http://www.egejfas.org
Ege Journal of Fisheries and Aquatic Sciences, 43(2), 120-128 (2026)

Su Ürünleri Dergisi (2026)
DOI: 10.12714/egejfas.43.2.04

RESEARCH ARTICLE ARAŞTIRMA MAKALESİ

Blue economy and economic development: The function of aquaculture and capture fisheries in Next-11 nations

Mavi ekonomi ve ekonomik kalkınma: Next-11 ülkelerinde su ürünleri yetiştiriciliği ve avcılığının işlevi

Asım Çoban[1] • Ömer Faruk Biçen[2] • Mustafa Necati Çoban[3]* • Fatih Yeter[4] Ayşe Ölmez[5]

[1]Faculty of Education, Amasya University, 05100, Amasya, Türkiye
[2]Faculty of Economics and Administrative Sciences, Balıkesir University, 10145, Balıkesir, Türkiye
[3]Faculty of Economics and Administrative Sciences, Tokat Gaziosmanpaşa University, 60250, Tokat, Türkiye
[4]Turhal Faculty of Applied Sciences, Tokat Gaziosmanpaşa University, 60250, Tokat, Türkiye
[5]Faculty of Agriculture, Tokat Gaziosmanpaşa University, 60250, Tokat, Türkiye

*Corresponding author: necati.coban@gop.edu.tr
Received date: 01.01.2026 Accepted date: 18.03.2026

How to cite this paper:
Çoban, A., Biçen, Ö.F., Çoban, M.N., Yeter, F., & Ölmez, A. (2026). Blue economy and economic development: The function of aquaculture and capture fisheries in Next-11 nations. *Ege Journal of Fisheries and Aquatic Sciences, 43*(2), 120-128. https://doi.org/10.12714/egejfas.43.2.04

Abstract: Capture fisheries and aquaculture are sectors that provide important benefits and support for the economic development of the countries. Especially for developing countries, these sub-sectors of blue economy are of great importance. The aim of the study is to investigate the impact of capture fisheries and aquaculture sector on economic development in the Next 11 countries for the period from 1990 to 2022.To achieve this goal, we use the novel Method of Moments Quantile Regression (MMQR) approach. The Driscoll-Kraay estimator was also used in the research to test for robustness. The influence of trade openness, energy use, total labor force participation rate, and value added in forestry, agriculture, and fishery (as a percentage of GDP) on economic development in the Next-11 nations was also examined. According to an examination of the study's MMQR findings, aquaculture and capture fisheries have a positive impact on economic development across all quantiles. The research also found that although trade openness and value added in forestry, agriculture, and fisheries (as a percentage of GDP) decrease economic development, labor force participation rate and energy use in the Next-11 nations increase economic development. Additionally, the robustness test results support these findings. We provide policy suggestions based on our results.

Keywords: Fisheries, aquaculture, economic development, Method of Moments Quantile Regression, blue economy.

Öz: Su ürünleri avcılığı ve yetiştiriciliği, ülkelerin ekonomik kalkınmasına önemli fayda ve destek sağlayan sektörlerdir. Özellikle gelişmekte olan ülkeler için mavi ekonominin bu alt sektörleri büyük önem taşımaktadır. Çalışmanın amacı, 1990-2022 dönemi için Next-11 ülkelerinde su ürünleri avcılığı ve yetiştiriciliği sektörlerinin ekonomik kalkınma üzerindeki etkisini araştırmaktır ve bu amaca ulaşmak için yeni bir yöntem olarak Momentler Kantil Regresyon Yöntemi (MMQR) çalışma kapsamında kullanılmaktadır. Çalışmada ayrıca sağlamlık sınaması için Driscoll-Kraay tahmincisine başvurulmuştur. Next-11 ülkelerinde ayrıca ticari açıklığın, enerji kullanımının, toplam işgücü katılım oranının ve ormancılık, tarım ve balıkçılık sektörlerinde oluşan katma değerin GSYİH içindeki % payının da ekonomik kalkınma üzerindeki etkisi incelenmiştir. MMQR analizinden elde edilen sonuçlar, su ürünleri avcılığı ve su ürünleri yetiştiriciliği sektörlerinin Next-11 ülkelerinde tüm kantil düzeylerinde ekonomik kalkınma üzerinde olumlu bir etkiye sahip olduğunu göstermektedir. Araştırmada ayrıca, ticari açıklığın ve ormancılık, tarım ve balıkçılık sektörlerinde oluşan katma değerin GSYİH içindeki % payının Next 11 ülkelerinde ekonomik kalkınmayı azalttığı, toplam işgücüne katılım oranı ile enerji kullanımının ise ekonomik kalkınmayı artırdığı tespit edilmiştir. Bununla beraber MMQR yöntemi ile elde edilen tüm bu bulgular, sağlamlık testi ile ulaşılan bulgularla da desteklenmektedir. Çalışmada elde edilen bulgular doğrultusunda politika önerileri ortaya konulmuştur.

Anahtar kelimeler: Balıkçılık, akuakültür, ekonomik kalkınma, Momentler Kantil Regresyon Yöntemi, mavi ekonomi.

INTRODUCTION

Oceans and inland waters (rivers, lakes, reservoirs and seas) provide significant benefits to all humanity in important areas such as aquaculture(hereafter, AC) and fishing, maritime and coastal tourism, mineral extraction and power (Ababouch and Fipi, 2015). It is well known that fish provide a variety of minerals and vitamins essential to human health. Fish is also a significant source of protein (Sun, 2008). Along with all this, animal feed can be produced with fish meal obtained from the fish. Again, the fishing sector contributes to the GDP of countries that are coastal and surrounded by rivers. These countries, which are coastal and surrounded by rivers, can export fish to regional and international markets, thus providing a significant source of foreign exchange. Again, the fish industry supports local and national government revenues through various taxes, tariffs and licensing fees. For fishing communities living in distant areas, the growth of the fishing industry has also aided in the acquisition of more advanced infrastructural prospects. In this context, physical infrastructure facilities such as roads, schools and hospitals have been improved and social facilities have been rehabilitated both directly and indirectly (Odongkara et al., 2005).

One of the first productive endeavors in the history of humanity is said to be fishing. In this context, archaeological research provides important evidence. Pictures found in the caves show that seafood was important for survival and that

significant amounts of seafood were consumed in those times. Similarly, anthropological research indicates that hunting marine organisms was an important part of the feeding activities of many primitive tribes. Historical sources indicate that fishing was an important production activity in the past as well as today (Arnason, 2010). Fish production from the seas and oceans is carried out through capture fisheries (hereafter, CF) and AC sectors. For those who live near streams, the sea, or other bodies of water, the CF and AC sectors are considered a vital source of food and a means of subsistence (Smith et al., 2010). More than a billion people make a living on CF and AC sectors (Asche, 2011).

Through the CF and AC sectors, many countries are able to generate significant revenues through production and trade. These sectors can also create jobs and stimulate economic development (hereafter, ED). Apart from all this, growth in these sectors is also important for food security (Payne, 2000; Phuong and Gopalakrishnan, 2004; Rad and Rad, 2012; Welcomme et al., 2010). Fishing activities contribute to the economic structure by having indirect effects as well as direct effects. Indirect effects of the fishing sector can be observed in many sectors, from the agricultural sector to forestry, from the manufacturing sector to financial services(Dyck and Sumaila, 2010).

The report (FAO, 2025) states that the total amount of aquaculture produced worldwide in 2023 was valued at US$365.98 billion and hit a record high of 136.16 million tonnes (Mt, live wet weight equivalent). In comparison, the total output from catch fisheries worldwide has been calculated to be 91.74 Mt in 2023 (FAO, 2025, Tacon et al., 2025). It has been noted that there has been a notable reduction in the global fish populations in the last several years. Because of this, it is observed that global fishing activities can no longer produce maximum sustainable yields (Agnew et al., 2009). The reduction in these stocks has encouraged AC in particular. The remarkable increase in the availability of seafood for consumption by individuals is mostly due to AC (Cressey, 2016).

The benefits of CF for humans in the context of nutrition, employment, recreation and socio-ED have been ongoing since 90,000 years ago to the present day. CF, which is the most common way of collecting water resources, has been practiced since prehistoric times (Lackey, 2005). For coastal communities, CF is an important source of food and economic activity. This also makes capture fishing an important determinant of social structure (Ochiewo, 2016). CF sector is of great importance within the scope of food supply. The CF industry may contract if future production growth is not possible and if it is not well managed. This may leave the world with a new problem of food shortages (Garcia and Rosenberg, 2010). Most of the harvest obtained through CF is consumed by humans. The remainder are mostly utilized for other than food or related food purposes, including as the manufacturing of fish oil and meal, which are used as ingredients in animal, pet, and AC feed (Cashion, 2016).

Although CF offers a very important potential to countries, it also faces significant threats such as illegal fishing activities, overfishing, and the degradation of marine ecosystems (Costello et al., 2020). Efforts are being carried out to prevent these threats within the scope of the concept of blue economy(hereafter, BE) which has been put forward by international organizations in recent years (Çoban and Ölmez, 2017) While global wild fisheries has been almost constant for three decades, potential annual production is actually above the current level. Enhancements in management of fisheries will lead to increased output levels (Costello et al., 2020).

The AC sector offers people around the world to feed on farmed fish (Pauly et al., 2003). Growing AC has a great deal of potential to contribute to feeding the world's population in a sustainable manner (Froehlich et al., 2018). Despite all of this, AC is recognized for concentrating on a small number of species (Sampantamit et al., 2020).For the world food regime, trade is an important factor as well as production. Fish products from CF and AC make up approximately ten percent of the world's agricultural commerce. The worth of the world's fish trade is more than the value of all other foods generated from animals combined (Anderson et al., 2011). Fisheries and aquaculture make up around 1.3% of the world's GDP, according to the FAO (2020). This number might be much higher in developing countries, demonstrating the sectors' significance for economic development (Qase, 2025). The food industry in AC is expanding at the fastest rate in the globe, and the BE agenda aligns nicely with the possibility for significant output increases (European Commission, 2012).

While blue growth (hereafter, BG) is often understood to represent economic expansion in the marine sector, some of its proponents use it to introduce new initiatives in the BE since these initiatives have room to expand. Seen from this angle, the 'conventional sector' of CF seems to have little to no promise for BG. However, some advocates of BG decide to add CF. Some people just consider how CF may be consumed by humans, whereas others consider all forms of CF (Boonstra et al., 2018; Klinger et al., 2017; FAO, 2015; Ehlers, 2016; European Commission, 2012; ECORYS, 2012).

CF and AC are seen as components of the "BE," a concept that maximizes revenue from the wise use of marine resources while minimizing harm to the environment and bolstering social benefits (Farmery et al., 2021). In order to achieve ecologically sustainable economic growth and enhance social equity and human well-being, the BE has been suggested as an ocean-based equivalent to the Green Economy development plan (Cisneros Montemayor et al., 2019). The CF and AC sector can be crucial for the transition to a BE/ BG because of their interdependence with the aquatic ecosystem and their dependence on them, and because of the potential of the people involved in them to act as not only users of the resource, but as resource managers. Though it would be prudent to go on as normal, in the end, this would not be sustainable, leading

to hazards that would restrict economic progress and impose costs on people and the environment (Ababouch and Fipi, 2015). With its use of maritime areas, the growth of wild CF and AC is inextricably linked to the existence of a lucrative and sustainable BE, which is entirely dependent upon a robust and productive environment (Tsiouvalas et al., 2022).

A few studies in the literature look at how AC and CF affect ED (Esin et al., 2025; Kusdiantoro Fahrudin et al., 2019; Ahammed et al., 2025; Liza et al., 2025; Alharthi and Hanif, 2020). Subsectors of the BE, such AC and CF, have been shown to support ED in these studies, which were carried out for various nations and country groups.

The nations that make up the Next 11 have a lot of potential since they are located near seas and oceans: Bangladesh, Vietnam, Egypt, Pakistan, Indonesia, South Korea, Iran, Türkiye, Mexico, the Philippines and Nigeria. Examining the impact of the CF and AC sectors on the ED of the Next 11 countries between 1990 and 2022 is the goal of this study. An essential research question will be answered by this study:

What role do the blue economy sectors—such as aquaculture and capture fisheries—play in the Next-11 nations' economic development?

The majority of the Next 11 countries are developing countries. These nations have substantial potential for blue growth. Given the blue economy's potential to create new jobs and its importance in the context of food security, it is necessary to investigate the impact of blue economy sectors on economic development. Motivated by this, the goal is to add to the body of knowledge by examining how the blue economy sectors—capture fisheries and aquaculture—affect economic development in the Next-11 nations over an extensive period of time, from 1990 to 2022. Mentioning the study's further contributions to the literature is also crucial. Regarding the study's another contributions, it may be said that one of its most significant undertakings was the use of a novel methodology. The present research employs a novel approach called "the Method of Moments Quantile Regression" (MMQR), which was developed by Machado and Silva (2019). The study's findings also address a gap in the literature: very few studies have looked at how the BE's subsectors affect ED. Therefore, the goal is to add to the body of knowledge by examining how the sectors of the blue economy affect the economic development of the Next-11 nations. In the end, a comprehensive analysis was made possible by the wide range of methodologies used in the study. By analyzing the effects of variables like trade openness, energy use, the total labor force participation rate, and value added in forestry, agriculture, and fisheries (as a percentage of GDP), along with capture fisheries and aquaculture, on economic development, the study seeks to provide a thorough analysis. With all these contributions, it is expected that the study would fill an important gap in the literature.

MATERIALS AND METHODS

Data set and model

In the study, data from 1990-2022 belonging to Bangladesh, Vietnam, Egypt, Pakistan, Indonesia, South Korea, Iran, Türkiye, Mexico, the Philippines and Nigeria, known as the Next 11 countries, were used and MMQR (Method of Moments Quantile Regression) approach was performed. The availability of data from all the Next 11 countries for the relevant period has been effective in choosing this period as the data range. GDP per capita (constant 2015 US $) was used as a dependent variable. As independent variables, CF and AC output were measured in metric tons each. In addition to these variables, trade (% of GDP), forestry, agriculture, and fisheries, value added (% of GDP), energy use, and total labor force participation rate were used as control variables. Data on all these variables was taken from the World Bank (2023).

The model laid out within the scope of the study is as follows:

$$LNGDP_{it} = \alpha_0 + \alpha_1 LNCFP_{i,t} + \alpha_2 LNAP_{i,t} + \alpha_3 LNTRD_{i,t} + \alpha_4 LNFAF_{i,t} + \alpha_4 LNEU_{i,t} + \alpha_4 LNTLF_{i,t} + \varepsilon_{i,t}$$

Every variable has been transformed into its natural logarithmic form. As for the abbreviations expressed in econometric form, GDP shows GDP per capita; CFP shows capture fisheries production; AP shows AC production; TRD shows trade openness rate; FAF shows forestry, agriculture, and fisheries, value added (% of GDP); EU shows energy use; and TLF shows total labor force participation rate.

Variables in the study, code of these variables, description of data and the source of data are seen in Table 1.

Table 1. Details of variables

Code of Variables	Description of Data	Source of Data
LNGDP	GDP per capita (constant 2015 US$)	World Bank (2023)
LNCFP	CF production (metric ton)	World Bank (2023)
LNAP	AC production (metric ton)	World Bank (2023)
LNTRD	Trade (% of GDP)	World Bank (2023)
LNFAF	Forestry, agriculture, and fisheries, value added (% of GDP)	World Bank (2023)
LNEU	Usage of energy (kg of oil equivalent per person)	World Bank (2023)
LNTLF	Total labor force participation rate (% of the population aged 15–64) (based on an ILO estimate)	World Bank (2023)

Method

In the study, the analysis was carried out with the MMQR method, which is a novel method. This novel methodology was developed by Machado and Silva (2019). The main benefit of this MMQR model is that, unlike many other approaches, it is capable of capturing the heterogeneity and distributional differences between the reaction and explanatory variables at various quantiles (Jahanger et al., 2023). This makes it simpler

to see the actual variations in a dependent variable throughout a variety of phases, which linear approaches are unable to capture (Guan et al., 2023). When the model has individual effects and endogenous explanatory variables, this method is also helpful (Adebayo et al., 2022). This approach is believed to be helpful in managing any outliers that might distort the distribution of the data overall (Hieu and Mai, 2023). This approach is far more effective in estimating and drawing conclusions from the estimates than the conventional approaches. Traditional panel data estimation methods use the average of the whole panel data to evaluate the quantiles of the regression, ignoring the variability of individual cross-sections. If the heterogeneity is considered, though, the estimation processes may yield more accurate insights. This problem is handled by the MMQR approach, which is by far the best estimating methodology when compared to traditional methods (Yang et al., 2022).

RESULTS

The selected variables' descriptive statistics are shown in Table 2. Table 2 lists the total number of observations, standard deviations, mean values, lowest and maximum values.

Table 2. Descriptive statistics

Variable	Number of Observations	Mean	Std. Dev.	Min.	Max.	Skewness	Kurtosis	Jarque Bera
LNGDP	363	8.061262	0.9720066	6.160036	10.48596	0.4876554	2.66728	13.51***
LNCFP	363	13.83301	0.851284	12.38174	15.79055	0.2937765	2.101805	37.95***
LNAP	363	12.78168	1.732205	8.662505	16.59546	-0.165028	2.420538	10.07***
LNTRD	363	3.914016	0.4418895	2.794362	5.228261	0.5186029	3.326462	14.57***
LNFAF	363	2.442281	0.7351845	0.3704223	3.701034	-0.9456646	3.139352	33.51***
LNEU	363	6.627154	0.9162407	4.704713	8.618265	0.2916867	2.454874	11.55***
LNTLF	363	4.111765	0.1856939	3.754527	4.445705	0.1139386	2.142262	29.29***

Note: The symbols *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

Table 2 shows that the number of observations for each variable is 363. Once again, Table 2 displays the mean, standard deviation, minimum, and maximum values of the variables that were part of the research. The results of the variables' skewness, kurtosis, and Jarque-Bera tests are also shown in Table 3. All of the chosen series—aside from LNAP and LNFAF—have a positive skew. According to the Kurtosis findings, the variables LNGDP, LNCFP, LNAP, LNEU, and LNTLF have less than normal distributions, but LNTRD and LNFAF have bigger than normal distributions. None of the variables have a normal distribution, according to the Jarque-Bera test findings. As a result, for every series, the null hypothesis that the series has a normal distribution has been rejected. The quantile-based framework is the best strategy for addressing the non-linearity in the data series, according to the Jarque–Bera test statistics (Radulescu et al., 2024).

A graphical tool used in statistics to determine if a dataset follows a certain theoretical distribution, such a normal distribution, is a Q-Q (Quantile-Quantile) plot (Majeed et al., 2023). Q-Q plots, which are used to assess whether or not the data series follow a normal distribution, are seen in Figure 1.

The multicollinearity problem, known as the relationship of two or more independent variables to each other, may be important according to its extent. The fact that the multicollinearity problem is minimal indicates that this problem can sometimes cause large problems, while the fact that this problem is at a medium or high level indicates that analysis should not be performed without overcoming this problem (Daoud, 2017).Although there are a number of methods for testing multicollinearity, the most common one among these methods is the VIF test. In this study, the VIF test was expressed to investigate multicollinearity. The VIF test results are shown inTable 3.

Table 3. VIF test

Variables	VIF	1/VIF
LNEU	4.62	0.216340
LNFAF	4.11	0.243426
LNCFP	2.87	0.348058
LNAP	2.30	0.435324
LNTLF	1.83	0.546939
LNTRD	1.75	0.570911
Mean	2.91	

Table 3's VIF test results show that the VIF values are below 10. Furthermore, the 1/VIF values are higher than 0.10. Multicollinearity is not a concern in the model since the VIF values are fewer than 10 and the 1/VIF values are more than 0.10.

Panel data models have a crucial problem with cross-sectional dependence (CD), and if it is not properly handled, the results might become erroneous, ineffective, and unsatisfactory (Ng et al., 2020; Jahanger et al., 2023).

The Next-11 nations have certain commonalities, which is the rationale for evaluating the CD problem. Therefore, these commonalities may impact the result via a common variance, which must be considered when estimating the unit root, cointegration, and regression analysis (Ahmad and Zhao, 2018; Aziz et al., 2021; Yang et al., 2022). The Pesaran (2015) CD test was used in this investigation to check for reliance on the cross-sectional dependency.

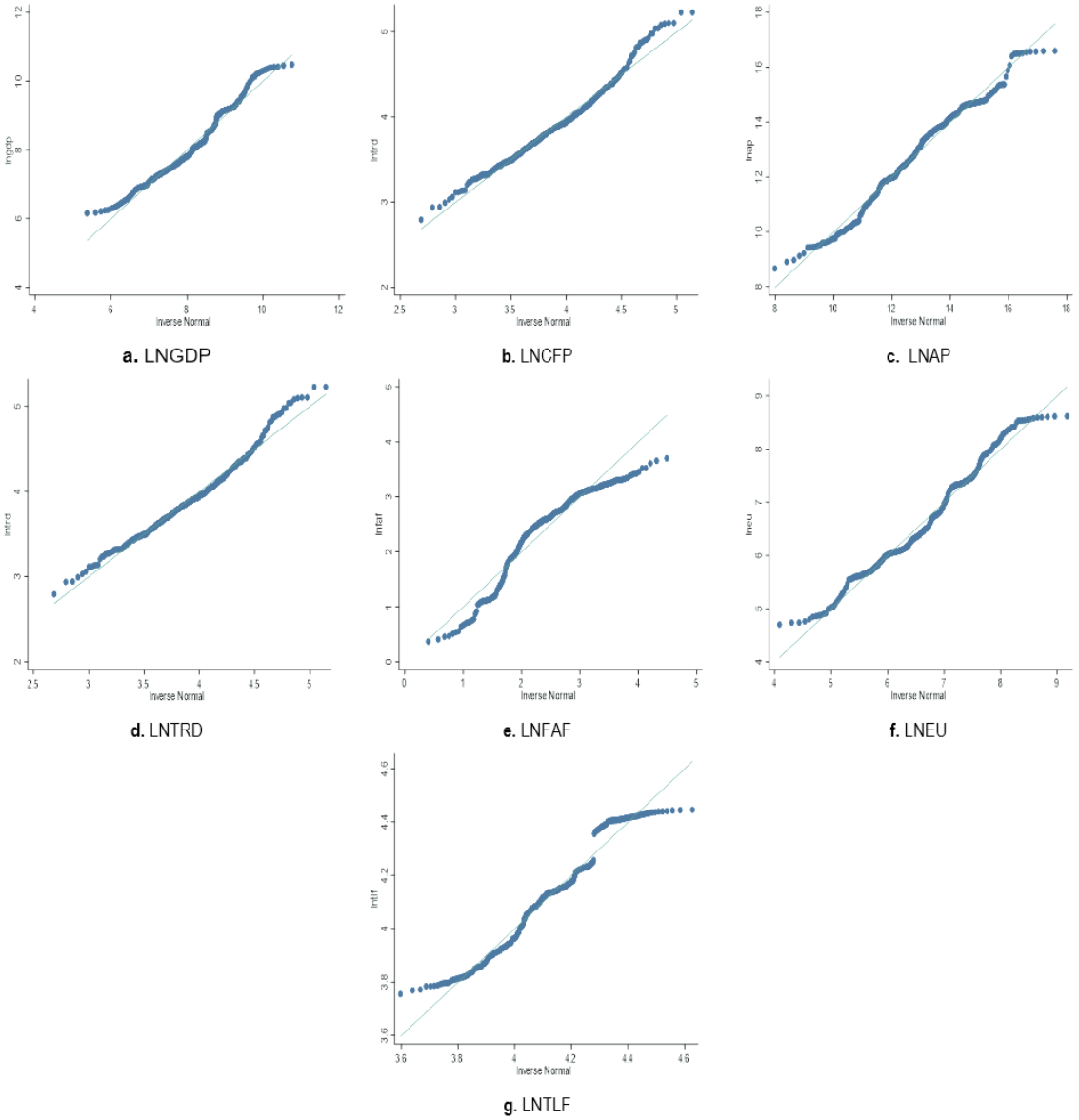

Figure 1. Q-Q Plots, a) LNGDP, b) LNCFP, c) LNAP, d) LNTRD, e) LNFAF f) LNEU, g) LNTLF

Table 4 displays the Pesaran (2015) CD test results. LNGDP, LNCFP, LNAP, LNTRD, LNFAF, and LNEU show cross-sectional dependency at the 1% significance level, according to the Pesaran (2015) CD test findings. Applying second-generation unit root tests that consider cross-sectional dependence comes next (Pesaran, 2007). Consequently, this research uses the Cross-sectionally Augmented Dickey-Fuller (CADF) test. The Cross-sectionally Augmented Dickey-Fuller (CADF) test was developed by Pesaran (2007).

Table 5 displays the results of the CADF test. Every variable series is integrated at first order I(1) at the 0.01% significance level, according to the CADF unit root test. The next stage is to look at the long-term connection between the variables since all of them are stationary in the first difference. To determine the long-term association between LNGDP, LNCFP, LNAP, LNTRD, LNFAF, LNEU, and LNTLF among the panel nations, we use two cointegration tests. We use two panel cointegration tests: the Pedroni (2004) cointegration test and Kao (1999) cointegration test.

Table 4. Pesaran (2015) CD test

Variables	Statistic	p-value
LNGDP	39.22	0.000***
LNCFP	5.85	0.000***
LNAP	39.41	0.000***
LNTRD	5.04	0.000***
LNFAF	22.99	0.000***
LNEU	26.57	0.000***
LNTLF	0.16	0.873

Note: The symbols *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

Table 5. CADF test

Variables	CADF Level	First Difference
LNGDP	-1.950	-2.464***
LNCFP	-2.067	-3.357***
LNAP	-2.185*	-2.711***
LNTRD	-1.568	-3.157***
LNFAF	-1.645	-3.291***
LNEU	-1.964	-2.863***
LNTLF	-1.660	-2.863***

Note: The symbols *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

The Pedroni (2004) panel cointegration test results are shown in Table 6. The null hypothesis, which states that there is no cointegration relationship among the variables for two of the three sub-tests of the Pedroni test, is rejected. As a result, the variables have a long-term relationship. The Kao (1999) cointegration test was performed in addition to the Pedroni (2004) cointegration test.

Table 6. Results of the Pedroni (2004) cointegration test

Test Statistics	Statistics	Probability
Modified phillips-perron t	2.3833	0.0086***
Phillips-Perron t	-2.0640	0.0195**
Augmented Dickey Fuller t	-0.5704	0.2842

Note: The symbols *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

Table 7 displays the Kao (1999) cointegration test results. The null hypothesis, which asserts that there is no cointegration among the variables, was rejected in each of the test's five subtests, according to an analysis of Kao's (1999) cointegration test results. The results of Kao's (1999) cointegration test, therefore, also support the presence of a long-term link between the variables. The MMQR approach is used to estimate the model in the study's subsequent phase.

Table 7. Results of the Kao (1999) cointegration test

Test Statistics	Statistics	P-value
Modified Dickey–Fuller t	-3.1130	0.0009***
Dickey–Fuller t	-2.6749	0.0037***
Augmented Dickey–Fuller t	-2.8617	0.0021***
Unadjusted modified Dickey–Fuller t	-2.5401	0.0055***
Unadjusted Dickey–Fuller t	-2.4681	0.0068***

Note: The symbols *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

The MMQR test results are shown in Table 8. The Next-11 nations' economic development was shown to be positively impacted by capture fisheries across all quantiles, as shown in Table 8. With the exception of the 0.90th quantile, all quantile levels' results are statistically significant. It was determined that there is a positive relationship between the variables across all quantiles based on findings showing the relationship between aquaculture and economic development. Furthermore, all quantile results are statistically significant. The MMQR findings show that the trade openness has a negative impact on economic development across all quantiles in the Next 11 nations. Additionally, this result is statistically significant across all quantiles. For every quantile, a negative relationship between the LNFAF and LNGDP variables was discovered. This result is statistically significant for all quantiles. Energy use has been proven to promote economic growth across all quantiles, according to another finding. Additionally, this result is statistically significant for every quantile. For every quantile, a positive relationship between the LNTLF and LNGDP variables was discovered; it should be noted that this result is statistically significant for every quantile.

Table 8. Estimation findings of MMQR approach

Variables	Location	Scale	Quantiles								
			0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90
LNCFP	0.0932404***	-0.0312451**	0.141414***	0.1268432***	0.1151478***	0.1028825***	0.0910658***	0.0818881***	0.0719875***	0.0584244**	0.0403847
LNAP	0.0669559***	-0.0014004	0.069115***	0.068462***	0.0679378***	0.0673881***	0.0668585***	0.0664471***	0.0660034***	0.0653955***	0.064587***
LNTRD	-0.1245868***	-0.0073004	-0.113331***	-0.1167354***	-0.1194681***	-0.1223339***	-0.1250949***	-0.1272392***	-0.1295525***	-0.1327215***	-0.1369365***
LNFAF	-0.4452864***	0.0109667	-0.4621948***	-0.4570806***	-0.4529756***	-0.4486707***	-0.4445232***	-0.4413019***	-0.4378269***	-0.4330664***	-0.4267347***
LNEU	0.5304214***	0.0195721	0.5002453***	0.5093725***	0.5166985***	0.5243816***	0.5317836***	0.5375326***	0.5437343***	0.5522303***	0.5635304***
LNTLF	0.8080071***	0.0792845	0.6857665***	0.7227399***	0.7524171***	0.7835402***	0.8135251***	0.8368137***	0.8619364***	0.8963527***	0.9421284***

Note: The symbols *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

Following the presentation of the MMQR analysis results, a robustness test must be carried out. The Driscoll-Kraay (1998) estimator was used in the study's analysis for robustness testing. By determining the cross-sectional dependencies in the panel data analysis, the DK approach re-estimates the standard errors, guaranteeing the precision and dependability of the computed coefficients (İnce and Ecevit, 2026).

Table 9 displays the outcomes of the Driscoll-Kraay (1998) estimator. These results show that an increase in LNCFP of 1% raises LNGDP by 0.0932404%. A 1% rise in LNAP increases LNGDP by 0.0669559%, according to another finding obtained through the Driscoll-Kraay approach. These results are in line with the MMQR method's findings. Blue economy sectors like aquaculture and capture fisheries have boosted economic development in the Next-11 countries. Additionally, the results are statistically significant. According to the other results, LNGDP is decreased by 0.1245868% for every 1% rise in LNTRD and 0.4452864% for every 1% increase in LNFAF. These results align with the MMQR findings and are statistically significant as well. The research also discovered that a 1% rise in LNEU increases LNGDP by 0.5304214%, while a 1% increase in LNTLF increases LNGDP by 0.8080071%. Additionally, these results are statistically significant. Furthermore, it matches the results of the MMQR.

Table 9. Estimation findings of Driscoll-Kraay Estimator

Variables	Driscoll-Kraay Estimator			
	Coefficient	Driscoll-Kraay Std Errors	t	p-value
LNCFP	0.0932404	.0340325	2.74	0.010***
LNAP	0.0669559	.0096739	6.92	0.000***
LNTRD	-0.1245868	.0314494	-3.96	0.000***
LNFAF	-0.4452864	.0700483	9.98	0.000***
LNEU	0.5304214	.0531696	4.44	0.000***
LNTLF	0.8080071	.1820736	-6.36	0.000***

Note: The symbols *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

DISCUSSION

The blue economy has significant value for emerging nations. The blue economy and its related industries have the potential to propel economic development. The objective of this research is to look at how the Next-11 countries' economic development is affected by blue economy sectors like aquaculture and capture fisheries. The influence of factors including trade openness, energy use, the total labor force participation rate, and value added in forestry, agriculture, and fisheries (as a proportion of GDP) on economic development was also examined. The Next 11 nations' data from 1990 to 2022 are used in the analysis. The data was analyzed using the MMQR technique. Analysis of the study's results showed that, across all quantiles, capture fisheries boost economic development in the Next 11 nations. The finding of this investigation seems to be consistent with a large number of findings from related research published in the literature (Alharthi and Hanif, 2020; Kusdiantoro Fahrudin et al., 2019; Neiland et al., 2016; Rehman et al., 2019). Except for the result for the 0.90th percentile, these results are statistically significant. There is a positive relationship between the variables across all quantiles, according to an analysis of the data showing the connection between aquaculture and economic development. This finding is in line with the vast majority of findings from similar studies in the literature (Alharthi and Hanif, 2020; Rehman et al., 2019; Ahammed et al, 2025; Huyen et al., 2021; Liza et al., 2025). The results are statistically significant. According to other findings obtained using the MMQR method, trade openness and value added in forestry, agriculture, and fisheries (as a percentage of GDP) reduce economic development in all quantiles, while energy use and the total labor force participation rate increase economic development in all quantiles. These results are all statistically significant. Additionally, all of these MMQR results are in line with the robustness test results from Driscoll-Kraay.

CONCLUSION

According to this research, which looks at how blue economy sectors affect economic development in the Next 11 countries, sectors like aquaculture and capture fisheries contribute to economic development. The Next-11 nations should put policies in place to create sustainable fisheries management in light of these results. To maintain the beneficial effects of capture fisheries on economic development, regulations targeted at sustainable fisheries management must be developed since certain fish species are at danger of overfishing. Additionally, strategies to encourage the use modern production methods should be created, and policies targeted at growing the aquaculture industry in the Next-11 nations should be put into action. The Next-11 nations have to concentrate on blue growth policies and endeavor to create sustainable economic development in these nations. Additionally, it is critical that the socioeconomic development of coastal populations in the Next-11 nations be taken into account while developing these blue growth strategies. In order to help secure food security in the Next-11 countries, efforts should be undertaken to encourage small-scale fishing in these nations. Incentive programs must be put in place right away in order to increase the output of small-scale fisheries in these nations. It is imperative that incentive programs be extended in order to increase the output of small-scale fisheries in these nations.

One of the study's limitations is that a larger range of data could not be examined because of data limitations. Another limitation of the study is that certain variables could not be included in the econometric model due to data constraints in some countries, such as Nigeria. Future study should look at how blue economy sectors affect economic development in African nations, which have not yet received much attention.

ACKNOWLEDGEMENTS AND FUNDING

The authors affirm that they did not accept any grants, funding, or other forms of assistance in order to prepare this paper.

AUTHOR CONTRIBUTIONS

Asım Çoban: Writing–original draft, writing–review & editing, investigation, resources, supervision. Ömer Faruk Biçen: Writing–original draft, writing–review & editing, investigation, data curation. Mustafa Necati Çoban: Writing–original draft, writing–review & editing, supervision, data curation, methodology, software, formal analysis, project administration, investigation, resources, visualization. Fatih Yeter: Writing–original draft, writing–review & editing, investigation, conceptualization. Ayşe Ölmez: Writing–original draft, writing–review & editing, investigation, validation.

CONFLICT OF INTEREST

There are no relevant financial or non-financial interests that the authors need to declare.

ETHICAL APPROVAL

This research does not need clearance from an ethical committee.

DECLARATION OF AI USE

AI-assisted language editing tools (e.g., Grammarly) were used for grammatical and stylistic improvements of the English text.

DATA AVAILABILITY

The datasets used and/or analyzed during the current study are not publicly available due to data use restrictions but are available from the corresponding author on reasonable request.

REFERENCES

Ababouch, L., & Fipi, F. (2015). Fisheries and Aquaculture in the context of blue economy. *Feeding Africa*, *2*(21–23), 13.

Adebayo, T.S., Rjoub, H., Akadiri, S.S., Oladipupo, S.D., Sharif, A., & Adeshola, I. (2022). The role of economic complexity in the environmental Kuznets curve of MINT economies: evidence from method of moments quantile regression. *Environmental Science and Pollution Research*, *29*(16), 24248-24260. https://doi.org/10.1007/s11356-021-17524-0

Agnew, D.J., Pearce, J., Pramod, G., Peatman, T., Watson, R., Beddington, J.R., & Pitcher, T.J. (2009). Estimating the worldwide extent of illegal fishing. *PloS One*, *4*(2), e4570. https://doi.org/10.1371/journal.pone.0004570

Ahammed, S., Rana, M.M., Uddin, H., Majumder, S.C., & Shaha, S. (2025). Impact of blue economy factors on the sustainable economic growth of China. *Environment, Development and Sustainability*, *27*(6), 12625-12652. https://doi.org/10.1007/s10668-023-04411-6

Ahmad, M., & Zhao, Z.Y. (2018). Empirics on linkages among industrialization, urbanization, energy consumption, CO2 emissions and economic growth: a heterogeneous panel study of China. *Environmental Science and Pollution Research*, *25*, 30617-30632. https://doi.org/10.1007/s11356-018-3054-3

Alharthi, M., & Hanif, I. (2020). Impact of blue economy factors on economic growth in the SAARC countries. *Maritime Business Review*. 5 (3), 253-269. https://doi.org/10.1108/MABR-01-2020-0006

Anderson, J.L., Bostock, T., Arbuckle, M., Kobayashi, M., Brummett, R., & Chu, J. (2011). *The global program on fisheries: strategic vision for fisheries and aquaculture*. The World Bank.

Arnason, R. (2010). Economics of Fisheries and Aquaculture. *Fundamental Economics–Volume II*, 344.

Asche, F. (2011). Green Growth in Fisheries and Aquaculture Production and Trade. *Department of Industrial Economics, University of Stavenger, Norway*.

Aziz, N., Sharif, A., Raza, A., & Jermsittiparsert, K. (2021). The role of natural resources, globalization, and renewable energy in testing the EKC hypothesis in MINT countries: New evidence from method of moments quantile regression approach. *Environmental Science and Pollution Research*, *28*, 13454-13468. https://doi.org/10.1007/s11356-020-11540-2

Boonstra, W.J., Valman, M., & Björkvik, E. (2018). A sea of many colours–How relevant is blue growth for capture fisheries in the Global North, and vice versa? *Marine Policy*, *87*, 340-349. https://doi.org/10.1016/j.marpol.2017.09.007

Cashion, T. (2016). The end use of marine fisheries landings. *Fisheries Centre Research Reports,* 24, 108.

Cisneros-Montemayor, A.M., Moreno-Báez, M., Voyer, M., Allison, E.H., Cheung, W.W.L., Hessing-Lewis, M., Oyinlola, M.A., Singh, G.G., Swartz, W., & Ota, Y. (2019). Social equity and benefits as the nexus of a transformative blue economy: a sectoral review of implications. *Marine Policy, 109*, 103702. https://doi.org/10.1016/j.marpol.2019.103702

Çoban, M.N., & Ölmez, Ü. (2017). Mavi Ekonomi ve Mavi Büyüme. *Electronic Turkish Studies*, *12*(3), 155-166. http://dx.doi.org/10.7827/TurkishStudies.11122

Costello, C., Cao, L., Gelcich, S., Cisneros-Mata, M.Á., Free, C.M., Froehlich, H.E., Golden, C.D., Ishimura, G., Maier, J., Macadam-Somer, I., Mangin, T., Melnychuk, M.C., Miyahara, M., de Moor, C.L., Naylor, R., Nøstbakken, L., Ojea, E., O'Reilly, E., Parma, A.M., Plantinga, A.J., Thilsted, S.H., & Lubchenco, J. (2020). The future of food from the sea. Nature 588, 95–100. https://doi.org/10.1038/s41586-020-2616-y

Cressey, D. (2016). Farmed fish drive sea change in global consumption. *Nature*, 7. https://doi.org/10.1038/nature.2016.20223

Daoud, J.I. (2017). Multicollinearity and regression analysis. *Journal of Physics: Conference Series*, *949*(1), 12009. https://doi.org/10.1088/1742-6596/949/1/012009

Driscoll, J.C., & Kraay, A.C. (1998). Consistent covariance matrix estimation with spatially dependent panel data. *Review of Economics and Statistics*, *80*(4), 549-560. https://doi.org/10.1162/003465398557825

Dyck, A.J., & Sumaila, U.R. (2010). Economic impact of ocean fish populations in the global fishery. *Journal of Bioeconomics*, *12*(3), 227–243. https://doi.org/10.1007/s10818-010-9088-3

ECORYS. (2012). Blue Growth: Scenarios and drivers for Sustainable Growth from the Oceans, Seas and Coasts. Rotterdam: European Commission, DG MARE, 2012 13 August 2012. Report No.: MARE/2010/01.

Ehlers, P. (2016). Blue growth and ocean governance—how to balance the use and the protection of the seas. *WMU J Marit Affairs, 15*, 187–203. https://doi.org/10.1007/s13437-016-0104-x

Esin, J.O., Evans, U.F., & Affiong, I.N. (2025). Blue economy and the fisheries sector in Nigeria: Analysis of the performance of capture and aquaculture fisheries to fish production and ımplication on economic growth. *International Journal of Research and Innovation in Applied Science*, *10*(3), 723-737. https://doi.org/10.51584/IJRIAS.2025.10030053

European Commission (2012). "Blue growth, Opportunities for marine and maritime sustainable growth". (Brussels: European Commission).

FAO (2015). FAO's Blue Growth Initative and AC. Brasilia, Brazil: 2015 5-9 October. Report.

FAO (2020) The State of World Fisheries and Aquaculture 2020. Rome: Food and Agriculture Organization of the United Nations; c2020.

FAO (2025) FishStatJ - Software for Fishery and Aquaculture Statistical Time Series https://www.fao.org/fishery/en/statistics/software/fishstatj

Farmery, A.K., Allison, E.H., Andrew, N.L., Troell, M., Voyer, M., Campbell, B., Eriksson, H., Fabinyi, M., Song, A.M., & Steenbergen, D. (2021). Blind spots in visions of a "blue economy" could undermine the ocean's contribution to eliminating hunger and malnutrition. *One Earth, 4*(1), 28-38. https://doi.org/10.1016/j.oneear.2020.12.002

Froehlich, H.E., Gentry, R.R., & Halpern, B.S. (2018). Global change in marine aquaculture production potential under climate change. *Nature Ecology & Evolution*, *2*(11), 1745-1750. https://doi.org/10.1038/s41559-018-0669-1

Garcia, S.M., & Rosenberg, A.A. (2010). Food security and marine capture fisheries: characteristics, trends, drivers and future perspectives. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *365*(1554), 2869–2880. https://doi.org/10.1098/rstb.2010.0171

Guan, Z., Hossain, M.R., Sheikh, M.R., Khan, Z., & Gu, X. (2023). Unveiling the interconnectedness between energy-related GHGs and pro-environmental energy technology: Lessons from G-7 economies with MMQR approach. *Energy*, *281*, 128234.https://doi.org/10.1016/j.energy.2023.128234

Hieu, V.M., & Mai, N.H. (2023). Impact of renewable energy on economic growth? Novel evidence from developing countries through MMQR estimations. *Environmental Science and Pollution Research*, *30*(1), 578-593. https://doi.org/10.1007/s11356-022-21956-7

Huyen, N.T., Thang, P.Q., & Nham, N.H. (2021). Impacts of the blue economy on economic growth in Vietnam. *Indian Journal of Economics and Development*, *17*(4), 777-785. https://doi.org/10.35716/IJED/21200

İnce, K., & Ecevit, E. (2026). Consumption dynamics from the framework of consumption theories: an empirical analysis in G7 countries. *Qual Quant, 60, 1979–1993*. https://doi.org/10.1007/s11135-025-02340-2

Jahanger, A., Zaman, U., Hossain, M.R., & Awan, A. (2023). Articulating CO2 emissions limiting roles of nuclear energy and ICT under the EKC hypothesis: An application of non-parametric MMQR approach. *Geoscience Frontiers*, *14*(5), 101589. https://doi.org/10.1016/j.gsf.2023.101589

Kao, C. (1999). Spurious regression and residual-based tests for cointegration in panel data. *Journal of Econometrics*, *90*(1), 1-44. https://doi.org/10.1016/S0304-4076(98)00023-2

Klinger, D.H., Levin, S.A. & Watson, J.R. (2017). The growth of finfish in global open-ocean aquaculture under climate change. *Proceedings of the Royal*

Society B: Biological Sciences, *284*, 20170834. https://doi.org/10.1098/rspb.2017.0834

Kusdiantoro Fahrudin, A., Wisudo, S.H., & Juanda, B. (2019). The economic impact of capture fisheries development in Indonesia. *AACL Bioflux*, *12*(5), 1698–1709.

Lackey, R.T. (2005). Fisheries: history, science, and management. *Water Encyclopedia*, *3*, 121–129.

Liza, J.I., Majumder, S.C., & Rahman, M.H. (2025). Scrutinizing the impact of blue economy factors on the economic growth in Bangladesh: An empirical study. *Marine Policy*, *173*, 106542. https://doi.org/10.1016/j.marpol.2024.106542

Machado, J.A., & Silva, J.S. (2019). Quantiles via moments. *Journal of Econometrics*, *213*(1), 145-173. https://doi.org/10.1016/j.jeconom.2019.04.009

Majeed, M.T., Mazhar, M., & Hussain, Z. (2023). Environmental impact of digital financial inclusion and green growth: Insights from global panel data analysis. *Pakistan Journal of Commerce and Social Sciences (PJCSS)*, *17*(3), 558-587.

Neiland, A.E., Cunningham, S., Arbuckle, M., Baio, A., Bostock, T., Coulibaly, D., Gitonga, N.K., Long, R., & Sei, S. (2016). Assessing the potential contribution of fisheries to economic development—The case of post-Ebola Sierra Leone. *Natural Resources*, *7*(6), 356–376. http://dx.doi.org/10.4236/nr.2016.76031

Ng, C.F., Choong, C.K., & Lau, L.S. (2020). Environmental Kuznets curve hypothesis: asymmetry analysis and robust estimation under cross-section dependence. *Environmental Science and Pollution Research*, *27*, 18685-18698. https://doi.org/10.1007/s11356-020-08351-w

Ochiewo, J. (2016). Social and economic impacts of capture fisheries and mariculture. The Regional State of the Coast Report: Western Indian Ocean, UNEP-Nairobi Convention and WIOMSA. https://doi.org/10.18356/2307cb15-en

Odongkara, K., Abila, R., & Onyango, P. (2005). Distribution of economic benefits from the fisheries of Lake Victoria. *Proceedings of the Lake Victoria Stakeholders Conference: Meeting the Challenges to Sustainability of the Fisheries Resources*.

Pauly, D., Alder, J., Bennett, E., Christensen, V., Tyedmers, P., & Watson, R. (2003). The future for fisheries. *Science*, *302*(5649), 1359–1361. https://doi.org/10.1126/science.1088667

Payne, I. (2000). *The changing role of fisheries in development policy*. ODI Natural Resource perspectives, Number: 59.

Pedroni P (2004) Panel cointegration: asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. *Economic Theory*, 20(3): 597–625.

Pesaran, M.H. (2007). A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics*, *22*(2), 265-312. https://doi.org/10.1002/jae.951

Pesaran, M.H. (2015). Testing weak cross-sectional dependence in large panels. *Econometric Reviews*, *34*(6-10), 1089-1117. https://doi.org/10.1080/07474938.2014.956623

Phuong, D.M., & Gopalakrishnan, C. (2004). Optimal management of water for sustainable fisheries and aquaculture. *International Journal of Water Resources Development*, *20*(4), 493-506. https://doi.org/10.1080/07900620412331319144

Qase, A.O. (2025). The Role of Small Fisheries on Economic Growth in: Case Study Mogashu, Somalia, *International Journal of Multidisciplinary Comprehensive Research, 4*(1), 15-25. https://doi.org/10.54660/IJMCR.2025.4.1.15-22

Rad, F., & Rad, S. (2012). A comparative assessment of Turkish Inland fisheries and aquaculture using economic sustainability indicators. *Turkish Journal of Fisheries and Aquatic Sciences*, *12*(2), 349-361. https://doi.org/10.4194/1303-2712-v12_2_22

Radulescu, M., Barut, A., Si Mohammed, K., Nassani, A.A., & Cutcu, I. (2024). Insights of resources productivity and green technologies impact on renewable energy consumption: Novel MMQR approach. *Geological Journal*, *59*(11), 3033-3047. https://doi.org/10.1002/gj.5044

Rehman, A., Deyuan, Z., Hena, S., & Chandio, A. A. (2019). Do fisheries and aquaculture production have dominant roles within the economic growth of Pakistan? A long-run and short-run investigation. *British Food Journal*, *121*(8), 1926-1935. https://doi.org/10.1108/BFJ-01-2019-0005

Sampantamit, T., Ho, L., Lachat, C., Sutummawong, N., Sorgeloos, P., & Goethals, P. (2020). Aquaculture production and ıts environmental sustainability in Thailand: Challenges and potential solutions. *Sustainability*, *12*(5), https://doi.org/10.3390/su12052010

Smith, M.D., Roheim, C.A., Crowder, L.B., Halpern, B.S., Turnipseed, M., Anderson, JL., Asche, F., Bourillón, L., Guttormsen, A.G., Khan, A., Liguori, L.A., McNevin, A., O'Connor, M.I., Squires, D., Tyedmers, P., Brownstein, C., Carden, K., Klinger, D.H., Sagarin, R., & Selkoe, K.A. (2010). Sustainability and global seafood. *Science*, *327*(5967), 784-786. https://doi.org/10.1126/science.1185345

Sun, Y.H.C. (2008). Health concern, food choice motives, and attitudes toward healthy eating: The mediating role of food choice motives. *Appetite*, *51*(1), 42–49. https://doi.org/10.1016/j.appet.2007.11.004

Tacon, A.G., Metian, M., Parsons, G.J., & Shumway, S.E. (2025). A global aquaculture and aquafeed production update: 2010 to 2023. *Reviews in Fisheries Science & Aquaculture*, 1-10. https://doi.org/10.1080/23308249.2025.2568830

Tsiouvalas, A., Stoeva, G., & Raspotnik, A. (2022). Looking for Common Ground: Marine Living Resource Development in Alaska and Northern Norway in the Context of the Blue Economy. *Sustainability*, *14*(4115). https://doi.org/10.3390/su14074115

Welcomme, R.L., Cowx, I.G., Coates, D., Béné, C., Funge-Smith, S., Halls, A., & Lorenzen, K. (2010). Inland Capture Fisheries. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *365*(1554), 2881–2896. https://doi.org/10.1098/rstb.2010.0168

World Bank (2023). World Bank open data. Available from: https://data.worldbank. org/ (Accessed 10 February 2023).

Yang, Q., Huo, J., Saqib, N., & Mahmood, H. (2022). Modelling the effect of renewable energy and public-private partnership in testing EKC hypothesis: evidence from methods moment of quantile regression. *Renewable Energy*, *192*, 485-494. https://doi.org/10.1016/j.renene.2022.03.123