SCHOOL OF ECONOMICS AND MANAGEMENT

Bachelor's programme in Economy and Society

The Correlation Between CO_2 Emissions and GDP in Bhutan - A Threat to Carbon Neutrality?

by

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Abstract: The nexus between environmental degradation and economic growth is becoming of greater importance globally and in order to limit global warming at an increase of 1.5 ° C there needs to be a net zero-transition towards carbon neutrality. The Kingdom of Bhutan has over the last decades experienced continuous economic growth while being carbon negative and adhering to its unique Gross National Happiness development framework. This study investigates the relationship between carbon dioxide emissions and gross domestic product in Bhutan and evaluates how Bhutan's aspirations toward economic growth might threaten its carbon-neutral status. The analysis is drawn from descriptive statistics and compared to the theory of the environmental Kuznets curve, the Decoupling theory and the theory on Green growth. The study finds a positive linear relationship between CO_2 emissions per capita and GDP per capita and no substantial evidence of sustained decoupling. While an immediate threat to carbon neutrality is not found due to the country's large carbon sequestering capacity, there are challenges ahead if Bhutan wants to experience sustained economic growth and remain carbon neutral.

Keywords: Bhutan, Gross Domestic Product (GDP), Carbon dioxide (CO_2) emissions, Carbon Neutrality, Environmental Kuznets Curve (EKC), The Decoupling Theory, Green Growth, Degrowth, Gross National Happiness (GNH)

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List of Abbreviations

CDP	Committee for Development Policy
CH_4	Methane
CO_2	Carbon dioxide
EKC	The Environmental Kuznets Curve
FDI	Foreign Direct Investment
FYP	Five-year Plan for Socio-Economic Development in Bhutan
GDP	Gross Domestic Product
GHG	Greenhouse gas
GNH	Gross National Happiness
LDC	Least Developed Country
MNC	Multinational Corporation
N_2O	Nitrous oxide
NKRAs	National Key Result Areas
OECD	Organisation for Economic Cooperation and Development
R&D	Research and Development
SDG	Sustainable Development Goals
UN COP21	United Nations Climate Change Conference in Paris, 2015
UNFCCC	United Nations Framework Convention on Climate Change
WDI	World Development Indicators

1. Introduction

1.1. Introduction

The achievement of sustainable development has been argued to be one of the greatest challenges of the 21st century (Yangka, Newman, Rauland & Devereux, 2018). Ellison (2014) emphasizes that there is a power struggle between the protection of the environment and economic development, as one often undermines the other. Historically, it can be seen that economic development often has won, and high growth and increasing productivity have as a result become threats to the environment (Ellison, 2014; UN. Secretary-General & World Commission on Environment and Development, 1987). Global warming and environmental degradation as a result of increasing greenhouse gas emissions and CO_2 concentration in the atmosphere have thereby brought environmental concerns to the forefront of modern issues for both developing and developed countries (Ansari, Haider & Khan, 2020; Sadiq, Kannaiah, Khan, Shabbir, Bilal & Zamir, 2023).

Over the last three decades, there have been numerous global conferences and agreements that have contributed to establishing the fundamental aspects of sustainable development (Yangka, Newman, Rauland & Devereux, 2018). The nexus that is the balance between environmental protection, economic development and social goals can be seen from the Brundtland Commission in 1987 to the present 2030 Agenda for Sustainable Development (Yangka, Rauland & Newman 2023; UN. Secretary-General & World Commission on Environment and Development, 1987). One of the most vital aspects of climate change is global warming and during the UN Climate Change Conference (COP21) in Paris 2015, The Paris Agreement was adopted by 196 parties (United Nations Climate Change, n.d.a). The agreement stipulates that there needs to be a global net zero transition, i.e. carbon neutrality, by 2050 in order to limit global warming at an increase of 1.5 degrees Celsius (United Nations, n.d.a).

One of the countries that signed the agreement was the Kingdom of Bhutan (United Nations, 2016). Bhutan first committed to carbon neutrality in 2009 and during the UN COP21 meeting in 2015, Bhutan pledged to be carbon neutral in perpetuity (Directorate-General for

Climate Action, 2015; National Environment Commission, 2020a). The country is presently a carbon sink, making it one out of three countries in the world to be carbon-negative (the other two being Surinam and Panama) (Directorate-General for Climate Action, 2015; Das, Bhujel, Laha, & Mishra, 2022; Safiya Zahid, 2022). While having committed to carbon neutrality Bhutan moreover aims towards achieving middle-income status in the year 2023 and has experienced continuously growing GDP at an average rate of around 5-6 % over the last decades (The World Bank, 2022; Brooks, 2013; Yangka, Rauland & Newman, 2023; Venkatraja, 2022). A significant characteristic of Bhutan is their unique development philosophy, known as Gross National Happiness (GNH) (Brooks, 2013; Balasubramanian & Cashin, 2019). The GNH framework takes a comprehensive and holistic approach to progress and well-being by accounting for non-economic factors (Kamei et al. 2021).

The uniqueness of Bhutan in terms of carbon neutrality, GNH objectives and economic growth aspirations make it interesting to study in light of the global environmental challenge that the correlation between economic growth and CO_2 emissions poses. Yangka, Rauland & Newman (2023) stress that the interconnection of GDP, GNH and greenhouse gas emission (CO_2) can be found as central themes in both the Sustainable Development Goals (SDGs) and the Paris Agreement which are presently two of the most prominent global framings of sustainable development. Discoveries of this study could therefore possibly guide other countries towards a more sustainable development path and contribute to the literature within this field.

1.2. Aim

The aim of this thesis is to investigate the relationship between GDP per capita and CO_2 emissions per capita in Bhutan for the time period 1980-2021 using secondary descriptive statistics. The thesis will utilise the theory of the environmental Kuznets curve, the decoupling theory and green growth to analyse the nature of the relationship in order to explore the potential threat that increasing GDP poses to the country's carbon-neutral status.

1.3. Research Question

What is the relationship between CO_2 emissions per capita and GDP per capita in Bhutan, and does this relationship threaten Bhutan's carbon-neutral status?

1.4. Thesis Outline

The thesis proceeds as follows; Section 2 provides a background and context relevant to the case of Bhutan. Section 3 presents the theoretical framework of the environmental Kuznets curve, the decoupling theory and green growth as well as the interconnection between the three theories. Section 4, thereafter reviews previous literature on the theories and other considerations such as population growth, the development stage of a country, production and consumption emissions, and the GNH framework. Section 5 describes the research design as well as data collection. Section 6 presents the results and the analysis whereafter Section 7 makes out the discussion in which results, theories and previous research are brought together. Section 8 concludes and emphasises future research.

2. Background and Context

2.1. Regional Characteristics

Bhutan is a small country situated in the eastern Himalayas with a population of approximately 777,500 people as of 2021 (The World Bank, n.d.a; Brooks, 2013). It has a unique history as it remained uncolonized and fairly isolated until 1961 (The World Bank, n.d.a; IMF 1995; Brooks, 2013). In 2008, it transitioned to democratic governance under a constitutional monarchy, as the *Constitution of the Kingdom of Bhutan* was enacted which separated legislative, juridical and executive power. (Gross National Happiness Commission, 2019a; Göpel, 2016). This change had been ongoing since the 1970s when Bhutan first moved from an absolute monarchy to a constitutional monarchy (Gross National Happiness Commission, 2019a; Göpel, 2016). They have since then had a large focus on good governance, also included as a main pillar of the GNH framework, and worked towards increasing the peoples' participation in decision-making (Gross National Happiness Commission, 2019a). Yangka, Newman, Rauland & Devereux (2018) stress that Bhutan can be regarded as having three prominent goals. That of; increasing wealth to attain middle-income status, upholding a carbon-neutral status for greenhouse gas emissions and following their GNH development path for socio, cultural and economic goals.

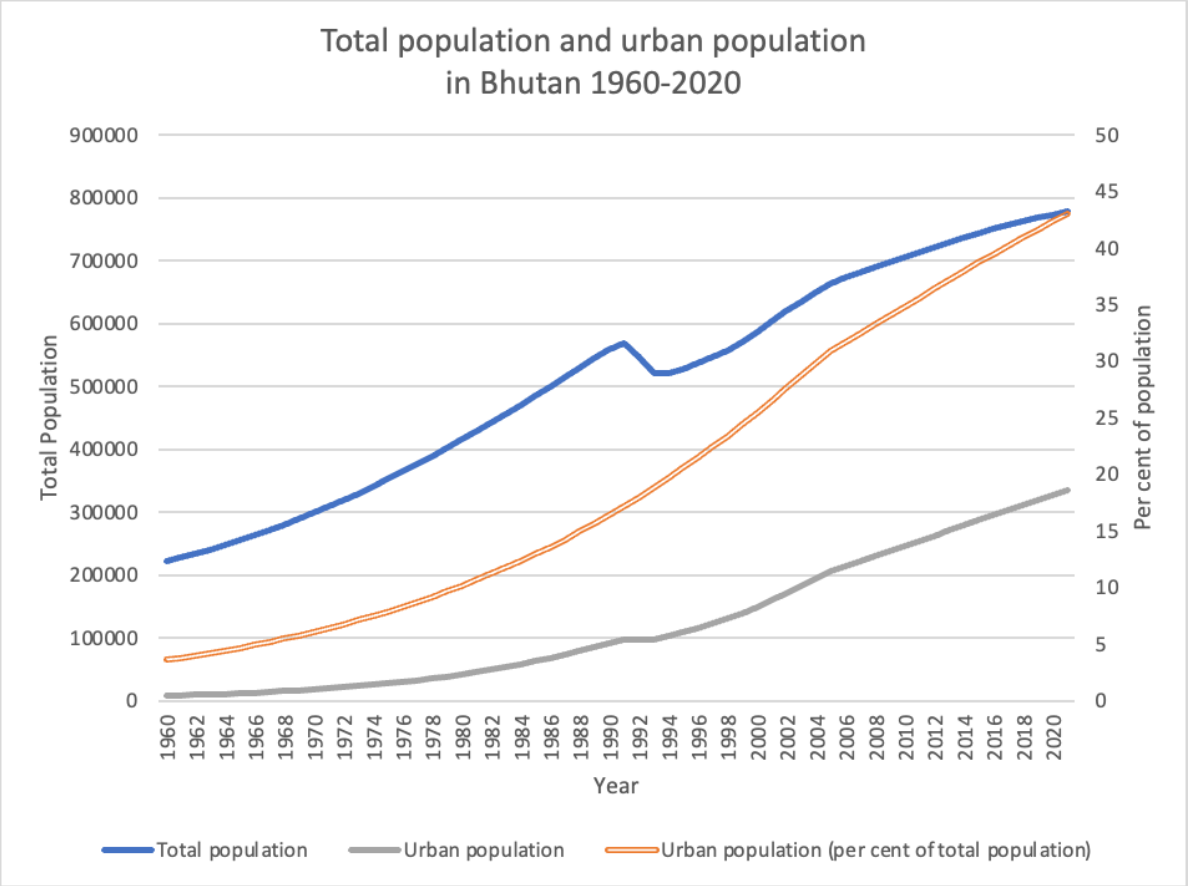

Figure 1. Total population and urban population in Bhutan 1960-2020 (The World Bank, 2023)
Note: Time-span is modified due to data availability

There has been a substantial population increase since the 1960s and an increasing share of the population migrating to urban areas, visible in Figure 1. In the 1960s the government introduced major development programmes, including free health care and education, job opportunities and agricultural subsidies (Kharat, 2001). This resulted in a substantial influx of Nepalese immigrants (Kharat, 2001) Due to an increasing fear of losing Bhutan's cultural strength and unity the King introduced a "One Nation, One People" ideology based on the Bhutanese Drukpa cultural norms (Kharat, 2001, p.41). Together with the implementation in the mid-1980s of more stringent citizenship laws, this led to an ethnic cleansing in 1990 where almost 100,000 people of Nepalese origin were exiled (Nikku, 2017). This explains the sudden decrease in the total population in 1990 in Figure 1. The increasing urbanisation trend is primarily among young people seeking education and job opportunities and rural-urban migration is expected to lead to an urban population of 77 % of the total population in 2040 (Kamei et al. 2021; Yangka, Rauland and Newman, 2019).

2.1.1. Economic Structure and Development in Bhutan

Venkatraja (2022) stresses that Bhutan as a country has had a slow economic development and economic backwardness over the decades. It was not until GNH was introduced as a leading principle that economic development and the creation of wealth, in addition to environmental sustainability, were emphasised as national goals. Before this, foreign direct investment (FDI) was prohibited by statutes and there was no support for the advancement of the industrial and manufacturing sector. By 2009, the country started to encourage industrialisation, approve certain MNCs and FDIs and invest in hydropower projects. Over the last decades the structure of the economy in terms of the primary, secondary and tertiary sectors has changed in Bhutan (Yangka, Newman, Rauland & Devereux, 2018). There has thereby been a shift from a more traditional forestry and agrarian economy towards an economy that is more industry and service-based (Kamei et al. 2021; Venkatraja, 2022) with a more market-oriented economic system (Bruggeman, Meyfroidt & Lambin, 2016; Yangka, Rauland & Newman, 2019)

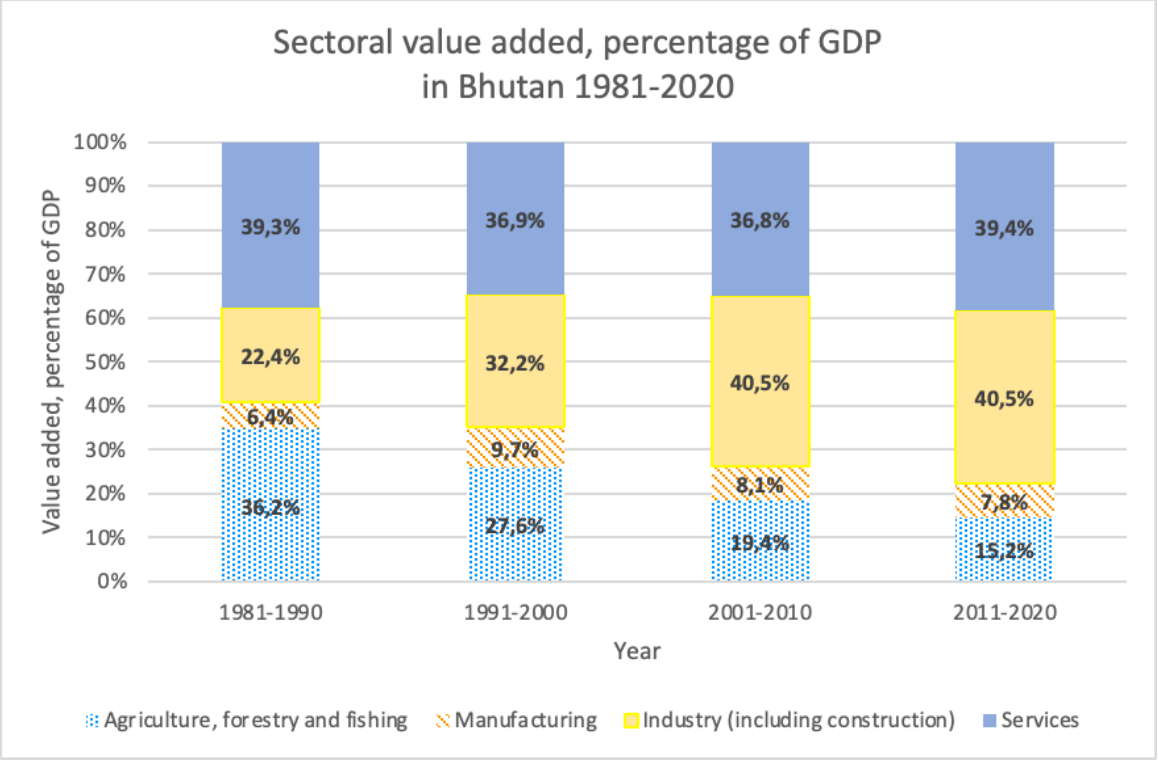

Figure 2. Sectoral value added, percentage of GDP in Bhutan 1981-2020 (The World Bank, 2023)

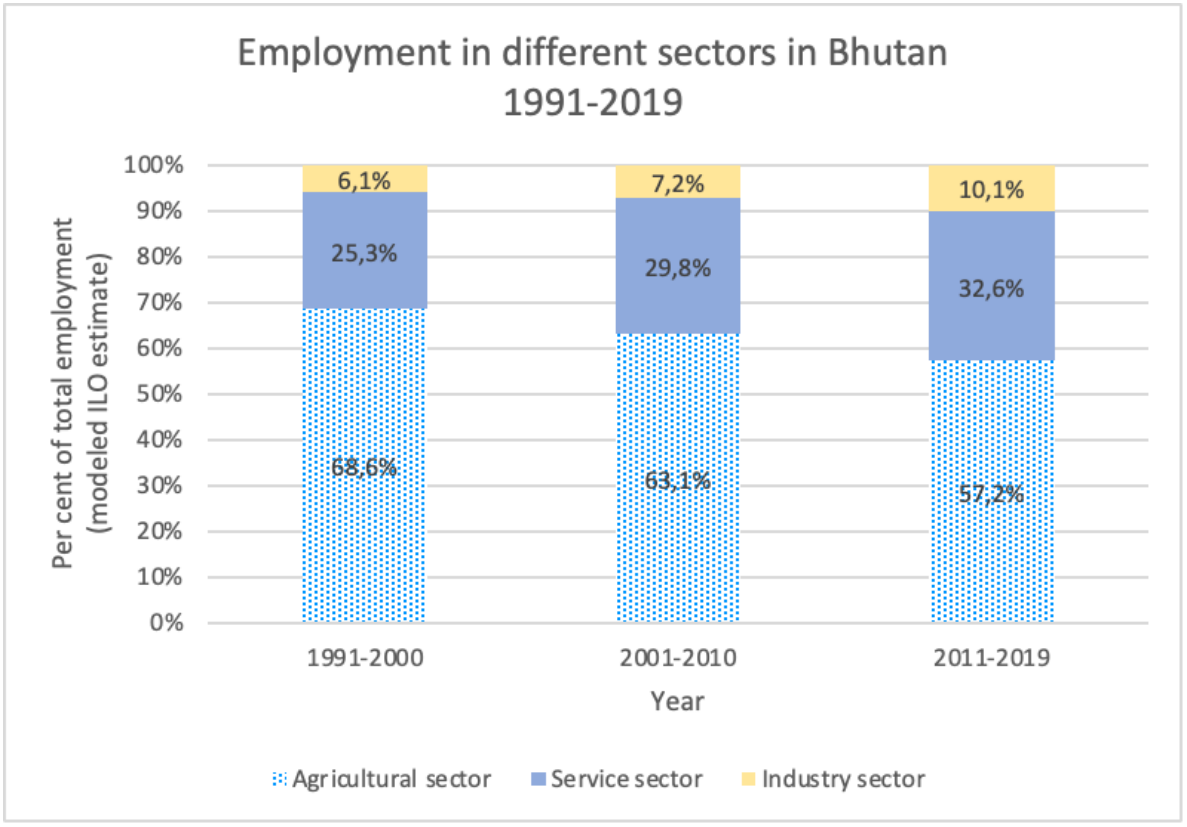

Figure 3. Employment in different sectors in Bhutan 1991-2019 (The World Bank, 2023)
Note: Time-span is modified due to data availability

The value added to GDP from different sectors in Bhutan (Figure 2) has changed since the 1980s where the largest shift has been a diminishing agricultural sector and an increasing industrial sector. Even though the value added to GDP from the service sector has remained at a similar level it is possible to see an expansion of the sector in terms of employment (Figure 3). Nevertheless, the agricultural sector still employs around 57 % of the working population and is therefore still of large importance in the country.

Hydropower is the main contributor to Bhutan's economic activity and the development of hydropower and the export of electricity to India is the main driver of the large sustained growth, of around 5-6% annual GDP growth since the 1980s (Gross National Happiness Commission, n.d.; Asian Development Bank, 2022). Hydroelectricity exports account for approximately 63% of total exports and hence constitute the primary source of revenue from exports in the country (Venkatraja, 2022)**.** The importance of hydropower as an economic driver is argued to imply Bhutan having a mono-economy, potentially indicating a vulnerable economic system (Yangka, Rauland & Newman, 2019; Asian Development Bank, 2022).

This has also thus led to other sectors being underdeveloped and stagnation in employment opportunities (Gross National Happiness Commission, n.d.)

Bhutan is presently classified as a least developed country (LDC) by the United Nations but has committed to graduating in 2023 (Gross National Happiness Commission, 2019a; UNCTAD, n.d.). Graduating from an LDC is based on three different criteria; 1) GNI per capita, 2) Human Asset Index (measuring the level of human capital) and 3) Economic Vulnerability Index (Gross National Happiness Commission, 2019b; United Nations, n.d.b.). During the 2015 and subsequent 2018 Triennial review as well as the 2023 update, Bhutan's performance was as follows:

Table 1. Bhutan Triennial Review (Gross National Happiness Commission, 2019b; Committee for Development Policy, 2023)

Criteria	Threshold (2021)	2015 Triennial review	2018 Triennial review	2023 Triennial review
GNI per capita (USD),	≥ 1 222	2277	2401	2914
Huma Asset Index	≥ 66.0	67.9	72.9	82.6
Economic Vulnerability Index	≤ 32.0	40.2	36.3	25.2

During the Triennial reviews in 2015 and 2018 by the Committee for Development Policy (CDP), Bhutan had a GNI and Human Asset Index scoring above the threshold (Gross National Happiness Commission, 2019b; Committee for Development Policy, 2023). In regard to the economic vulnerability index, on the other hand, Bhutan scored below the threshold. Bhutan has since 1961 implemented five-year plans (FYP) for socio-economic development that stipulates priorities and execution of programmes in five-year cycles (Gross National Happiness Commission, n.d.). The goal to graduate is included in the twelfth FYP covering the years 2018-2023 and aims to create a strong and resilient national economy. The Committee for Development Policy (2023) assert in their report from February 2023 that Bhutan has managed to meet all thresholds and is therefore eligible to graduate in December 2023. However, they stress that Bhutan needs to have a continuing diversification of its economy in order to avoid mainly relying on hydropower exports, agriculture and tourism and to decrease its dependency on imports.

2.1.2. Gross National Happiness

Gross National Happiness was first articulated as a concept in 1972 by Jigme Singhye Wangchuk, the fourth king of Bhutan (Balasubramanian & Cashin, 2019). The king expressed the need for a more holistic development approach, based on Buddhist philosophy and the concept of the middle path (Balasubramanian & Cashin, 2019; Brooks, 2013). In comparison to GDP, GNH has a more holistic approach and does not solely consider economic growth as a measure of progress (Brooks, 2013; Centre for Bhutan Studies, 2012). In 2008 GNH became an official guiding principle for development in Bhutan, prior it had however still been embedded in the country's development strategies and program (Göpel, 2016; Bruggeman, Meyfroidt & Lambin, 2016). The more encompassing dimensions of social, economic and environmental development have characterised the Bhutanese society for the last decades and central themes can currently be found in other global development frameworks such as the 2030 Agenda for Sustainable Development (Gross National Happiness Commission, n.d.; Gross National Happiness Commission, 2019a).

There are four pillars of GNH; 1) equitable economic development, 2) cultural resilience, 3) good governance and 4) environmental preservation (Centre for Bhutan Studies, 2012; Adler, 2009; Brooks, 2013). These four pillars represent an effort to reach collective well-being and happiness as well as preservation of the environment and thereby aligning economic growth with the country's values (Balasubramanian & Cashin, 2019; Brooks, 2013). The four pillars are specified by nine areas, namely "psychological wellbeing, health, education, cultural diversity and resilience, time use, good governance, community vitality, living standard, and ecological diversity and resilience" (Gross National Happiness Commission, 2019a; Centre for Bhutan Studies, 2012, p. 10). These are in turn evaluated by the use of surveys, thus far three surveys have been carried out; a trial survey conducted in 2007-2008, and subsequently one in 2010 and 2015 (Gross National Happiness Commission 2019b). These comprise thirty-three subjective and objective indicators which in turn consist of 124 variables and make out the Gross National Happiness Index (Balasubramanian & Cashin, 2019; Gross National Happiness Commission 2019b). The GNH index is used as a framework in which the provision of indicators can aid in guiding development, allocating resources and supporting policy design as well as measuring the well-being and happiness of the people over time and across the country (Balasubramanian & Cashin, 2019; Centre for Bhutan Studies, 2012).

2.1.3. Carbon Neutrality in Bhutan

Carbon neutrality is defined as the zero balance between the amount of CO_2 emissions emitted into the atmosphere and the amount absorbed in carbon sinks, leaving a zero-carbon footprint (Das et al. 2022; National Environment Commission, 2020b). Natural carbon sinks are primary forests, oceans and soil (Das et al. 2022). In Bhutan's case, the main driver for carbon neutrality is forest-based carbon sequestration meaning that the forest absorbs more carbon dioxide than is being emitted, hence making the country carbon-negative (Yangka, Rauland & Newman 2023). Bhutan possesses a comparative advantage in regard to its forest cover and electricity production from hydropower for its success in being carbon neutral (Yangka & Newman (2018). Bhutan has a distinct forest policy that is incorporated in the constitution and dictates that the country should have a forest cover of at least 60 % (Bruggeman, Meyfroidt & Lambin, 2016; United Nations Development Programme, 2019). Forest currently covers 71 % of the land area, which is a substantial increase from 53 % in 1990 (Figure 4). Moreover, hydropower enables Bhutan to safeguard its forestry since firewood is not an essential source of energy, and additionally, hydropower contributes to low carbon emissions as it is a renewable source of energy (Yangka, Rauland & Newman, 2019). At the same time, hydropower as an energy source is also faced with criticism. The reason is that methane and CO_2 emissions emerge in the decomposition process of subaquatic vegetation (Yangka, Rauland & Newman, 2019). Nevertheless, hydropower is mainly run-of-the-river schemes in Bhutan which is more environmentally friendly than having expansive water reservoirs (Yangka, Rauland & Newman, 2019). Furthermore, developers in Bhutan also plant trees to compensate for logging during construction (Yangka, Rauland & Newman, 2019).

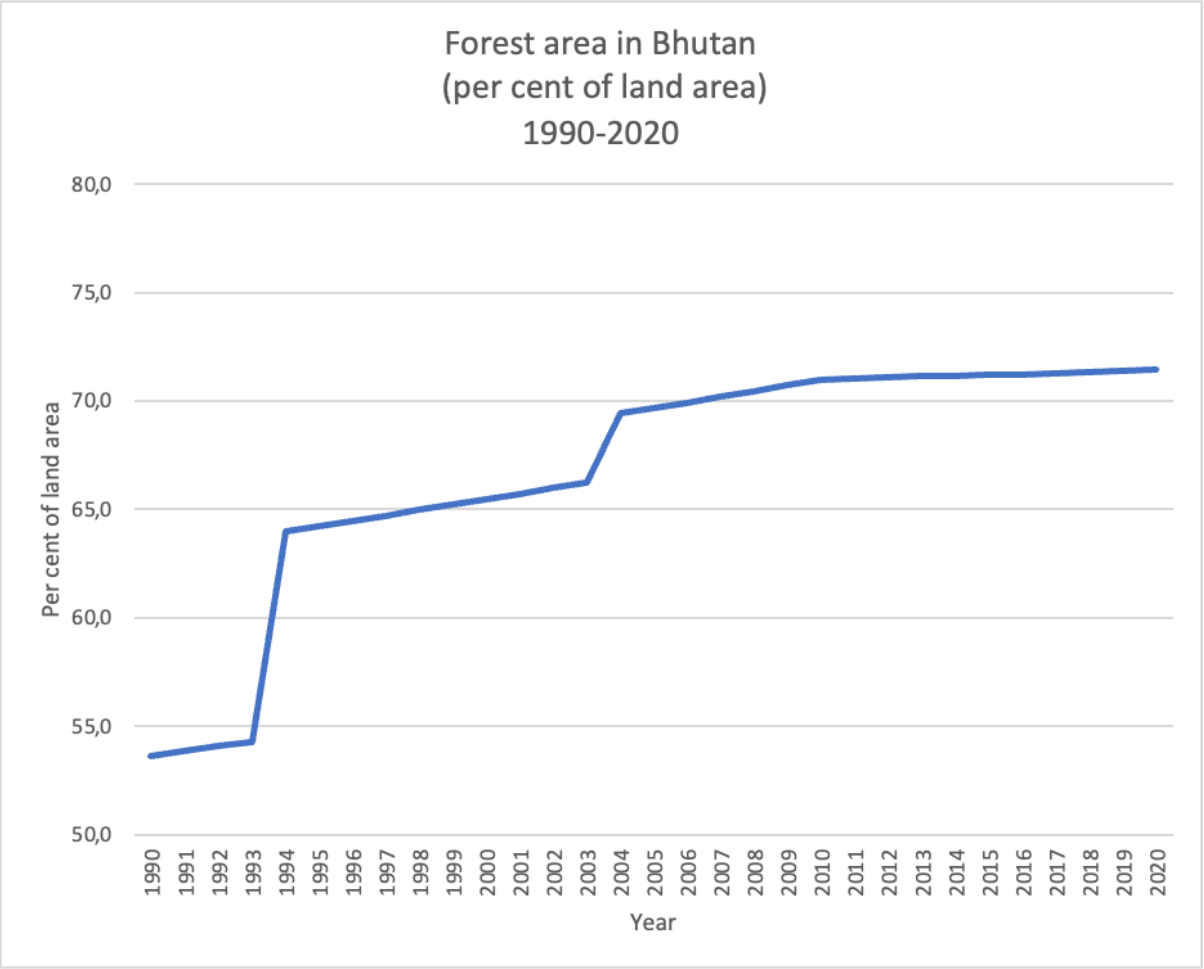

Figure 4. Forest area in Bhutan (% of land area) 1990-2020 (The World Bank, 2023)

Note: Time-span is modified due to data availability

2.1.4. The climate in Bhutan

Bhutan's geographical location might pose a threat in itself to further development. The reason is that the country is especially vulnerable to climate change as it is landlocked in a mountainous and fragile climate (Yangka & Newman, 2018; Gross National Happiness Commission, 2019a). Himalayan glaciers have melted at an increasing rate and this has been accompanied by a rise in the frequency of severe rainstorms resulting in heightened incidents of landslides and floods (Gross National Happiness Commission, 2019a). Furthermore, there is an increasing risk of forest fires, water drought, storms, diseases affecting the crops as well as earthquakes (Gross National Happiness Commission, 2019b). Potential damages and changing environmental prerequisites might therefore threaten the potential for further clean energy production and forest sequestering capacity (Yangka, Rauland & Newman, 2019). It might moreover affect the core of Bhutan's main economic activities which are "forestry, agriculture, tourism and hydropower" (Yangka, Rauland & Newman, 2019, p.680).

3. Theoretical Approach

3.1. The Environmental Kuznets Curve

The environmental Kuznets curve (EKC) hypothesis was articulated in the 1990s and originates from a group of economists (Grossman & Krueger, 1991; Shafik and Bandyopadhyay, 1992; Panayotou, 1993) whose research led them to find a negative correlation between economic growth and environmental degradation in the long run (Parrique, Barth, Briens, Kerschner, Kraus-Polk, Kuokkanen & Spangenberg, 2019; Venkatraja; 2022; Hanif & Gago-de-Santos, 2017). The inverted U-curve shape and the name *Kuznets curve* originate from Simon Kuznet's theory on the relationship between per capita income and income inequality (Kuznets, 1955; Hanif and Gago-de-Santos, 2017; Venkatraja, 2022). It is argued that the variables correlate in the shape of an inverted U-curve where inequality initially rises as income rise, whereafter a certain threshold inequality decrease as income continues to rise (Kuznets, 1955; Hanif and Gago-de-Santos, 2017; Venkatraja, 2022). During the 1990s this same relationship was found between economic growth and environmental degradation, and hence the emergence of the environmental Kuznets curve hypothesis. The relationship is often measured by GDP per capita and different variables for environmental degradation such as various greenhouse gas emissions, biodiversity loss or air quality (Tunali, 2022; Stern, 2017).

When a country is at an early stage of development environmental degradation is limited to the effect of subsistence-based livelihood, having a low impact both in regards to intensity and amount of climate change (Panaytou, 1993). As the country starts to develop, increasing economic activity and growth generally include an expansion of the agricultural sector, greater extraction of natural resources and the onset of industrialisation (Panaytou, 1993; Wang, Zhang & Li, 2023; Venkatraja, 2022). This leads to resources being used at a higher rate than their regeneration capacity, higher energy demands and increasing environmental pollution (Panaytou, 1993; Wang, Zhang & Li, 2023; Venkatraja, 2022). Beyond a certain threshold of GDP per capita, environmental degradation starts to decline according to the theory (Tunali, 2022; Stern, 2004). The mechanism behind the turning point is that as an economy reaches a higher level of development structural changes are anticipated to occur

(Panayotou, 1993). This will alter the economic composition towards less energy-demanding and polluting sectors, such as the service sector, and more information-intensive industries (Panayotou, 1993). Moreover, technological advancements and increased investment in environmental protection as well as higher environmental awareness amongst the population and environmental regulations will lead to environmental improvements beyond the threshold (Panayotou, 1993; Venkatraja, 2022; Wang, Zhang & Li, 2023; Hanif & Gago-de-Santos, 2017).

3.2. The Decoupling Theory

The main idea of the decoupling theory is the possibility to separate economic growth from its negative environmental impacts (Fletcher & Rammelt, 2017; Vadén, Lähde, Majava, Järvensivu, Toivanen, Hakala & Eronen, 2020; Pao & Chen, 2019). OECD (2002) states that the theory refers to the comparative growth rate of an environmental indicator and an economic indicator to which it is correlated (OECD, 2002). There is a distinction between relative and absolute decoupling. Relative decoupling refers to when there is a diminishing use of primary resources, meaning that the same economic output is generated by the use of less material, energy input, and land and water resources (Fletcher & Rammelt, 2017). This is the same as when the relative growth rate of the environmental indicator is positive, yet lower than that of relative economic growth (OECD, 2002; Vadén et al. 2020; Pao & Chen, 2019). Absolute decoupling, on the other hand, is when the economy grows while there is an overall reduction in the use of resources. This is conversely when the relative growth of the environmental indicator is negative or zero as the economic indicator continues to grow (OECD, 2002; Vadén et al. 2020; Pao & Chen, 2019). Moreover, there is a differentiation between resource (input) and impact (output) decoupling. Fletcher & Rammelt (2017) describes resource decoupling as the increase in productivity of resources, meaning lower resource input per output, also called dematerialisation (UNEP, 2011). Impact decoupling, however, is the increase in eco-efficiency, meaning declining negative environmental impacts per output due to using resources in a more environmentally friendly way (UNEP, 2011).

UNEP (2011) stress that the key solution for achieving decoupling is innovation in resource efficiency. They further state that innovation is not solely defined as technological inventions. It can also be institutional innovations, which include effectively handling incentives, minimising transaction costs, addressing rents, fulfilling contractual obligations, taking precautions, and recognising individual responsibilities (UNEP, 2011). Alternatively, it can be

relations innovations, including overseeing collaboration, promoting solidarity, fostering social unity, facilitating social learning and ensuring equitable sharing of benefits (UNEP, 2011).

3.3. Green Growth and Degrowth

Green growth aspires to find alternative ways for continuous development as a middle path between a zero-growth economy, where the environment is protected at the cost of growth, and an economy with uncontrolled growth, where growth is in focus while sacrificing the environment in the process (Vazquez-Brust & Sarkis, 2012). Economic growth is seen to be possible through capital allocation which is aimed at environmental protection (Belmonte-Urena, Plaza-Úbeda, Vazquez-Brust & Yakovleva, 2021). Green growth can be defined as strong, meaning that environmental policies positively affect economic output (Jakob & Edenhofer, 2014). A more modest definition is that environmental policies are enforced at relatively low costs while having a good impact on the environment for future generations and yielding economic benefits for the immediate term (Jakob & Edenhofer, 2014; OECD, 2011). Vazquez-Brust & Sarkis (2012) stress that the concept exceeds the balance between environmental protection and growth. The key concepts of green growth include promoting growth that prioritizes quality, low-carbon emissions, and energy efficiency while emphasizing value-creation through clean technology, natural infrastructure (for instance biodiversity, water bodies and forests), and innovation in environmental goods and services markets (Vazquez-Brust & Sarkis, 2012; Jakob & Edenhofer, 2014). This includes investments in R&D for energy technologies, environmental industries and sustainable production, and natural capital (such as preservation efforts of soil, water supply and forests) in order to find synergies between economic growth and environmental protection (Vazquez-Brust & Sarkis, 2012; Belmonte-Urena et al. 2021).

Those advocating for degrowth emphasise the ecological limits and planetary boundaries of our world (Vadén et al. 2020; Parrique et al. 2019). Proponents of degrowth argue that environmental sustainability can only be reached if economic growth experiences a deceleration (Jakob & Edenhofer, 2014; Belmonte-Urena et al. 2021). Vadén et al. (2020) emphasize the field of steady-state economics, in which the idea is to determine the optimal size of the economy whereafter any additional growth will not be favourable. This is due to the negative environmental effects outweighing potential benefits, leading to what they call uneconomic growth (Vadén et al. 2020). Moreover, they assert that human well-being must

not necessarily be an effect of economic growth but other efforts for evaluating well-being should also be considered. (Vadén et al. 2020; Belmonte-Urena et al. 2021).

3.4. Interconnection of the Theories

The three concepts presented above are closely related and many ideas and mechanisms behind the changes in environmental and economic circumstances are alike. The decoupling process can be seen as a part of the environmental Kuznets curve as the mechanisms behind the decoupling process, such as structural transformation and technological advancements in energy-saving methods, also are anticipated to lessen environmental degradation (Wu, Zhu & Zhu, 2018). Moreover, absolute decoupling can be perceived to happen when reaching the tipping point of the EKC as a decrease in environmental degradation implicates negative or zero growth of the environmental indicator (UNEP, 2011).

General themes that can be found in the three theories which are anticipated to offset negative environmental trends are; investment in environmental preservation, innovations and development of technology, and structural change. The EKC hypothesis also emphasizes increasing environmental awareness and regulations. The decoupling theory and the EKC illustrate a more explicit separation of environmental degradation and economic growth. The green growth approach has however a larger policy focus and instead of decoupling economic growth and environmental impacts, it aspires to through environmental investments be able to consolidate growth and environmental protection (Belmonte-Urena et al. 2021).

4. Previous Research

4.1. Economic Development and Environmental Impact

The challenge of climate change have become an increasingly global issue of interest since the 1990s (Ru, Chen, Dong, 2012). With the increasing threat that climate change poses to future generations and the growing consensus over the past decades on the interconnection between economic growth and environmental degradation, there has been an increase in the quantity of research conducted within the field (Ansari, Haider & Khan, 2020).

Carbon dioxide as a driver of climate change has since the UN Convention on Climate Change Kyoto Conference in 1997 gained more attention (Ru, Chen, Dong, 2012). The aspiration to reduce greenhouse gas emissions and especially CO_2 coexists with the aspiration for socio-economic development. However, economic development is generally accompanied by an increase in CO_2 emissions (Ru, Chen, Dong, 2012).

The high current levels of global carbon emissions can according to Wang, Zhang and Li (2023) and Venkatraja (2022) be seen to stem from the rapid economic growth in the Western world during industrialisation in the eighteenth and nineteenth centuries. Dong, Hockman and Timilsina (2020) similarly assert that even though CO_2 emissions have been increasing at a higher rate in developing countries in the last decades, the global stock of CO_2 concentration and other greenhouse gases are mainly due to the historically high emission trends from developed countries. Moreover, Dong, Hockman and Timilsina (2020) state that increased income has been the primary reason for increasing CO_2 concentration globally and Marjanovica, Milovancevi and Mladenovica (2016) assert that there is a general consensus that GDP growth and increasing CO_2 emissions are positively correlated. The reason is that as GDP per capita increases so does production and consumption which entails a larger use of material, natural resources, fuel and energy (Marjanovica, Milovancevi, & Mladenovica, 2016; Fernández-Amador, Francoisa, Oberdaberniga, & Tomberger, 2017). These aspects have a negative effect on the environment in terms of emissions and over-exploitation of resources (Venkatraja, 2022; Sadiq et al. 2023). While the relationship between economic growth, CO_2 emissions and energy use may seem simple, Yangka, Rauland & Newman (2023) stress that it is more complicated than meets the eye as the interconnection between the two variables seems to differ between countries, research methods and level of development in the country examined.

4.2. The Environmental Kuznets Curve

Despite the initial findings and development of the environmental Kuznets curve there is a large volume of research on the validity of the EKC, however, the empirical results are of varying conclusions. The relationship is highly sensitive to which explanatory variables are being used, which countries are being examined, data sources, methodology and time interval (Ansari, Haider & Khan, 2020; Kaya Kanlı & Küçükefe, 2023; Wang, Zhang & Li, 2023)

Grossman and Krueger (1991) first examined the link between economic growth and environmental degradation in regard to the North American Free Trade Agreement by examining 42 countries and the relationship between economic growth and air quality. In their study, they found an inverted U-curve relationship where there was an alleviation of pollution problems after a certain level of GDP per capita (Grossman and Krueger, 1991). Panayotou (1993) examined the EKC relationship by looking at air pollutants and deforestation and rising income for a selection of developed and developing nations and also found an inverted U-curve relationship.

Hanif and Gago-de-Santos (2017) examine the EKC relationship using GDP per capita and CO_2 emissions for 86 developing countries (1972-2011) and find the existence of EKC in this sample. However, they also assert that it is essential for the countries to actively implement environmentally friendly policies in order to avoid a linear relationship between economic growth and environmental deterioration (Hanif and Gago-de-Santos, 2017). Hanif and Gago-de-Santos (2017) further assert that since empirical evidence is still inconclusive it is not appropriate to make universally applicable policy recommendations.

Kaya Kanlı and Küçükefe (2023) examine 43 countries (1970-2019) that have a population of at least 10 million people and CO_2 emission per capita of at least 1 Mt. The authors conclude that air pollution does not decrease globally as income rise and that the overall trend for CO_2 emissions per capita is positive. On the other hand, Wang, Zhang and Li (2023) find that the EKC hypothesis is valid on a global level between 1990-2018 for income per capita and carbon emissions when accounting for the impacts of trade liberalisation, natural resource rents, utilisation of renewable energy sources and human capital.

Holding the EKC hypothesis valid would imply that environmental sustainability would be possible without sacrificing economic growth (Kaya Kanlı and Küçükefe, 2023). There are however opponents that argue that the EKC is unattainable and might encourage growth policies that will lead the environment over irreversible tipping points (Stern, 2017). Those advocating against the existence of the EKC relationship emphasize that there are environmental pollutants that are not monitored and that the environment might therefore still be negatively affected by economic growth even though a selection of indicators decline as income rises (Kaya Kanlı & Küçükefe, 2023). Moreover, some environmental impacts might be irreversible, such as biodiversity loss, even if the concentration of pollutants in the

atmosphere decrease (Kaya Kanlı & Küçükefe, 2023). Furthermore, as studies have reached different conclusions on when a country reaches the threshold of environmental degradation it is therefore uncertain to what point of development a country needs to reach before there is an environmental alleviation (Kaya Kanlı & Küçükefe, 2023). Development paths also differ between countries and time periods, and regional characteristics such as political, historical, economic or social circumstances could therefore also affect the relationship making it difficult to draw general conclusions (Kaya Kanlı & Küçükefe, 2023; Wang, Zhang & Li, 2023)

4.3. The Decoupling Theory

Decoupling as a concept was first articulated and adopted in 2001 by the OECD (Organisation for Economic Cooperation and Development) as it was emphasized as one of the primary objectives in their policy document *Environmental Strategy for the First Decade of the 21st Century* (Fletcher & Rammelt, 2017; OECD, 2002). Advocates of the decoupling theory emphasize the possibility that through increasing efficiency being able to attain unlimited economic growth in alignment with environmental sustainability (Fletcher & Rammelt, 2017). However, UNEP (2011) stress that the global society needs to acknowledge that there is a limit to growth in terms of planetary boundaries.

Fletcher and Rammelt (2017) examine the decoupling theory in regard to the global SDGs and argue that achieving these goals will be close to impossible without decoupling. However, the authors argue in their paper that decoupling seems to be an infeasible fantasy and can be used as a smokescreen in order to persist with current economic practices. The authors argue that empirical research and conceptualisation of the theory remain poor but that it will probably take some time before its proponents recognise that the theory is not realisable. The environment, therefore, risks further deterioration before a real change is made (Fletcher & Rammelt, 2017).

Vadén et al. (2020) examine 179 articles between 1990-2019 that conduct research on decoupling. They found that 23 of the articles examined observed absolute resource decoupling and only 11 of these claimed evidence of this at an economy-wide and national level. Nevertheless, Vadén et al. (2020) states that these were however lacking evidence of sustained, fast or international absolute resource decoupling. Both Vadén et al. (2020) and Dale, Mathai and Puppim de Oliveira (2016) state that greenhouse gas emissions need to be

decoupled from GDP growth in absolute terms. Furthermore, they state that it is essential for this decoupling to be substantial and of great magnitude globally, as well as quick and lasting in order to reach environmental sustainability. This means that even though evidence of decoupling was found in Vadén et al.'s study (2020) this was not necessarily sustained or happening at a pace, rate or magnitude that makes it ecologically sustainable.

Moreover, Fletcher and Rammelt (2017) state that evidence for decoupling is often regarding relative decoupling since absolute decoupling is rare. Nevertheless, other phenomena such as the offshoring of more pollution-intensive industries to developing countries might also induce a relative decoupling. Relative decoupling might therefore not be as straightforward as it seems. OECD (2002) states that if the economy grows at the same time, a relative decoupling might not equal diminishing emission levels, and moreover if relative or absolute decoupling occurs when there is a recession in economic activity this might not be beneficial for the collective well-being of society.

Wu, Zhu and Zhu (2018) examine decoupling in a set of developing and developed countries for the years 1965-2015 and find strong decoupling in the developed countries (France, United Kingdom, Germany and the United States) while there is a weak decoupling and high fluctuation in developing countries (China, Brazil & India). The authors stress that in order to reach decoupling, policies need to be implemented. They stress that energy efficiency is a vital aspect and suggest that developing countries should leverage their late-start advantage and foster strategic partnerships with developed nations to attract foreign investments as well as focus investment efforts towards energy-saving technology. Additionally, they need to find a strategy for the increasing rate of urbanisation that is occurring in many developing countries and has an effect on CO_2 emissions. Lastly, they assert that as economic development and subsequent structural change of the economy occur there needs to be a focus on reforming the economic structure in order to facilitate the advancement of low-energy tertiary sectors characterised by high-added value and low CO_2 emissions (Wu, Zhu & Zhu, 2018).

Similarly, Hoffmann (2016) stresses that two essential components of decoupling are increased efficiency in regards to energy as well as other resource-use, alongside increased use of energy and material that is renewable. The effect of technology advancements and structural/composition transition needs to be higher compared to the growth of emissions

from the effect of increasing scale of a growing economy. However, Hoffmann (2016) states that the structural changes have not had the effect one might have hoped for. They claim that in order for structural changes to be effective industries that are high polluters have to retreat at a faster rate compared to the expansion of more eco-efficient ones, and this is not something that empirically has been observed (Hoffmann, 2016).

Nevertheless, while innovations are necessary for sustainable development, UNEP (2011) stress that technological innovations also can lead to greater consumption of resources. The reason is that as productivity increases this might lead to, for instance, decreasing cost of production, expanded availability or increased affordability which in turn can increase resource demand (Hoffmann, 2016).

4.4. Green Growth and Degrowth

Dale, Mathai and Puppim de Oliveira (2016) stress that green growth and green economy is the most recent stage in reshaping political discourse in response to environmental challenges and movements. Green growth stems from the environmental discourse that started in the 1970s (Dale, Mathai & Puppim de Oliveira, 2016). Nevertheless, it gained attention in 2005, during the "Fith Ministerial Conference on Environment and Development" where 52 governments and stakeholders in the Asia-Pacific region reached a consensus to expand the sustainable development discourse and embark on a trajectory of green growth (Dale, Mathai & Puppim de Oliveira, 2016, p.11). The concept was then emphasised as it was discussed and reported on by organisations such as the OECD (2011) and the World Bank (2012). The transition towards inclusive and green growth would require improving energy efficiency and changes in the material and energy mix as well as achieving structural changes and in turn, the aspiration is that it would lead to new job opportunities and the creation of wealth (Hoffmann, 2016).

Dale, Mathai and Puppim de Oliveira stress that in comparison to the sustainable development discourse, green growth is more in line with "green (neo)liberalism" where environmental sustainability both aligns with and relies on the economic market system (2016, p. 4). Nature is perceived as capital in need of measuring, accumulation, conservation and production. Vazquez-Brust and Sarkis (2012) similarly state that the founding principle of green growth is economic and not ecological. Green growth aims to direct the global economy towards investing in environmental services and goods markets and create new

low-carbon environmental sectors while also investing in “natural infrastructure” (water, biodiversity and forest for instance) (Vazquez-Brust & Sarkis, 2012, p.8). The goal is to create job opportunities both in high and low-skill employment, such as in R&D for energy technologies or organic agricultural activities and forestry (Vazquez-Brust & Sarkis, 2012). Degrowth is more controversial in the eyes of many economic and political policymakers as it opposes the growth-oriented capitalistic system (Belmonte-Urena et al. 2021).

Ghosh (2022) states that the economic strategies suggested by both those who advocate for green growth and degrowth are similar and that there is a need to change focus from economic growth and GDP as a measure. Jakob and Edenhofer (2014) similarly stress that both green growth and degrowth can be seen as misleading as their primary foundation is economic growth. The aspiration of green growth creating new job opportunities, eradicating poverty and increasing human well-being is according to the authors not backed by empirical evidence. Moreover, in the case of degrowth carbon dioxide emissions do not necessarily decrease at a high rate just as a result of a stagnating economy (Jakob & Edenhofer 2014; Belmonte-Urena et al. 2021). Jakob and Edenhofer (2014) instead propose policies based on the notion that natural capital is common goods and argue that the nexus that is the environment and economic development should be assessed from a social welfare perspective and not solely economic advancements.

Green growth proponents argue that economic growth can be separated from increasing emissions and energy consumption by advancements in technology and structural changes (Hoffmann, 2016; Parrique et al. 2019). However, Hoffmann argues that this suggests disregarding “asymmetrical market structures, related supply-chain governance, and economic driving forces.” and that dematerialised growth will not succeed unless changes occur in regard to cultural norms for consumption and distribution of income (2016, p. 36). The author further states that structural change and technological advancements will not in itself decouple economic growth from greenhouse gas emissions. Dale, Mathai and Puppim de Oliveira (2016) put forward three elements for transformation. The first one being to align production, consumption and technologies with nature's capacity and recreational capability, the second being, exercising sufficiency and collective use instead of individual over-consumption and the third is a better income distribution. In order to attain this the authors suggest the following development strategies; abandoning GDP as the absolute measure of welfare, stepping away from extensive commercialisation of services and

activities, focusing on quality instead of quantity, engaging in reuse and reselling items and materials, promoting innovations in social and ecological domains and creating incentives to protect and develop common goods. Green growth as a concept might if you disregard the actual steps needed to take create false hope and lead to a continuation of environmental distortion (Hoffmann, 2016).

4.5. Other Considerations

4.5.1. Population

The global population is anticipated to increase to 9.3 billion people in 2050 and this change is expected to drive a massive increase in resource use due to the increasing scale of production and consumption (UNEP, 2011; Hoffman, 2016). Hoffman (2016) states that population growth can occur without resulting in increased greenhouse gas emissions, however, this is only true if people remain poor. As poverty reduction is one of the international communities' main agendas, the connection between population growth, poverty, economic growth and environmental degradation will be a great challenge in the future.

Yangka, Rauland and Newman (2019) stress that Bhutan's small population can be seen as an advantage in regard to its carbon neutrality. However, there is a possibility that population growth and increasing urbanisation pose a threat as these two aspects often contribute to increasing carbon emissions (Yangka, Rauland and Newman, 2019; Venkatraja, 2022). In regards to increasing urbanisation in Bhutan, Yangka, Rauland and Newman (2019) state that some interviewees in their study, argue that consumption and hence emission levels might increase as the urban population increases, while others imagine that less populated rural areas can lead to an increase in forestry and hence higher sink capacity. Moreover, Venkatraja (2022) asserts that emissions created from rural activities might be expected to increase as well since increased economic activity and the creation of wealth in conjunction with agrarian reforms leads to heightened demand in the farming sector.

4.5.2. Developing versus Developed Country

UNEP (2011) states that being a developing country might be beneficial in some aspects when it comes to sustainable development. The authors stress that it might be easier to adopt eco-innovations since regulatory structures might not be as firmly established and new

technologies might therefore have more room for development. Moreover, the less sunk cost in already established infrastructure creates room to adopt new innovations that are more environmentally friendly, also younger markets might enable the shaping of new consumer behaviours. Furthermore, technological leapfrogging, where you adopt technologies and innovations that are more advanced from developed countries, is a possibility and can allow developing countries to skip some of the more polluting stages of development which industrialised nations have already surpassed (UNEP, 2011).

Wu, Zhu and Zhu (2018) however assert that developed countries possess greater potential to decrease their CO_2 emissions without significantly impacting economic growth. Developing countries on the other hand have, according to the authors, a stronger correlation between their emissions and economic growth. Accordingly, an increase in economic activity will be much more likely to cause a massive increase in CO_2 emissions (Wu, Zhu & Zhu, 2018). As a result, the authors stress that it is of large importance that developing countries have policies aimed at energy-saving efforts and emission control.

4.5.3. Production versus Consumption-Based Emissions

Stern (2017) asserts that as countries develop and go through structural transformations, arguably leading to lower emission levels, there is a risk that they in practice off-shore activities that are emission-intensive to developing countries. Emissions embedded in traded goods create the risk that developed countries instead import emissions by importing services and goods from developing countries that use technologies that are more pollutant-intensive (UNEP, 2011; Stern, 2017). Off-shoring and trade make pollution a cross-border externality and as international trade has a significant impact on the environment it therefore becomes difficult to assess countries' real environmental impact and hold parties responsible for environmental degradation (UNEP,2011; OECD, 2002; Stern, 2017). This geographical movement of environmental pressures might therefore lead to a trend of decoupling, achieving green growth or reaching the tipping point of the EKC while in reality environmental pollution can solely have been displaced to another place on the planet (Vadén et al. 2020; Parrique et al. 2019).

4.5.4. GNH and Other Measures of Development

GDP as a measure of progress has often been criticized as its main focus for assessing development is economic growth (Vadén et al. 2020; Ghosh, 2022). Examples of

shortcomings of the indicator are that it does not separate GDP generated from good or bad development, consider leisure time or unpaid work and it does not measure social, natural or human capital (Ura, 2015). Gross National Happiness is as mentioned before a more holistic development approach and Ura (2015) stresses that GNH can be seen as an attempt to address these shortcomings of GDP. In Bhutan's twelfth five-year plan, the Gross National Happiness Commission (2019b) stressed that their GNH objective is in great alignment with global development goals such as the SDGs. Ura (2015), states that GNH as a framework has had a considerable impact on the creation of norms and guiding development principles. They further state that Bhutan has succeeded in finding a balance between tradition and modernity as well as between economic growth and environmental sustainability which according to them would not have been possible without the GNH framework.

In regards to measuring development, UNEP (2011) stresses that economic innovations such as new measures and indicators, complementing GDP, might be necessary in order to embrace social and environmental concerns to a larger extent. UNEP (2011) highlights the possibility to a larger extent by using indicators such as the Genuine Progress Indicator (GPI) or Happiness Indices such as the Human Development Index (HDI) since GDP as a measure will always rely on increasing resource extractions. United Nations Development Programme (2019) states the GNH can be seen to assess advancements aligned with the HDI since they both emphasize good governance and works as guiding principles where peoples' rights, needs and aspirations are at the core of the development strategy. Dale, Mathai and Puppim de Oliveira, (2016) further stress that the current measures of development, such as GDP, number of jobs, water quality, or even HDI are lacking in the sense that they fail to encompass intricate ecological and social aspects. GNH takes a more comprehensive approach to happiness where it is partly evaluated by more traditional areas such as education, health and living standard, but also by factors such as culture, psychological health, time use and environmental diversity (Oxford Poverty and Human Development Initiative, n.d.).

According to the GNH index which rose from 0.743 in 2010 to 0.756 in 2015, people are becoming happier in Bhutan (United Nations Development Programme, 2019). GNH is a somewhat disputed concept; while some see the framework more as a loose definition of green growth, others have the idea that GNH equals the GNH Index and should guide development and replace GDP as a measure, and others still see GNH as a philosophy which

addresses societal well-being and aims for contentment, balance and sufficiency in economic advancements once fundamental needs have been fulfilled (Gerber and Raina, 2018). The GNH survey has thus far only been conducted twice and United Nation Development Programme (2019) stress that a critical drawback is insufficient data and proof to measure the extent of GNH progress. Yangka, Newman, Rauland & Devereux (2018) stress that GNH, for instance, lacks biophysical indicators which is a critical constraint on GNH as an evaluator of ecological resources.

5. Methodology

5.1. Research Design

The method used in order to answer the research question: *What is the relationship between CO_2 emissions per capita and GDP per capita in Bhutan, and does this relationship threaten Bhutan's carbon-neutral status?* is a secondary data analysis using descriptive statistics. A quantitative approach is suitable in this case as the aim of this paper is to examine the relationship between two specific variables (Creswell, 2014). It will be a nonexperimental correlation design which in this study will examine the relationship between the independent variable GDP per capita and the dependent variable CO_2 emissions per capita for the years 1980 to 2021 (Creswell, 2014). The purpose is to investigate the correlation between the variables in order to examine potential implications on Bhutan's carbon-neutral status. More specifically a bivariate correlation plot (scatterplot) and regression line will be constructed to visualise the relationship (Djurfeldt, Larsson, & Stjärnhagen, 2018). Moreover, statistical analysis in the form of R-square and P-value will be considered to analyse the correlation and determine its variance and significance (Djurfeldt, Larsson, & Stjärnhagen, 2018; Barnmark & Durfeldt, 2016). Secondary information on Bhutan's environmental policies and strategic framework will furthermore be gathered in order to analyse mitigating environmental efforts such as policy implementation, technological advancements, priorities and investments.

The results will then be analysed in relation to the theoretical framework presented in previous sections. The three theories are closely related but provide small variations in the perspective of the relationship, and therefore together contribute to a bigger picture.

Additionally, previous research within the field is used in the analysis in order to benchmark the results to what has previously been found.

5.2. Data

The data on GDP is collected from the World Bank's Database, World Development Indicator (The World Bank, 2023) and the data on CO_2 emissions are collected from Our World in Data (Our World in Data, n.d.a.). Our World in Data gathers its main data on carbon emissions from the Global Carbon Project, whereafter they calculate and compile its descriptive statistics. Meaning that they for instance collect annual CO_2 emissions from the Global Carbon Project (published by Friedlingstein et al. 2022) and then calculate their own per capita estimates (Our World in Data, 2022; Global Carbon Project, n.d.). The Global Carbon Project is updated every year and dates back to the year 1750. Their dataset first and foremost use the underlying dataset from the Carbon Dioxide Information and Analysis Center by Dennis Gillfillan and Gregg Marland (Appalachian Energy Center, n.d.) and complements it by using and calculating recent data from BP Statistical Review of World Energy (BP, 2023), as well as energy data from other sources such as the International Energy Agency (Our World in Data, n.d.a). The reason for using Our World in Data for data on CO_2 is that their dataset is more comprehensive compared to for instance the World Bank's carbon emission dataset.

The data is longitudinal with the timespan from 1980 to 2021, this timeframe was partly selected due to data availability, partly due to it covering the years of interest for this study. The reason is that Bhutan introduced the GNH framework, pledged carbon neutrality and aspired to reach higher economic growth during these years. This data is used to study the correlation between the two variables. Moreover, GDP and CO_2 metrics are used to visualise and calculate economic growth as well as CO_2 emission growth in Bhutan. Additionally, data to investigate Bhutan's carbon-neutral status is gathered from Bhutan's National Environment Commission (2022). The variables; total CO_2 emissions and CO_2 sink capacity are used in order to calculate Bhutan's net emission account which dictates its carbon neutral status. The purpose of the National Environment Commission's report (2022) is to present it to the United Nations Framework Convention on Climate Change, and presented data is therefore prepared using the 2006 IPCC guidelines and software (National Environment Commission, 2022). Funds and methodological support have been provided by the the Global Environment

Facility through GEF Umbrella Support Program implemented by UNEP, Nairobi and the Secretariat of UNFCCC and the United Nations Environment Programme.

The variables used in the thesis are explained in their entirety in Appendix A.

5.3. Limitations and Considerations

This thesis investigates a small landlocked country in South Asia that has very country-specific prerequisites in terms of both natural endowments and cultural and political circumstances. This might therefore affect the external validity of this paper. Nevertheless, the uniqueness of the country is also one of its strengths. The global community aims towards carbon neutrality, and as Bhutan is one out of three countries in the world that have achieved this it becomes interesting to examine the reason behind it.

Moreover, in regard to limitations, the theories being used are debated, as discussed in section 4, and there are both proponents and opponents regarding evidential empirical support. However, as methodology, timeframe, country, and explanatory variables seem to play a big role in results it is interesting to investigate this relationship on the background of the three theories in Bhutan based on the framing and definitions of this thesis.

Considering Bhutan being a small and fairly isolated country until recently there are limitations in regard to data availability. Data on consumption-based emissions in Bhutan is for example not available. This means that it is not possible to calculate trade emissions for Bhutan. The data on CO_2 emissions is therefore limited to production-based emissions where the considered emissions are those allocated to the country of production and not consumption if traded (Our World in Data, n.d.a). Bhutan being a small and until fairly recently an isolated country also affect the availability of English academic literature.

Moreover, it is important to consider the effect that the Covid-19 pandemic has had on the economy and consequently CO_2 emissions. Since changes in GDP arguably affect CO_2 emissions levels, and thus Bhutan's carbon neutrality, it is relevant to include the years 2020 and 2021 for the purpose of this study. Furthermore, since Bhutan have the aspiration to graduate from their LDC status in 2023 it is considered relevant to take the most recent data available into account. Nevertheless, it is important to be aware of that the data from these years might be outliers.

There is a discourse on the use of CO_2 as an indicator of environmental degradation and empirical results regarding the relationship between carbon emissions and economic growth have been inconsistent (Wang, Zhang and Li, 2023). However, even though there are other greenhouse gases that contribute to climate change, around 75 % of greenhouse gases in the atmosphere are CO_2, and it is therefore seen as the main driver of climate change (Sadiq et al. 2023). Moreover, CO_2 is the main indicator that the international community has targeted for fighting climate change and for the purpose of this study investigating carbon neutrality CO_2 is the relevant indicator (Ansari, Haider & Khan, 2020). Nevertheless, Table 3 presents Gg CO_2e (carbon dioxide equivalent in Gg) which accounts for several greenhouse gases, such as methane (CH_4) and nitrous oxide (N_2O), that is transformed into the equivalent amount of CO_2 by accounting for their global-warming potential (GWP) (Eurostat, 2014). The reason for using this metric when looking at forest sequestration is that it more accurately represents the actual environmental impact of greenhouse gas emission and sink capacity, considering the fact that trees also absorb other greenhouse gases and not solely CO_2. Nevertheless, CO_2 amounts to the absolute majority of these gases. For instance, in the energy sector in the year 2020, 651.91 Gg out of 661.15 CO_2e Gg was CO_2 while only 0.022 Gg was N_2O and 0.10 Gg was CH_4 (Table 3).

6. Results and Analysis

6.1. Economic Growth and Environmental Degradation in Bhutan

Looking at the correlation between CO_2 per capita and GDP per capita in Bhutan from 1980 to 2021 there is not an inverted U-curve shape in accordance with the environmental Kuznets curve (figure 5). Instead, the regression line shows a positive linear correlation. There is an upswing around the years 2009 and 2010 when emissions significantly rose. This can be due to the introduction of GNH as a development framework and the country's decision to set the creation of wealth and economic growth as a goal to work towards (Venkatraja, 2022). Around the late 1990s and the beginning of the early 2000s, a negative or neutral correlation trend between GDP per capita and CO_2 per capita can be observed. During the period of 1998 to 2009 Bhutan however still experienced economic growth of an average of 5.7 % in GDP

per capita growth (The World Bank, 2023). CO_2 emissions per capita on the other hand only increased by an average of 0.5 % in the same period. The reason for the stagnation in CO_2 emissions for this period is difficult to determine as there can be many contributing factors. Nevertheless, it might be due to diminishing CO_2 emissions from coal during this period which is possible to see in Figure 6.

Nevertheless, the correlation in Figure 5 displays an R-square of 0.8886 which indicates that approximately 89 % of the variation of CO_2 emission per capita can be explained by GDP per capita (Djurfeldt, Larsson, & Stjärnhagen, 2018). The p-value is less than 0.001 which indicates that the probability that this correlation happens by chance is less than 0.1 % (Barnmark & Durfeldt, 2016). It is, therefore, possible to reject the null hypothesis and assume that the results are statistically significant (Barnmark & Durfeldt, 2016). Since Bhutan is still in their initial development stages there is a possibility that it will eventually reach the turning point of the EKC. At the same time since the correlation between the two variables is significant, an increase in GDP will certainly result in increasing CO2 emissions if mitigating measures are not implemented.

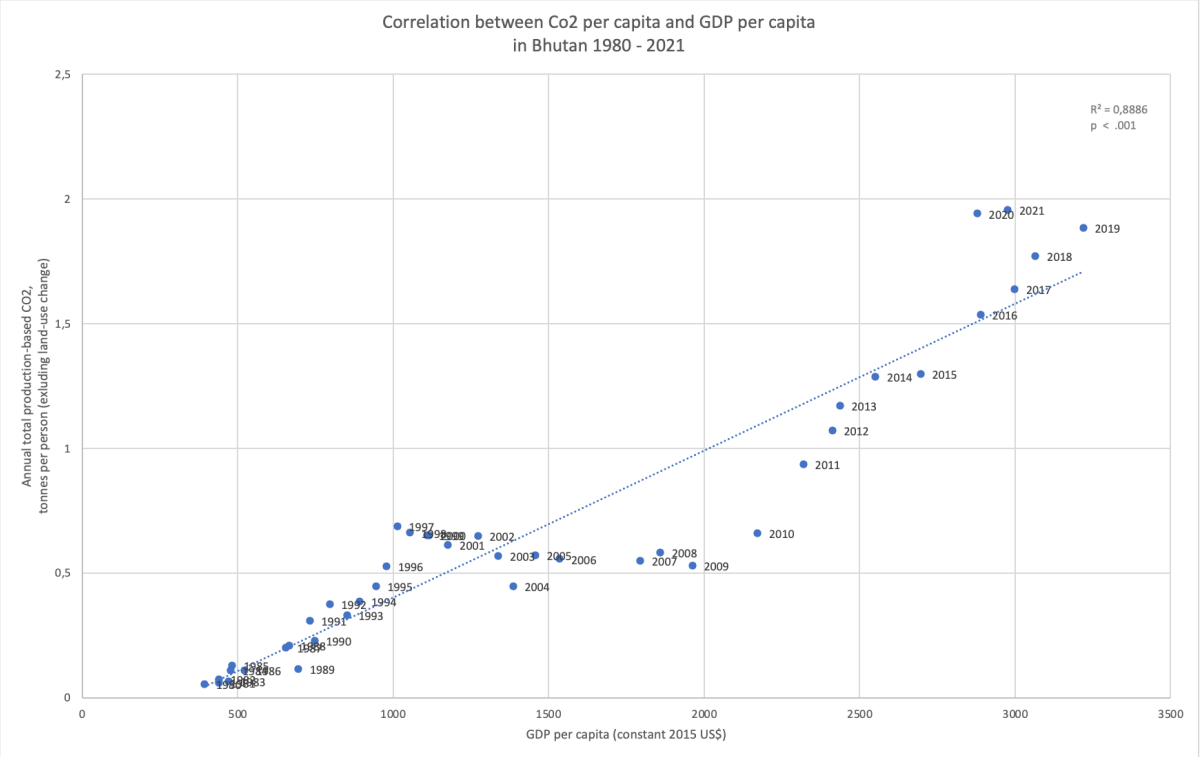

Figure 5. The correlation between CO_2 per capita and GDP per capita in Bhutan 1980-2021 (The World Bank, 2023; Our World in Data, n.d.a.)

Note: Time-span is modified due to data availability

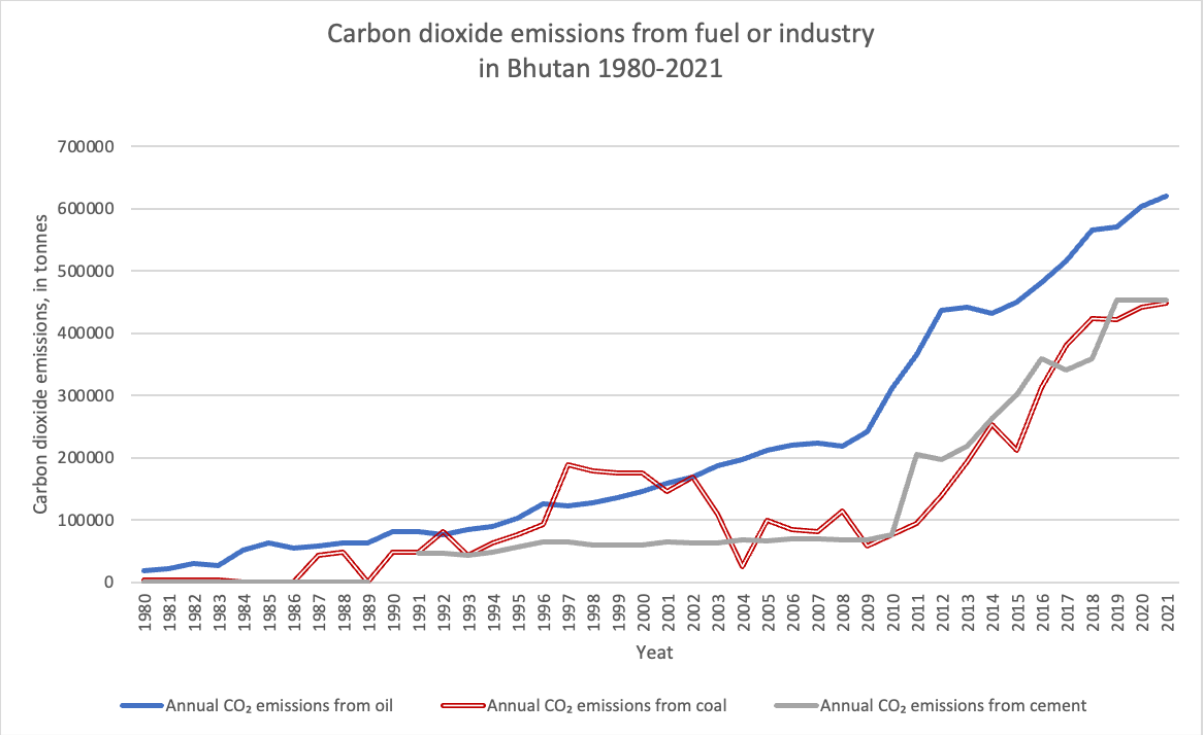

Figure 6. Carbon dioxide emissions from fuel or industry in Bhutan 1980-2021 (Our World in Data, n.d.a)

Table 2 presents evidence of relative decoupling for the period 2001-2010 as CO_2 emissions grow at a lower rate relative to GDP. However, this is the only period in this time interval where it is possible to see such a decoupling, and after 2010 there is an increase in the growth rate of emissions in Bhutan while a slower GDP growth. In order for there to be an absolute decoupling, or for Bhutan to reach the tipping point of the environmental Kuznets curve, CO_2 has to grow at a negative or neutral rate. In Figure 7, it is possible to see that there are considerable fluctuations in the growth rate of CO_2 emissions. Moreover, it is possible to observe negative CO_2 growth rates in the following years; 1983, 1986, 1989, 1993, 1998, 2001, 2003, 2004, 2006, 2007 and 2009, which would indicate absolute decoupling. Nevertheless, these negative growth rates are not sustained in the long run, and looking at Table 2 emissions are still being emitted at a relatively higher rate compared to economic growth for the period as a whole. Moreover, negative growth has not been observed in CO_2 emission levels since 2009 which as addressed previously was when Bhutan began to aspire for higher economic growth.

Table 2. Annual GDP and CO_2 growth in Bhutan, ten-year intervals (The World Bank, 2023; Our World in Data, n.d.a.)

Average annual growth rate (%)	GDP constant 2015 US$	CO2 production-based emission
1981-1990	10,05	27,51
1991-2000	4,64	12,63
2001-2010	8,93	2,98
2011-2021	3,94	11,90
1981-2021	6,82	13,71

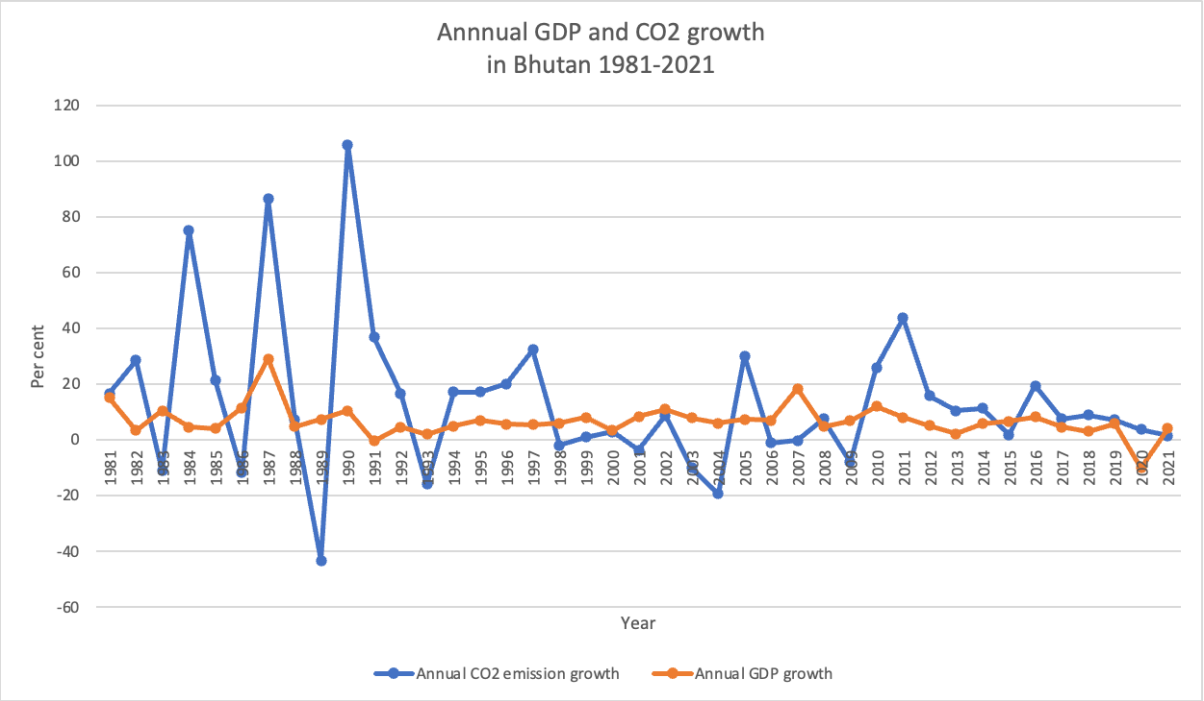

Figure 7. Annual GDP and CO_2 growth in Bhutan 1981-2021 (The World Bank, 2023; Our World in Data, n.d.a.)

6.2. Emission Trends and Structural Changes in Bhutan

The two largest contributors to emissions in Bhutan, shown in Table 3, are Energy and IPPU (Industrial Processes and Product Use). The contributors to emissions in the energy sector are the use of diesel, coal or furnace oil in manufacturing industries and construction (38.5 %), and gasoline/diesel use in the transport sector (56.5 %) as well as residential and commercial use of biomass, liquified petroleum gas and kerosene mainly for cooking and heating (5 %) (National Environment Commission, 2022). Within the IPPU sector, the main contributors to emissions are the metal industry (57 %), the mineral industry (40.5 %), and the chemical industry (2.5 %), (National Environment Commission, 2022). Livestock and agriculture contributed to 19 % of total emissions in 2020, mainly due to livestock and enteric fermentation (67 %), manure management (10 %), rice cultivation (6 %) and agricultural soil (17 %). The National Environment Commission states that the fairly stable and somewhat decreasing agricultural sectoral emission level indicates that these are *"*survival emissions required for the sustenance of people" (2022, p.47). Waste accounted for 5 % of total emissions in 2020, increasing by 128 % since 1994. The FOLU (forestry and land use) category stood for 23 % of total emissions in 2020, this was emissions from harvesting timber (50 %), deforestation (36 %) and emissions from forest fires (14 %), which is a decrease of 2 % since 1994. At the same time, forestry contributed to a carbon sequestering capacity of 9514 Gg CO_2e in 2020 (National Environment Commission, 2022).

Emissions from increasing economic activity are generally seen in the energy and IPPU sector (National Environment Commission, 2022). Table 3 displays an increase in emissions from energy with 606 % and 375 % in the IPPU sector between 1994-2020, it is, therefore, probable that a large share of increasing emissions that Bhutan has experienced results from increasing economic activity. The National Environment Commission (2022) states that as Bhutan aspires to transcend from a LDC in 2023 this trend of increasing emissions from energy and industry should be expected to continue. However, it is also possible to observe that the Bhutanese population has increased a lot, from approximately 221,000 people in 1960 to 777,500 in 2021 (Figure 1) which is an increase of 250 %. Apart from the aspiration for increasing economic activity and GDP growth, it is therefore likely that increasing emissions stem from increasing scale due to population growth.

Bhutan's sectoral development has resulted in a diminishing agricultural sector (Figure 2) which can also be seen in the amount of emissions from this sector which has decreased by 15 % since 1994. While The EKC stress that sectoral development towards services and other less emission-intensive industries should entail fewer emissions, and hence bring about the turning point of the U-curve, Bhutan is at a stage where the industrial sector still makes out a large part of its economy (Figure 4). The service sector has remained largely unchanged despite a moderate increase in employment over the last decades (Figure 3 & Figure 4). Moreover, Hoffmann (2016) stresses that the shift into a more service-based economy has not proven to be as effective in reducing emissions as has previously been argued. The reason is that activities such as health, tourism or transport are quite energy and resource intensive in regards to the establishment of their infrastructure. Furthermore, even if there is an increase in employment shares in the service sector and hence a somewhat decrease in emissions from production, consumption will mainly depend on the population's income (Hoffmann, 2016).

Table 3. Trends in emissions and removals 1994-2020, Gg CO_2e (National Environment Commission, 2022)

Year	Energy	IPPU	Agri-culture	Waste	Folu emission	Total Emissions	Sink capacity	Net emissions
1994	94	167	601	56	643	1560	8976	-7415
1995	121	181	642	64	980	1988	9007	-7018
1996	132	167	618	60	942	1919	9037	-7118
1997	112	219	593	63	920	1907	9068	-7161
1998	125	197	643	66	556	1587	9099	-7512
1999	259	241	621	69	811	2001	9130	-7129
2000	259	220	575	68	809	1932	9160	-7229
2001	290	250	526	71	661	1798	9170	-7372
2002	303	261	525	74	537	1700	9180	-7480
2003	381	252	538	79	467	1718	9190	-7472
2004	411	242	542	79	531	1806	9200	-7394
2005	357	259	622	81	449	1768	9210	-7442
2006	333	293	600	69	672	1968	9220	-7252
2007	386	419	601	71	1338	2816	9230	-6414
2008	368	466	601	73	562	2070	9240	-7170
2009	387	459	565	75	478	1964	9250	-7286
2010	469	497	570	88	644	2267	9260	-6992
2011	519	476	558	89	659	2302	9285	-6983
2012	589	483	542	114	660	2387	9310	-6923
2013	620	596	533	118	666	2533	9336	-6802
2014	689	660	550	122	1109	3130	9361	-6231
2015	708	796	553	127	744	2927	9387	-6459
2016	703	978	555	118	924	3278	9412	-6134
2017	761	1096	565	121	724	3267	9437	-6171
2018	864	1292	559	77	613	3404	9463	-6059
2019	833	1054	534	135	750	3306	9488	-6182
2020	661	793	513	127	629	2723	9514	-6790
Change in per cent 1994-2020	606	375	-15	128	-2	75	6	-8
Contribution in per cent of total emissions in 2020	24	29	19	5	23	100		

6.3. Sink Capacity and Carbon Neutrality

Evidently, there has been a substantial increase in carbon emissions from energy use and IPPU since 1994 while only a slight increase in the country's sink capacity. Nevertheless, Bhutan presently still has negative net emissions, that of 6790 $GgCO_2e$ in 2020. The large forest sequestration capacity entails that even though they have had a large increase in CO_2 emissions they still have good marginal for staying carbon neutral (Figure 8). Nevertheless, a continuous increase in CO_2 emissions might pose other environmental threats as their climate is sensitive to climate change.

Even though CO_2 is one of the more important and recognised environmental indicators there are numerous other indicators (beyond the scope of this thesis) that are of large importance when measuring the state of the environment. Taking a quick look at one of these indicators in Bhutan, Figure 9 illustrates their ecological footprint and biocapacity. Biocapacity represents the ability of an area to meet human demand and handle waste employing current technology and practises in resource management, while ecological footprint represents the area that a population or individual requires in order to produce what it consumes and handle generated waste (Global Footprint Network, 2023b; Rees, 2013) The first can hence be seen as the ecological supply and the latter the ecological demand (Global Footprint Network, 2023b; European Commission, 2006). Illustrated in Figure 9, a diminishing biocapacity per person and a somewhat increase in the ecological footprint per person can be observed. Biocapacity and ecological footprint can change depending on population size, technological advancements, resource efficiency and consumption pattern (European Commission, 2006; Rees, 2013). Nevertheless, economic growth and efficiency gains can also lead to lower prices and higher spending capital, leading to an increased risk of resource deficits (Rees, 2013). Bhutan had up until 2018 had an ecological reserve whereafter the ecological footprint exceeded the regenerative capacity of nature, hence moving the country into an ecological deficit. It is probable that the decrease in biocapacity in Bhutan is due to the increasing population as the per-person share of biocapacity diminishes as the population increase. This can indicate that even though they have negative carbon emissions their climate might not be able to handle their increased population size, economic growth and consumption in regards to other environmental indicators.

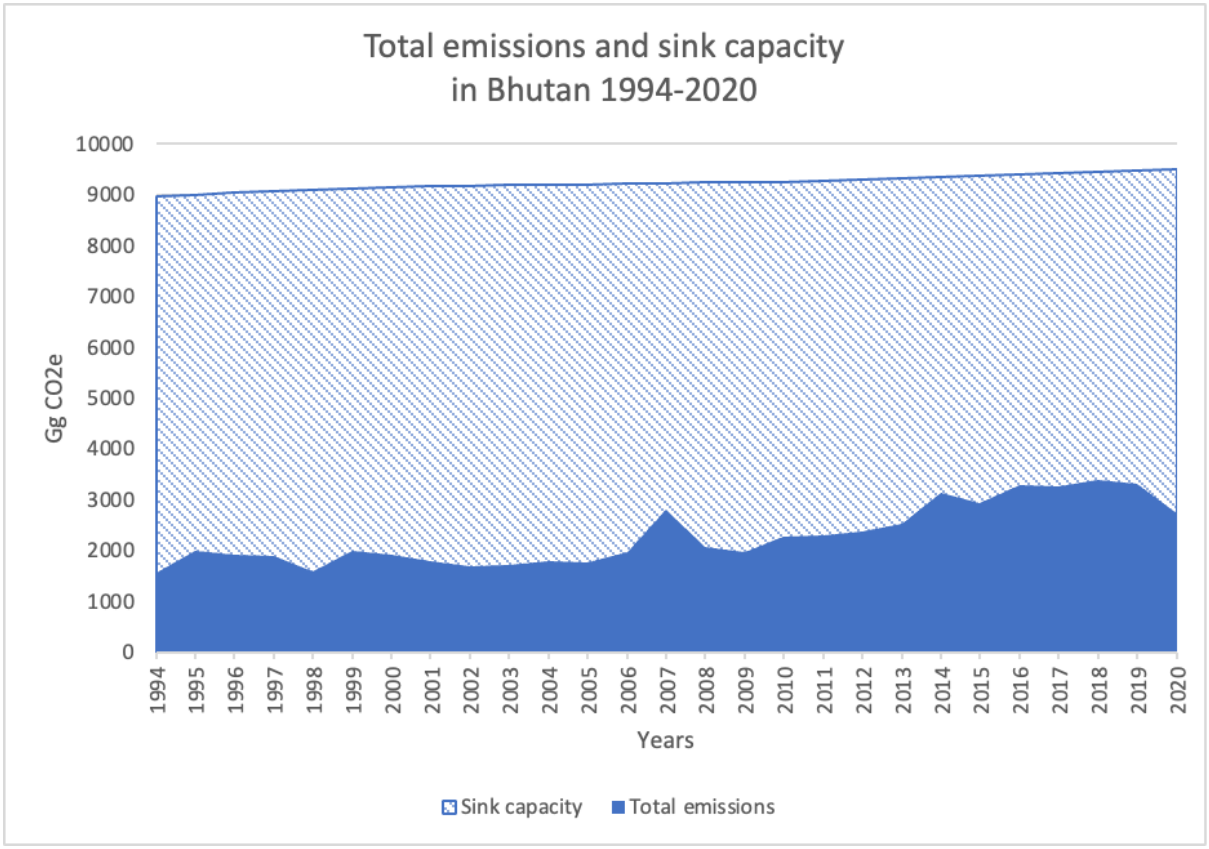

Figure 8. Total emissions and sink capacity in Bhutan 1994-2020 (National Environment Commission, 2022). Note: Time-span is modified due to data availability

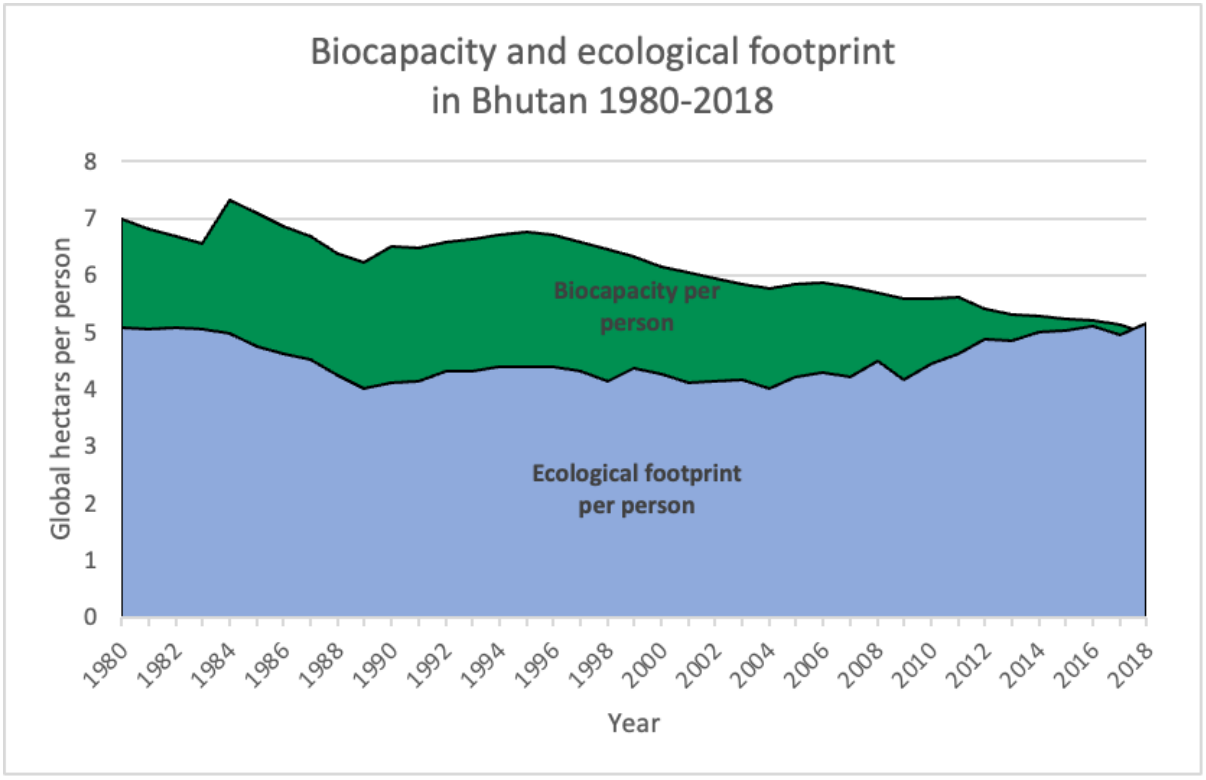

Figure 9. Biocapacity and ecological footprint in Bhutan 1980-2018 (Global Footprint Network, 2023a). Note: Time-span is modified due to data availability

6.4. Bhutanese Policies and Strategies

GNH guides the Bhutanese development framework and strategy and over the years the Bhutanese government has produced numerous policy documents and strategies for the purpose of achieving development in the four main areas of GNH.

As of the 10th five-year plan the GNH index was used as a guiding principle for development and resource allocation as well as in guiding the National Key Result Areas (NKRAs) (Gross National Happiness Commission, 2019b). The NKRAs are national goals that the local governments and central agencies are obliged to strive toward achieving, by setting up their own Local Government Key Result Areas and Agency Key Result Areas (Gross National Happiness Commission, 2019b). The 12th five-year plan features 17 NKRAs, there among NKRA 6: Carbon neutrality, climate and disaster resilience. This NRKA stresses their carbon-neutral goal and lays out intentions to for instance incorporate environmental considerations into all plans by different sectors and local governments, and implement waste management as a prominent national program. It also investigates the possible development of an environmentally friendly public transportation system. Moreover, it includes programmes that focus on enforcing the implementation of international environmental agreements, moving towards low-carbon development and promoting the development of new renewable energy sources (Gross National Happiness Commission, 2019b).

In their National Human Development report from 2011, the Gross National Happiness Commission (2011) states that their pledge to remain carbon neutral will entail sacrificing economic growth and opportunities. Nevertheless, it is possible to observe that they will now manage to graduate from their LDC status in 2023 and have had sustained increasing GDP growth over the last decade (disregarding the downturn due to the Covid-19 pandemic). In their Climate Change Policy from 2020 it is stated that Bhutan will need to work towards separating increasing emission levels from economic growth by striving for low-emission development strategies in all sectors in order to sustain their carbon neutrality and experience continuous development (National Environment Commission, 2020b). Strategies, for the purpose of this, are for instance Bhutan's decision to limit foreign investments, having high taxes on imported cars, banning outdoor advertising, restricting tourism and banning alpinism, and setting limitations on mining and logging (Gerber & Raina, 2018). Moreover, they aim to achieve 100 % organic agriculture as well as ensure at least 60 % forest-covered

land area and having approximately haft of the country's land designated as protected areas (Gerber & Raina, 2018). They further state that industrial growth, transportation, consumption and waste need to be managed carefully (Gross National Happiness Commission, 2011).

The Bhutanese government stresses in their Sustainable Hydropower Policy 2021 that their goal is to secure a clean energy supply through hydropower as it is an advantageous national asset (National Environment Commission, 2022). A clean energy supply is essential for sustainable economic growth as energy demand is expected to increase as an economy grows and as energy is the second largest contributor to CO_2e emissions in Bhutan (Table 3). Bhutan also aims to develop other renewable energy sources such as solar, wind and biogas. They have furthermore adopted measures such as the *National Energy Efficiency and Conservation Policy, the Energy Efficiency Roadmap 2030* and *the Renewable Energy Master Plan (2017-2032)* (National Environment Commissions, 2022). Expanding and making the energy sector more effective can also contribute to economic growth in the country as energy export is a large contributor to the country's economic development thus far (National Energy Commission, 2022; Gross National Happiness Commission, n.d.; Asian Development Bank, 2022; Venkatraja, 2022). Providing clean energy to the population is also expected to mitigate emissions as it will replace the use of biomass and liquified petroleum gas for heating and cooking (National Environment Commission, 2022). This potential improvement in energy efficiency and changing energy mix is emphasised as a crucial step by those advocating for both green growth and the decoupling of emissions from economic growth.

As a developing country, UNEP (2011) argue that they have an advantage in being able to make use of technological leapfrogging. Bhutan stresses in their First biennial update report to the UNFCC 2022 that they aim to embrace technological innovations and solutions like green ammonia, green hydrogen and green energy storage schemes (National Environment Commission, 2022). Another large area that contributes to its emissions is Bhutan's transport system and infrastructure which highly relies on imported fossil fuels. The government, therefore, aims towards developing public transportation as well as introducing hydrogen and hydrogen fuel cell vehicles for low and zero-emission vehicles. This would both result in lower emission levels and align with Bhutan's pursuit of national self-reliance (National Environment Commission, 2022). These two aspects of developing infrastructure and having self-reliance are something that Dale, Mathai and Puppim de Oliveira (2016) emphasise as

important steps towards environmentally sustainable development. Moreover, the aim is to reduce landfill waste disposal from currently being 80 % to 20 % by adopting circular economy concepts (National Environment Commission, 2022). Furthermore, efforts to protect their carbon sequestering capacity involve ensuring at least 60 % forest cover, at a current rate of 71 % (Figure 4). They have moreover created Bhutan for Life fund of 43.1 million US dollars which is funded by private and multilateral donors and aims to ensure the continuing and permanent preservation of protected areas (Gross National Happiness Commission, 2019b).

Construction is a large contributor to emissions and as urbanisation is increasing there will be a larger demand for housing and infrastructure in Bhutan which will pose a challenge to its carbon neutrality (Ministry of Works and Human Settlements, 2017). However, urbanisation is addressed in NRKA 15: Sustainable human settlements, the goal is to amongst other things create accessible and affordable and energy-efficient housing while also making the construction process more sustainable and eco-friendly (Gross National Happiness Commission, 2019b). To mitigate environmental effects such as increasing urbanisation Bhutan states that they, apart from green buildings and energy efficiency, aim towards developing waste management and public sustainable transport in urban areas (Ministry of Works and Human Settlements, 2017).

While Bhutan's development plans are extensive, King Jigme Khesar Namgyel Wangchuck has stated that the government and agencies are proficient in planning but struggle with effective implementation due to a lack of coordination among government ministries and agencies (United Nations Development Programme, 2019). Challenges that Bhutan face in regard to successful executions of plans and strategies are; 1) lacking financial resources, 2) insufficient technological and technical assistance and expertise, 3) poor coordination between governmental agencies, international financiers and the entities involved in the implementation of projects, 4) lacking regulatory framework and enforcement, 5) insufficient research for practical implementation and the effects of projects related to climate change mitigation and adaptation, and 6) universal integration of climate policies in all levels of society (National Environment Commission, 2022). Regarding financing, the government states in their 2022 update to the UNFCC that the country needs support to effectively implement its projects and plans for low-emission development. They estimate an amount of USD 3,392.76 million in order to successfully execute plans in forest conservation and

management, sustainable agricultural practises and food security, making human settlements environmentally friendly, technological advancements and diversifications of industries, and improving surface transport (National Environment Commission, 2022). Out of this amount they have received USD 82.5 million, mainly from the Global Environment Facility and the Green Climate Fund (National Environment Commission, 2022). Climate financing is therefore an area which Bhutan needs to develop and they hence strive towards creating a climate financing strategy and fund (National Environment Commission, 2022). Hoffmann (2016) similarly stresses that structural changes and technological advances require financial capital. Nevertheless, the author states that this, in turn, requires economic growth both in order to secure domestic financing and in order to pay potential interest or revenues on shares, this process might therefore in itself result in higher emissions.

7. Discussions

The environmental Kuznets curve hypothesis states that as a country reaches higher levels of economic development environmental awareness amongst the population will increase and there will be a higher focus on environmental protection and regulations. In the case of Bhutan however, it is evident that the GNH framework emphasizes environmental preservation and has done so without the need for a high level of GDP per capita. Nevertheless, it is possible to observe a strong positive correlation between GDP per capita and CO_2 per capita, and Bhutan's environmental protection plans have not hindered the increase in CO_2 emission. Evidently, economic expansion has increased CO_2 emissions, primarily from energy use and industrial processes and product use. Presently, the increase is nonetheless still sequestered due to Bhutan's extensive forest cover.

Structural change has occurred in Bhutan, moving the country from a more agrarian to a more industry and service-based economy. Nevertheless, this change has not driven a decrease in emissions such as the EKC hypothesis claims. One reason might be that Bhutan is still in their initial stage of development where there is an increase in energy demand and the onset of industrialisation (in accordance with the EKC hypothesis). Another reason might be that investment and the establishment of less emission-intensive services and industries have not

occurred at a sufficiently high rate compared to the retreat of high-polluting industries (Hoffman, 2016)

Key concepts highlighted by green growth theory are possible to see in Bhutan since the country strongly aspires to a transition to low-carbon emissions, energy efficiency and natural infrastructure. The green growth theory emphasizes investments in sustainable production, energy technology and natural capital. This is evident in Bhutan which aims to make use of technological leapfrogging for environmental innovations, preserve natural resources through programmes and policies as well as set concrete goals through the use of NKRAs. Green growth could possibly be seen in the energy sector as Bhutan aspires to expand and diversify their renewable energy sources. This is an investment in environmental protection as it can replace the use of other energy sources such as biomass and liquified petroleum gas and at the same time contribute to economic growth by increasing revenues from export. Bhutan has a large focus on finding alignments between economic growth and environmental preservation which is in line with the founding principles of green growth. Nevertheless, economic growth is not the sole purpose of development in Bhutan and the country has emphasised that they are willing to sacrifice economic growth in order to sustain its carbon-neutral status.

Bhutan stresses that they plan to invest in innovations and new technologies, which according to the decoupling theory is a step towards separating economic growth from its negative environmental impacts. Bhutan experiences high fluctuations in decoupling trends which is in accordance with what Wu, Zhu and Zhu (2018) found in their study regarding decoupling trends in developing countries. As previously stated there are no evidential substantial or long-term decoupling trends when looking at the growth rate of GDP and CO_2 which would be imperative in order to achieve environmental sustainability according to both Dale, Mathai and Puppim de Oliveira (2016) and Vadén et al. (2020). A key area for achieving decoupling is innovation, partly in regard to resource efficiency but also institutional and relational. The two latter can be seen as part of the aspiration of Bhutan's strategic development framework presented through, for instance, the NAKRs which aim to dictate operational responsibilities, create incentives and consider precautions. The GNH framework also addresses relational innovation with regard to collaboration, unity and solidarity. However, as Bhutan is experiencing somewhat inefficient strategic and practical implementations of plans, a decoupling due to institutional and relational innovations seems remote for now.

Other challenges that Bhutan might face are the increasing total population and rapid urbanisation which might pose a threat to its carbon neutrality due to increasing scale, new consumption patterns and demand for housing and infrastructure. Moreover, climate change in itself might affect Bhutan's carbon neutrality as it might change the country's prerequisites by for instance decreasing forest cover through events such as fires or floods or affecting the country's hydropower capacity. Apart from carbon neutrality, it is also important to consider that economic growth and changing circumstances might affect the environment negatively in other aspects than CO_2 emissions as it is for instance possible to see a diminishing biocapacity in the country.

Even though Bhutan has a comprehensive development framework in GNH, they are still experiencing increasing emission levels. Hanif and Gago-de-Santos (2017) and Wu, Zhu and Zhu (2018) assert that decoupling and the turning point where environmental degradation declines will not come automatically but it is essential to implement policies that will induce this change. Nevertheless, Bhutan faces challenges in effectively implementing and financing its plans and procedures which might be the reason why there have not been larger mitigation effects on CO_2 emissions. Good governance is part of the GNH development framework and as the economy and the society develop it might be possible that there will be stronger institutions and systems leading to better implementations of the programmes and hence a larger change towards environmental sustainability. However, unless Bhutan had had their policy objections and had the GNH as a guiding principle it is plausible that emission levels would have been even higher, posing a threat to carbon neutrality. Importantly, Bhutan currently has high marginals for their negative net emissions and there is hence not an immediate threat to their carbon neutral status. At the same time, it is important to consider that economic growth might not be sustainable in the long run if there is a sustained positive correlation between CO_2 emission and GDP as this could lead to emissions increasing to a level that exceeds the forest sink capacity.

8. Conclusion

The aim of this thesis is to examine the correlation between GDP per capita and CO_2 emissions per capita in order to answer the research question: *What is the relationship*

between CO_2 emissions per capita and GDP per capita in Bhutan, and does this relationship threaten Bhutan's carbon-neutral status?

The theoretical main findings are that neither an inverted u-curve in accordance with the EKC hypothesis, nor substantial and long-term decoupling is found. Nevertheless, it is possible to see an extensive development framework based on GNH. This includes policy documents and strategies for attaining higher and more environmentally friendly energy production, preservation and enhancement of natural assets. This is according to both the green growth theory and decoupling theory strategies towards sustainable growth and the decoupling between environmental degradation and economic growth. There is a possibility that Bhutan will manage to decouple economic growth and reach the threshold of the EKC in the future since the country is still in the initial stage of development. Nevertheless, the study finds that the current correlation between GDP per capita and CO_2 per capita emissions is significant and positive. Continuous economic growth under the current circumstances might hence pose a threat in the future. However, there is not an immediate threat as Bhutan's current forest sequestering capacity presently ensures carbon negativity.

GNH permeates the Bhutanese society as a guiding principle and economic growth is therefore not perceived as the sole measure of happiness and wellbeing. Since Bhutan has promised carbon neutrality in perpetuity and moreover expressed that they are willing to sacrifice economic opportunities for the benefit of this, there is a possibility that continuing economic development, unless a decoupling occurs, might be prevented in the future if it were to threaten the carbon-neutral status. Moreover, other potential threats to Bhutan's carbon neutrality, apart from economic growth, can be seen to be population growth, urbanisation and climate change. In order to mitigate negative environmental effects it seems imperative to evolve processes for implementing development strategies and plans as this will be the key to experiencing sustained economic growth while staying carbon-neutral in the future.

8.1. Future research

Bhutan as a country is a rather unique country considering its prerequisites and endowments which have led them to develop the GNH framework and focus on carbon neutrality. There are several aspects related to this study that would be interesting to explore further. Firstly, it

would be interesting to incorporate other environmental indicators, which are not concerned by Bhutan's carbon sequestering capacity, in order to investigate the comprehensive outlook of Bhutan's environmental state. Secondly, it would be relevant to further explore Bhutan's implementation process of environmental policies and directives in depth to investigate the real impact of these on the Bhutanese environment. Thirdly, it would be interesting to study Bhutan in relation to the two other carbon-negative countries, Surinam and Panama, to see if there are similarities that have contributed to them being the only carbon-negative countries in the world and hence if there are lessons to be learned in the global commitment to a zero-transition. Lastly, it would be intriguing to study the GNH framework more in-depth to examine if there are general lessons to be learned for the global community when aspiring for sustainable development and carbon neutrality.

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Appendix A

Table A, Description of variables

Variable	Description	Units	Timeframe	Figure / Table	Source
Total population	"Total population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship. The values shown are midyear estimates." (The World Bank, n.d.a, n.p)	Total numbers	1960-2021	Figure 1	The World Bank. (n.d.a). Population, total - Bhutan, Available online:https://data.worldbank.org/indicator/SP.POP.TOTL?locations=BT [Accessed 23 March 2023]
Total Urban population	"Urban population refers to people living in urban areas as defined by national statistical offices. It is calculated using World Bank population estimates and urban ratios from the United Nations World Urbanization Prospects. Aggregation of urban and rural population may not add up to total population because of different country coverages." (The World Bank, n.d.b, n.p)	Total numbers	1960-2022	Figure 1	The World Bank. (n.d.b). Urban population - Bhutan, Available online:https://data.worldbank.org/indicator/SP.URB.TOTL?locations=BT, [Accessed 23 March 2023]
Urban population share	Urban population refers to people living in urban areas as defined by national statistical offices. The data are collected and smoothed by United Nations Population Division. (The World Bank, n.d.c, n.p)	Per cent of total population	1960-2021	Figure 1	The World Bank. (n.d.c). Urban population (% of total population) - Bhutan, Available online: https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?locations=BT, [Accessed 23 March 2023]

Sectoral value added to GDP from agriculture, forestry, and fishing	"Agriculture, forestry, and fishing corresponds to ISIC divisions 1-3 and includes forestry, hunting, and fishing, as well as cultivation of crops and livestock production. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. The origin of value added is determined by the International Standard Industrial Classification (ISIC), revision 4" (The World Bank, n.d.d, n.p)	Percentage of GDP	1980-2021	Figure 2	The World Bank. (n.d.d). Agriculture, forestry, and fishing, value added (% of GDP) - Bhutan, Available online: https://data.worldbank.org/indicator/NV.AGR.TOTL.ZS?locations=BT, [Accessed 17 March 2023]
Sectoral value added to GDP from Manufacturing	"Manufacturing refers to industries belonging to ISIC divisions 15-37. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. The origin of value added is determined by the International Standard Industrial Classification (ISIC), revision 3." (The World Bank, n.d.e, n.p)	Percentage of GDP	1980-2021	Figure 2	The World Bank. (n.d.e). Manufacturing, value added (% of GDP) - Bhutan, Available online: https://data.worldbank.org/indicator/NV.IND.MANF.ZS?locations=BT, [Accessed 17 March 2023]
Sectoral value added to GDP from Industry (including construction)	"Industry (including construction) corresponds to ISIC divisions 05-43 and includes manufacturing (ISIC divisions 10-33). It comprises value added in mining, manufacturing (also reported as a separate subgroup), construction, electricity, water, and gas. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. The origin of value added is determined by the International Standard Industrial Classification (ISIC), revision 4." (The World Bank, n.d.f, n.p)	Percentage of GDP	1980-2021	Figure 2	The World Bank. (n.d.f). Industry (including constructing), value added (% of GDP) - Bhutan, Available online: https://data.worldbank.org/indicator/NV.IND.TOTL.ZS?locations=BT, [Accessed 17 March 2023]

Sectoral value added to GDP from services	"Services correspond to ISIC divisions 50-99 and they include value added in wholesale and retail trade (including hotels and restaurants), transport, and government, financial, professional, and personal services such as education, health care, and real estate services. Also included are imputed bank service charges, import duties, and any statistical discrepancies noted by national compilers as well as discrepancies arising from rescaling. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. The industrial origin of value added is determined by the International Standard Industrial Classification (ISIC), revision 3 or 4." (The World Bank, n.d.g, n.p)	Percentage of GDP	1980-2021	Figure 2	The World Bank. (n.d.g). Services, value added (% of GDP) - Bhutan, Available online: https://data.worldbank.org/indicator/NV.SRV.TOTL.ZS, [Accessed 17 March 2023]
Employment in industry (modeled ILO estimate)	"Employment is defined as persons of working age who were engaged in any activity to produce goods or provide services for pay or profit, whether at work during the reference period or not at work due to temporary absence from a job, or to working-time arrangement. The industry sector consists of mining and quarrying, manufacturing, construction, and public utilities (electricity, gas, and water), in accordance with divisions 2-5 (ISIC 2) or categories C-F (ISIC 3) or categories B-F (ISIC 4)." (The World Bank, n.d.h, n.p)	Per cent of total employment	1991-2019	Figure 3	The World Bank. (n.d.h). Employment in industry (% of total employment) (modeled ILO estimate), Available online: https://data.worldbank.org/indicator/SL.IND.EMPL.ZS?locations=BT, [Accessed 17 March 2023]
Employment in agriculture (modeled ILO estimate),	"Employment is defined as persons of working age who were engaged in any activity to produce goods or provide services for pay or profit, whether at work during the reference period or not at work due to temporary absence from a job, or to working-time arrangement. The agriculture sector consists of activities in agriculture, hunting, forestry and fishing, in accordance with division 1 (ISIC 2) or categories A-B (ISIC 3) or category A (ISIC 4)." (The World Bank, n.d.i, n.p)	Per cent of total employment	1991-2020	Figure 3	The World Bank. (n.d.i). Employment in agriculture (% of total employment) (modeled ILO estimate), Available online: https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS?locations=BT, [Accessed 17 March 2023]

Employment in services (modeled ILO estimate),	“Employment is defined as persons of working age who were engaged in any activity to produce goods or provide services for pay or profit, whether at work during the reference period or not at work due to temporary absence from a job, or to working-time arrangement. The services sector consists of wholesale and retail trade and restaurants and hotels; transport, storage, and communications; financing, insurance, real estate, and business services; and community, social, and personal services, in accordance with divisions 6-9 (ISIC 2) or categories G-Q (ISIC 3) or categories G-U (ISIC 4).” (The World Bank, n.d.j, n.p)	Per cent of total employment	1991-2021	Figure 3	The World Bank. (n.d.j). Employment in services (% of total employment) (modeled ILO estimate), Available online: https://data.worldbank.org/indicator/SL.SRV.EMPL.ZS, [Accessed 17 March 2023]
Forest area	“Forest area is land under natural or planted stands of trees of at least 5 meters in situ, whether productive or not, and excludes tree stands in agricultural production systems (for example, in fruit plantations and agroforestry systems) and trees in urban parks and gardens.” (The World Bank, n.d.k, n.p)	Per cent of land Area	1990-2020	Figure 4	The World Bank. (n.d.k). Forest area (% of land area) -Bhutan, Available online: https://data.worldbank.org/indicator/AG.LND.FRST.ZS?locations=BT, [Accessed 3 April 2023]
Annual gross domestic product per capita (GDP per capita)	"GDP per capita is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources." (The World Bank, n.d.l, n.p)	Constant 2015 US$ per person	1980-2021	Figure 5	The World Bank. (n.d.l). GDP per capita (constant 2015 US$) - Bhutan, Available online: https://data.worldbank.org/indicator/NY.GDP.PCAP.KD?locations=BT, [Accessed 10 March 2023]
Annual carbon dioxide emissions per capita (CO2 per capita)	"Annual total production-based emissions of carbon dioxide (CO_2), excluding land-use change.This is based on territorial emissions, which do not account for emissions embedded in traded goods." (Our World in Data, n.d.a, n.p.)	Tonnes (t) per person	1980-2021	Figure 5	* Our World in Data. (n.d.a). CO2 and Greenhouse Gas Emissions Data Explorer, Available online: https://ourworldindata.org/explorers/co2, [Accessed 10 March 2023]
Co2 emissions by fuel or industry	“Annual production-based emissions of carbon dioxide (CO_2) from cement, oil and coal. This is based on territorial emissions, which do not account for emissions embedded in traded goods.”(Our World in Data, n.d.a, n.p.)	Tonnes (t)	1980-2021	Figure 6	* Our World in Data. (n.d.a). CO2 and Greenhouse Gas Emissions Data Explorer, Available online: https://ourworldindata.org/explorers/co2, [Accessed 10 March 2023]

Annual carbon dioxide emissions (total) (CO2)	"Annual total production-based emissions of carbon dioxide (CO_2), excluding land-use change. This is based on territorial emissions, which do not account for emissions embedded in traded goods." (Our World in Data, n.d.a, n.p.)	Tonnes (t)	1980-2021	Figure 7 Table 2	* Our World in Data. (n.d.a). CO2 and Greenhouse Gas Emissions Data Explorer, Available online: https://ourworldindata.org/explorers/co2, [Accessed 10 March 2023]
GDP (constant 2015 US$)	"GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources." (The World Bank, n.d.m, n.p.)	Constant 2015 US$ (Dollar figures for GDP are converted from domestic currencies using 2015 official exchange rates.)	1980-2021	Figure 7 Table 2	The World Bank. (n.d.m). GDP (constant 2015 US$), Available online: https://data.worldbank.org/indicator/NY.GDP.MKTP.KD?locations=BT, [Accessed 10 March 2023]
Annual growth of carbon dioxide (Annual CO2 growth)	Calculated year on year change in per cent using annual CO2 emissions	Per cent	1981-2021	Figure 7 Table 2	Authors own calculations using the "Annual carbon dioxide emission (total)" variable
Annual growth of gross domestic product (Annual GDP growth)	Calculated year on year change in per cent using annual GDP	Per cent	1981-2021	Figure 7 Table 2	Authors own calculations using the "GDP (constant 3015 US$)"
Total Emissions in Bhutan, comprising of:	** a) Energy b) Industrial processes and product use (IPPU) c) Forestry and other land use (FOLU) d) Agriculture e) Waste	Gg Co_2e (Giga gram carbon dioxide equivalent, this metric accounts for several greenhouse gases and transforms them into the equivalent amount of CO2 by accounting for their global-warming potential (GWP) (Eurostat, 2014)	1994-2020	Table 3	National Environment Commission. (2022). Kingdom of Bhutan: First biennial update report to the UNFCC 2022, Royan Government of Bhutan, Available at: https://unfccc.int/sites/default/files/resource/BhutanBURreport.pdf, [Accessed 6 April 2023]

Sink capacity	"Encompasses forest sequestration. In this data "removals from non-forest lands", such as fruit plantation and agro-forestry is not included due to lacking data" (National Environment Commission, 2022)	Gg Co2e	1994-2020	Figure 8	National Environment Commission. (2022). Kingdom of Bhutan: First biennial update report to the UNFCC 2022, Royan Government of Bhutan, Available at: https://unfccc.int/sites/default/files/resource/BhutanBURreport.pdf, [Accessed 6 April 2023]
Biocapacity per person	"The capacity of ecosystems to regenerate what people demand from those surfaces. Life, including human life, competes for space. The biocapacity of a surface represents its ability to renew what people demand. Biocapacity is therefore the ecosystems' capacity to produce biological materials used by people and to absorb waste material generated by humans, under current management schemes and extraction technologies." (Global Footprint Network, 2023a, n.p.)	Global hectares	1980-2018	Figure 9	Global Footprint Network. (2023a).Country Trends, Available online: https://data.footprintnetwork.org/#/countryTrends?cn=18&type=BCpc,EFCpc,[Accessed 10 April 2023]
Ecological footprint per person	"A measure of how much area of biologically productive land and water an individual, population, or activity requires to produce all the resources it consumes and to absorb the waste it generates, using prevailing technology and resource management practices." (Global Footprint Network, 2023a, n.p.)	Global hectares	1980-2018	Figure 9	Global Footprint Network. (2023a). Country Trends, Available online: https://data.footprintnetwork.org/#/countryTrends?cn=18&type=BCpc,EFCpc, [Accessed 10 April 2023]

* Our World in Data gathers its underlying information for CO_2 emissions from the Global Carbon Project (n.d.) which is published by Friedlingstein et al. 2022, see the explanation of the underlying sources in section 5.2 Data.

** The different variables included in total emissions in Bhutan are explained in section 6.2 Emission Trends and Structural Changes in Bhutan.