States.* New York: United Nations.

United Nations Development Programme [UNDP]. (2018). *Small Island Developing States - a Summary of the State of Human Development.* United Nations.

United Nations Development Programme [UNDP]. (2017). *Climate risk, vulnerability and risk assessment in the northern province yn Papua New Guinea.* Belgium: Antea Belgium.

Organisation for Economic Co-operation and Development [OECD]. (2018). *Making Development Co-operation Work for Small Island Developing States.* Paris: OECD Publishing.

Assa, J., & Meddeb, R. (2021). *Towards a Multidimensional Vulnerability Index.* United Nations Development Programme.

World Bank. (2019). *Coastal resilience in Seychelles: Charting a path forward.* Retrieved from World Bank: https://www.worldbank.org/en/news/feature/2019/07/18/coastal-resilience-in-seychelles-charting-a-path-forward

Climate ADAPT. (2011). *Coastal Vulnerability Index – CVI.* Retrieved from Climate ADAPT: https://climate-adapt.eea.europa.eu/metadata/tools/coastal-vulnerability-index-2013-cvi

Caribsave. (2012). *Climate Change Risk Profile for Grenada.* DFID, AusAID and The CARIBSAVE Partnership.

Duvat, V. K., Anisimov, A., & Magnan, A. K. (2020). Assessment of coastal risk reduction and adaptation-labelled responses in Mauritius Island (Indian Ocean). *Regional Environmental Change, 20*(110), 1-15. doi:https://doi.org/10.1007/s10113-020-01699-2

UN-OHRLLS. (2015). *Small Island Developing States in Numbers. Climate change edition.* United Nations.

Klöck, C. (2015). Adapting to climate change in small island developing states. *Climatic Change, 133*, 481-489.

Mertz, O., Halsnæs, K., Olesen, J. E., & Rasmussen, K. (2009). Adaptation to Climate Change in Developing Countries. *Environmental Management , 43*(5), 743 - 752. doi:https://doi.org/10.1007/s00267-008-9259-3

Leal, W., Otoara, M., Lütz, J. M., & Li, C. (2020). Climate change adaptation as a development challenge to small Island states: A case study from the Solomon Islands. *Environmental Science and Policy, 107*, 179-187.

Nuun, P., & Kumar, R. (2018). Understanding climate-human interactions in Small Island Developing States (SIDS): Implications for future livelihood sustainability. *International Journal of Climate Change Strategies and Management, 10*(2), 245-271. doi:https://doi.org/10.1108/IJCCSM-01-2017-0012

Robinson, S. (2020). Climate change adaptation in SIDS: A systematic review of the literature pre and post the IPCC Fifth Assessment Report. *WIREs Climate Change, 11*(4), 1-21. doi:https://doi.org/10.1002/wcc.653

Petzold, J., & Magnan, A. K. (2019). Climate change: Thinking small islands beyond Small Island Developing States (SIDS). *Climatic Change, 152*, 145-165. doi:https://doi.org/10.1007/s10584-018-2363-3

Petzold, J., & Ratter, B. (2019). More than just SIDS: local solutions for global problems on small islands. *Island Studies Journal, 14*(1), 3-8. doi:https://doi.org/10.24043/isj.77

Caribsave. (2014). *Analayzing vulnerability of the Belize coastal tourism sector.* WWF, Belize Tourism Industry Asociation.

Sustainable Development United Nations. (2002). *Developing a Vulnerability Index for SIDS*. Retrieved from Sustainable Development United Nations: https://sustainabledevelopment.un.org/index.php?page=view&type=13&nr=380&menu=1634#:~:text=SIDS%20are%20estimated%20to%20be,high%20level%20of%20export%20concentration.

Aginam, O. (2011). *Climate Change Diplomacy and Small Island Developing States*. Retrieved from United Nations University: https://unu.edu/publications/articles/climate-change-diplomacy-and-small-island-developing-states.html

Collier, B., Skees, J., & Barnett, B. (2009). Weather Index Insurance and Climate Change: Opportunities and Challenges in Lower Income Countries. *Geneva Pap Risk Insur Issues, 34*, 401-424. doi:https://doi.org/10.1057/gpp.2009.11

Crossley, M. W., & Sprague, T. (2013). Education for Sustainable Development: Implications for Small Island Developing States. *International Journal of Educational Development, 35*, 86-95. doi:https://doi.org/10.1016/j.ijedudev.2013.03.002

Ebi, K., & Yohe, G. (2013). Adaptation in first- and second-best worlds. *Current Opinion in Environmental Sustainability, 5*(3-4), 373-377.

Gravelle, G., & Mimura, N. (2008). Vulnerability assessment of sea-level rise in Viti Levu, Fiji Islands. *Sustainability Science, 3*, 171-180. doi:https://doi.org/10.1007/s11625-008-0052-2

Hickel, J. (2020). The sustainable development index: Measuring the ecological efficiency of human development in the anthropocene. *Ecological Economics, 167*. doi:https://doi.org/10.1016/j.ecolecon.2019.05.011

Hamilton, J. M., Maddison, D., & Tol, R. S. (2005). Effects of climate change on international tourism. *Climate Research, 29*(3), 245-254. doi:http://www.jstor.org/stable/24868808

Khan, M., Robinson, S., Weikmans, R., Ciplet, D., & Roberts, T. (2020). Twenty-five years of adaptation finance through a climate justice lens. *Climatic Change, 161*, 251-269. doi:https://doi.org/10.1007/s10584-019-02563-x

McSweeney, C., New, M., Lizcano, G., & Lu, X. (2010). The UNDP Climate Change Country Profiles: Improving the Accessibility of Observed and Projected Climate Information for Studies of Climate Change in Developing Countries. *Bulletin of the American Meteorological Society, 91*(2), 157 - 166. doi:http://dx.doi.org/10.1175/2009BAMS2826.1

Ozturk, I., Al-Mulali, U., & Saboori, B. (2016). Investigating the environmental Kuznets curve hypothesis: the role of tourism and ecological footprint. *Environmental Science and Pollution Research, 23*(2), 1916-1928. doi:https://doi.org/10.1007/s11356-015-5447-x

Pratt, S. (2015). The economic impact of tourism in SIDS. *Annals of Tourism Research, 52*, 148-160.

Scobie, M. (2018). Accountability in climate change governance and Caribbean SIDS. *Environment, Development and Sustainability, 20*, 769-787. doi:https://doi.org/10.1007/s10668-017-9909-9

Sutton, P., & Payne, A. (1993). The Security Problems of Small Island and Enclave Developing States. *Political Studies, 41*(4), 579-593. doi:https://doi.org/10.1111/j.1467-9248.1993.tb01657.x

Intergovernmental Panel on Climate Change [IPCC]. (2007). *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the IPCC*. New York: Cambridge University Press.

Notteboom, T., Pallis, A., & Rodrigue, J. P. (2021). *Country and Port Level Liner Shipping Connectivity Index*. Retrieved from Port Economics, Management and Policy: https://porteconomicsmanagement.org/pemp/contents/part1/ports-and-container-shipping/country-port-level-liner-shipping-connectivity-index/

Botzen, J. C. (2018). Global Impact of a Climate treaty if the Human Development Index replaces GDP as a welfare proxy. *Climate Policy, 13*, 76-85.

Li Q, C. H. (2021). The Relationship between Human Well-Being and Carbon Emissions. *13*.

Rybski, D. C. (2011). Correlations between Human Development and CO2 emissions: projections and implications. *AGU Fall Meeting Abstracts*.

Zgheib, P. W. (2006). The impact of population growth on Human Development Index: a comparative analysis of Middle Eastern countries. *World Review of Science, Technology and Sustainable Development, 3*, 258-269.

Todaro, M. (1989). Economic Development in the Third World.

Costa, L. R. (2011). A human development framework for CO2 reductions. *Plos one, 6(12)*.

Reiter, S. &. (2010). Human Development and Foreign Direct Investment in Developing Countries: The influence of FDI Policy and Corruption. *World Development, 38(12)*, 1678-1691.

Hammarstrand, L. a. (2013). Aid Effectiveness on Living Standards: How Does Aid Affect Human Development Index (HDI) in SubSaharan Africa? *University of Gothenburg*.