IMPACT OF SEA LEVEL RISE ON LAND LOSS IN VIETNAM

On behalf of:

Federal Ministry
for the Environment, Climate Action,
Nature Conservation and Nuclear Safety

of the Federal Republic of Germany

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On behalf of
Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV)

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Abbreviations

AF&F	Agriculture, Forestry and Fishing
DEM	Digital Elevation Model
GDP	Gross Domestic Product
GIS	Geographic Information System
IPCC	Intergovernmental Panel on Climate Change
RCP	Representative Concentration Pathway
SLR	Sea-Level Rise
VND	Vietnamese Dong

Executive Summary

Vietnam is projected to be one of the countries most severely affected by climate change and extreme weather events (EWE). Vietnam is particularly vulnerable to rising sea levels. On top of this, the current climate projections for Vietnam show that higher average temperatures will challenge productive dynamics in critical economic sectors such as agriculture and manufacturing. Furthermore, the foreseeable higher intensity of cyclones and typhoons will put increasing pressure on Vietnamese infrastructure and inhabitants. In this sense, policymakers and stakeholders can benefit from having access to evidence-based economic projections that account for climate change to implement suitable policy measures. These may include shifting investment to more climate-resilient sectors and addressing the vulnerability of sectors particularly affected by climate change. Vietnam is also a signatory to the Paris Agreement and has pledged to become a net-zero emitter by 2050. This shows that Vietnamese policymakers are aware and concerned about the impact of climate change on the social and economic development of the country in the coming decades.

Considering this, GIZ implemented the project Policy Advise for Climate Resilient Economic Development (CRED) financed as part of the International Climate Initiative (IKI)[1]. The project was implemented in cooperation with technical support from the Halle Institute for Economic Research (IWH) to enable a systematic assessment of economic implications from climate change, and the viability of adaptation measures from a macroeconomic perspective. To support domestic capacity building the project was cooperating with the Central Institute for Economic Management (CIEM) from 2019-2023 to develop the Dynamic General Equilibrium Model for Climate Resilient Economic Development (DGE-CRED) to predict sectoral and regional economic effects of climate change on the Vietnamese economy (Drygalla et al. 2023). Key results and a description of the technical approach are available on the IKI website of the project.

Among the threats from climate change for Vietnam the impacts of **sea-level rise and coastal land loss could be particularly severe.** This is caused by high vulnerability largely because population and economic activity are concentrated in low-lying coastal regions such as the **Mekong River Delta** and the **Red River Delta**. These regions play a central role in Vietnam's economy, hosting major agricultural production, expanding urban areas, and important manufacturing and service activities.

This report presents insights how **sea-level rise may affect land availability across economic sectors in Vietnam** that have been generated in the context of the GIZ CRED project (Do et al. 2021). While agriculture, forestry, and fishing generate around **15 percent of value added**, these sectors currently occupy **more than 80 percent of total land area**. As a result, large parts of Vietnam's land resources are devoted to land-intensive activities that are particularly vulnerable to coastal inundation.

Using spatial analysis combining **sea-level rise projections, elevation data, and land-use information**, the study estimates potential land loss across regions. The results show that the **Mekong River Delta is the most exposed region**, followed by the **Red River Delta**. Under a sea-level rise of around **one meter**, Vietnam could lose **up to about 7 percent of its currently used agricultural land**, with significant impacts on rural livelihoods and food production.

While this report focuses on current land-use exposure, long-term outcomes will depend on how effectively Vietnam adapts. Potential responses include coastal protection, changes in land use, and the relocation of economic activity toward less vulnerable inland regions. Understanding these adjustment processes will be important for designing policies that support climate resilience and sustainable economic development in Vietnam.

[1] See: Policy Advice for Climate-Resilient Economic Development (CRED) - Methods of assessing and planning climate-resilient economic development | Internationale Klimaschutzinitiative (IKI)

1. OVERVIEW

Vietnam is among the countries most exposed to the economic consequences of sea-level rise and coastal land loss. This vulnerability arises from the concentration of population and economic activity in low-lying coastal regions, particularly in the Mekong Delta and around major coastal cities. The Mekong Delta plays a central role in the Vietnamese economy as a major center of rice production, aquaculture, and rural livelihoods, while coastal urban regions host growing manufacturing, logistics, and service sectors.

The economic implications of coastal land loss extend beyond the direct disappearance of land. Rising sea levels interact with subsidence, declining sediment supply, salinity intrusion, and changing land use to reshape economic conditions in coastal regions. These processes can reduce agricultural productivity, alter crop choices, affect aquaculture suitability, increase flood risks for urban and industrial areas, and degrade coastal amenities that support tourism and services.

The existing literature provides important insights into these processes. Global studies show that sea-level rise can generate substantial economic damages in coastal regions and major cities (Hallegatte et al. 2013; Hinkel et al. 2014). More recent work emphasizes that long-run economic losses depend strongly on spatial adjustment mechanisms such as migration and relocation of economic activity (Desmet et al. 2021). At the same time, improved elevation data suggest that global exposure to sea-level rise may be substantially higher than previously estimated (Kulp and Strauss 2019), and subsidence further increases vulnerability in many coastal regions (Li and Hill 2022; Parrado and others 2022).

For Vietnam, much of the existing research focuses on agricultural impacts, particularly in the Mekong Delta, where sea-level rise and salinity intrusion threaten rice production and agricultural livelihoods. However, coastal land loss also affects manufacturing, infrastructure, tourism, and urban development. As Vietnam continues to industrialize and urbanize, the economic consequences of coastal land loss increasingly depend on how different sectors of the economy are exposed and adapt to changing coastal conditions.

This paper analyzes the impact of land loss in Vietnam by economic activity. We examine how coastal land loss affects key sectors such as agriculture, aquaculture, manufacturing, and services, and we relate these impacts to the underlying physical drivers of land loss, including sea-level rise and coastal erosion. By focusing on sectoral exposure and economic activity, the analysis provides a more detailed understanding of how coastal land loss may reshape Vietnam's economic structure and development trajectory.

2. LITERATURE

The literature on sea-level rise and coastal land loss has evolved through three main strands. First, early research quantified exposure and direct coastal flood damages, demonstrating that low-lying coastal regions face rapidly increasing risks from rising sea levels and storm surges.

Global assessments show that coastal flooding could generate large economic losses in densely populated coastal cities unless protective infrastructure is upgraded (Hallegatte et al. 2013). Similarly, global coastal impact studies estimate large adaptation costs and damages from sea-level rise across coastal regions under different climate scenarios (Hinkel et al. 2014).

A second strand of literature examines economy-wide impacts and spatial adjustment mechanisms. These studies emphasize that the economic consequences of sea-level rise extend beyond direct physical damages. Permanent coastal inundation can alter migration patterns, trade flows, and the spatial allocation of economic activity. A prominent example is the spatial general equilibrium analysis of coastal flooding, which shows that the long-run economic costs depend strongly on how populations and economic activities relocate across regions (Desmet et al. 2021).

A third and more recent strand highlights that exposure to sea-level rise is often underestimated due to measurement issues, particularly related to elevation data and relative sea-level rise caused by land subsidence. Improved elevation datasets reveal that global vulnerability to sea-level rise is substantially larger than previously estimated (Kulp and Strauss 2019). In addition, studies emphasize that vertical land motion and subsidence can significantly amplify relative sea-level rise in coastal regions (Li and Hill 2022; Ohenhen et al. 2023).

For Vietnam, the Mekong Delta represents one of the most vulnerable regions globally because it combines high population density, intensive agriculture, and low elevation. Physical science studies show that the delta is significantly lower than previously assumed, which implies that land loss from sea-level rise may occur sooner and affect larger areas than earlier assessments suggested. In addition, the vulnerability of the delta is driven not only by sea-level rise but also by subsidence, reduced sediment supply, groundwater extraction, and salinity intrusion, which jointly accelerate land loss and environmental degradation.

Much of the Vietnam-specific literature has focused on agricultural impacts, reflecting the central role of the Mekong Delta in rice production and aquaculture. Land loss and salinity intrusion can reduce agricultural productivity, shift cropping patterns, and trigger transitions from rice cultivation toward aquaculture or other land uses. However, the economic consequences of coastal land loss extend beyond agriculture. Coastal cities such as Ho Chi Minh City concentrate manufacturing, logistics, and services, which depend on coastal infrastructure and flood protection. Furthermore, tourism and coastal services are vulnerable to shoreline erosion and degradation of coastal amenities.

Despite these insights, the literature still provides limited evidence on how land loss affects different economic sectors within coastal economies. Most studies either focus on aggregate damages or analyze individual sectors in isolation. A sectoral perspective is therefore important to understand how land loss reshapes the structure of economic activity in vulnerable coastal regions such as Vietnam.

3. LAND USE AND LAND LOSS

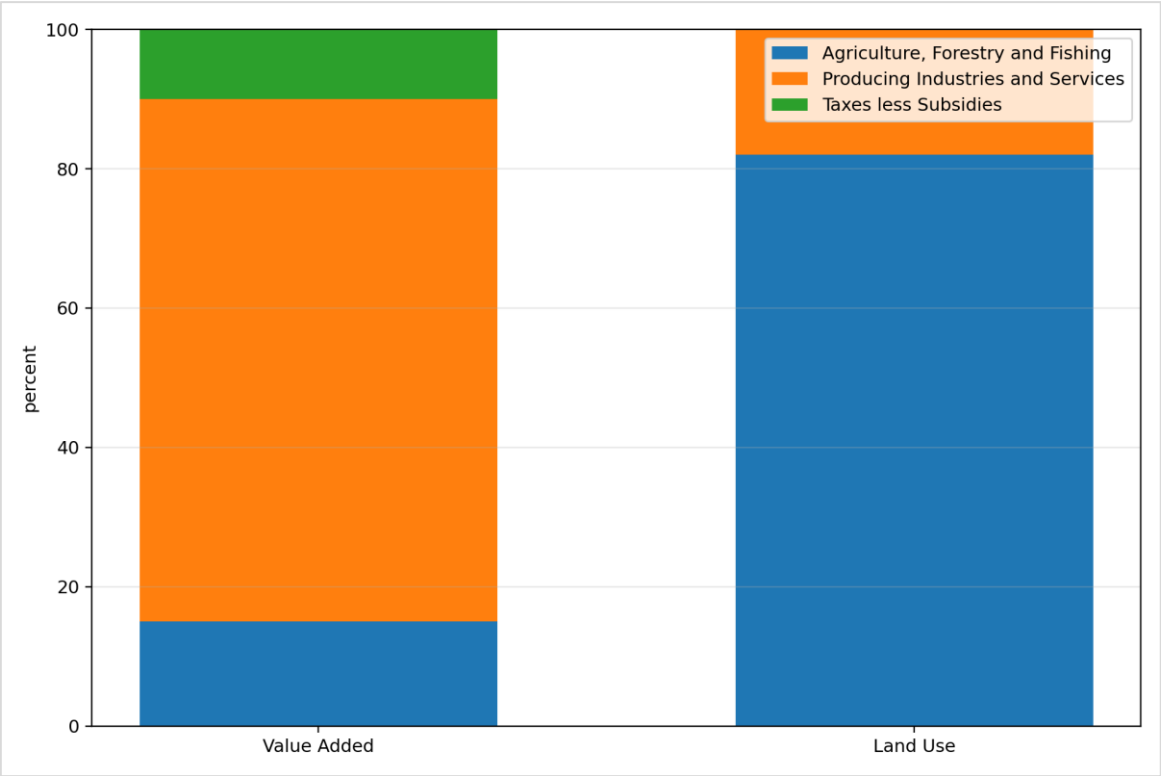
Vietnam currently generates around 15 percent of total value added in agriculture, forestry, and fishing, while producing industries and services account for approximately 85 percent of value added in the economy (see Figure 1).

However, the distribution of land use across sectors differs substantially from the distribution of economic output. Agriculture, forestry, and fishing occupy more than 80 percent of total land area, whereas producing industries and services use less than 20 percent of land. This indicates that large areas of land are devoted to primary activities with relatively low value added per unit of land.

Vietnam is divided into six major statistical regions: Red River Delta, Central Region, Southern Region, Mekong River Delta, Northern Midland and Mountainous Area, Central Highlands.

Land use patterns differ considerably across these regions (see Figure 2). The Central Region and the Northern Midland and Mountainous Area account for a large share of forest land in Vietnam, reflecting their extensive mountainous terrain. In contrast, the delta regions have comparatively lower land availability, as land is intensively used for agriculture, settlements, and economic activities.

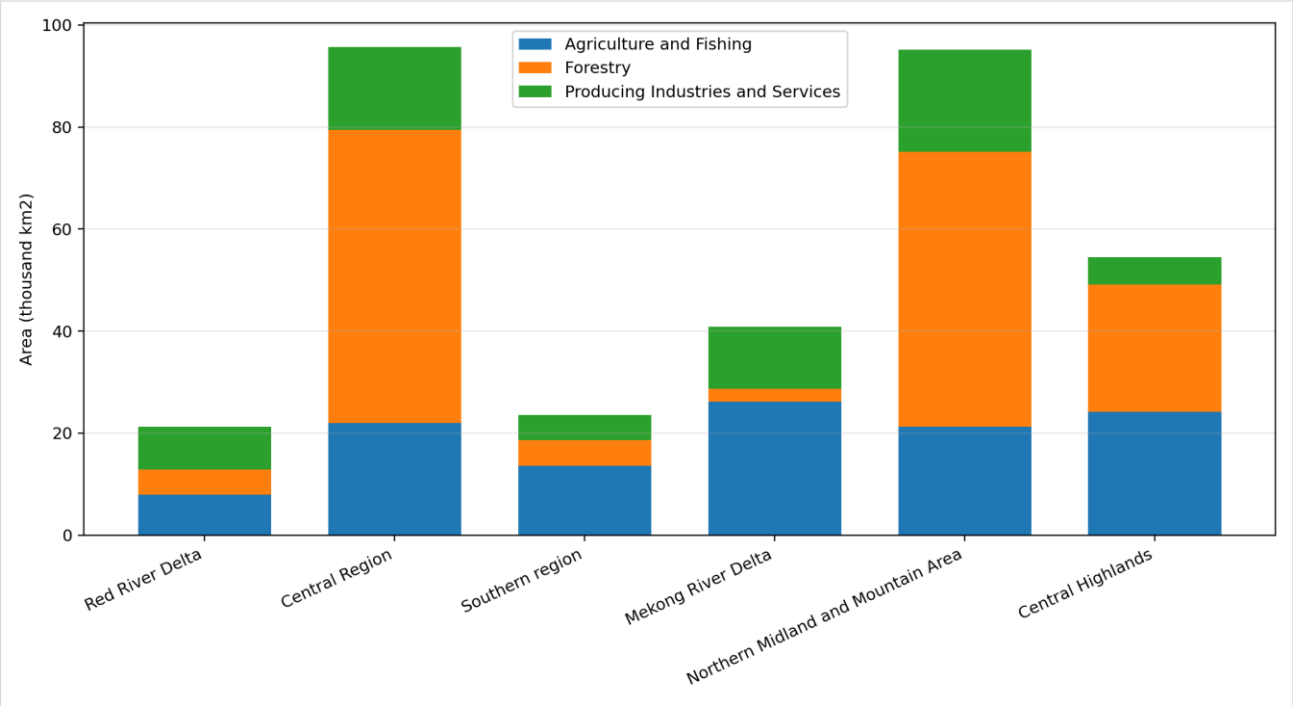
Figure 1. Stacked shares of value added and land used by economic activity in 2020.



Note: The bars show the decomposition of GDP and land use by economic activity. Slightly more than 10 percent of GDP consists of taxes less subsidies, which are not attributed to either agriculture, forestry and fishing or producing industries and services. Land use represents the share of currently utilized land allocated to each economic activity. The data for the figure is reported in Table A1.

Sources: General Statistical Office of Vietnam and own computation.

Figure 2: Stacked regional land use by economic activity in 2020.



Note: The bars show the decomposition of **land use by economic activity and statistical region in 2020**. Land use represents the **currently utilized land allocated to each economic activity**. The data for the figure is reported in Table A2.

Sources: General Statistical Office of Vietnam and own computation.

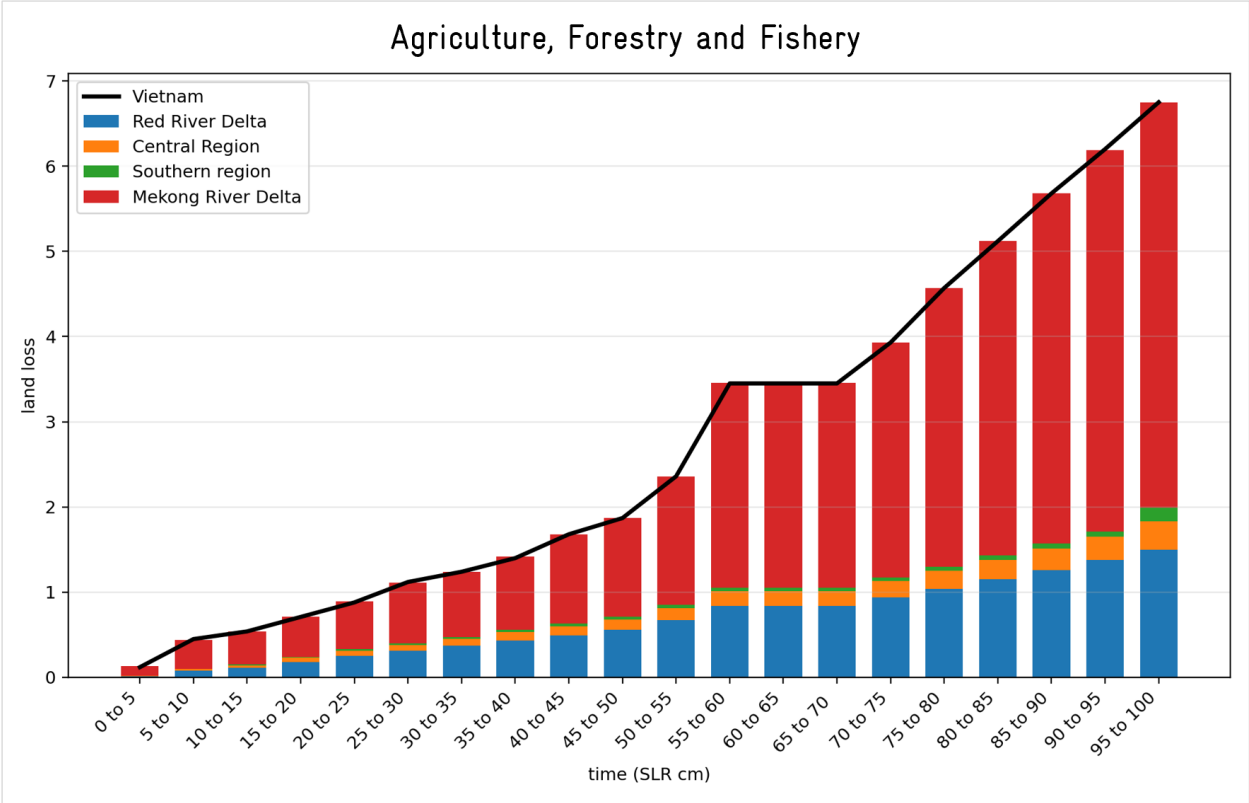
This study estimates land loss due to sea-level rise using a spatial analysis that combines sea-level rise projections with high-resolution elevation and land-use data (Đỗ et al. 2021). The methodology identifies areas that are expected to become permanently inundated under future sea-level scenarios and quantifies the associated exposure of land and economic activity.

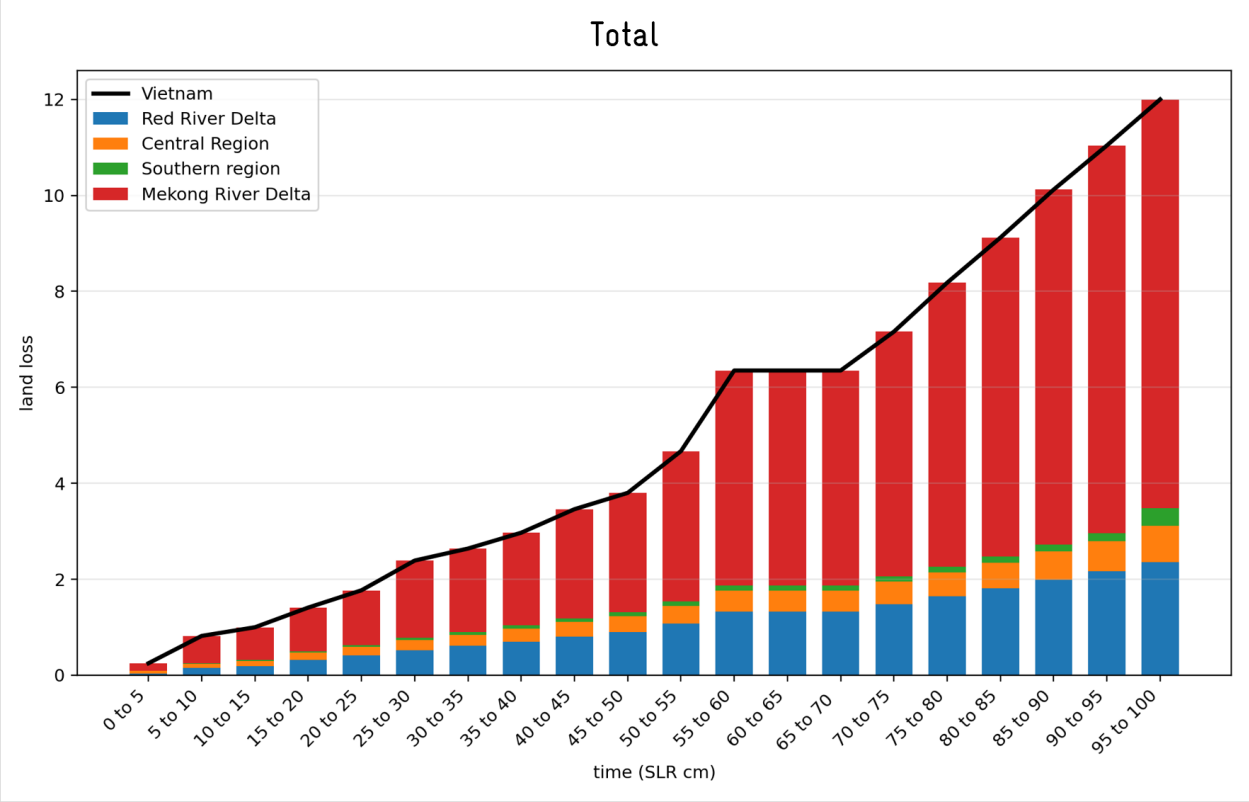
Future sea levels are based on climate change scenarios consistent with projections from the Intergovernmental Panel on Climate Change (IPCC). These scenarios provide estimates of mean sea-level rise for different time horizons. For each scenario and time period, the projected increase in sea level defines potential coastal inundation thresholds.

To determine potential land loss, sea-level projections are combined with digital elevation data using Geographic Information Systems (GIS). For each spatial unit, elevation is compared with the projected sea-level increase. A location is classified as inundated if its elevation lies below the projected sea-level threshold. This approach provides estimates of the share of land in each sector that becomes exposed to sea-level rise under different climate scenarios.

Total land loss is obtained by aggregating inundated land across all spatial units. Sectoral exposure measures are then used to identify which economic activities are most affected by coastal inundation. These estimates serve as an input for the subsequent economic assessment, including the evaluation of potential damage and the analysis of adaptation strategies in coastal regions.

Figure 3: Regional land loss by sea-level-rise band





Note: The bars show the decomposition of land loss **by statistical region as share of total land used in Viet Nam**. The data for the figure is reported in Table A3.

Sources: General Statistical Office of Vietnam, Đỗ et al. 2021 and own computation.

We observe that mainly the Mekong River Delta will be affected by sea level rise. For a projected sea level rise of 1m Viet Nam will lose up to 7 percent of its currently used land for agriculture, forestry and fishing. In addition, it will lose more than 10 percent oof its current used land. A sea level rise of up to one meter happen under the Reference concentration path 8.5 by the end of the 21st century.

The red River Delta is the second most vulnerable region in Viet Nam due to sea level rise. While the Central Region and the Southern Region are less vulnerable to sea level rise. However currently most of the population of Vietnam lives in the Mekong River Delta or the Red River Delta. Further, agricultural activity is highly concentrated in this area. Therefore, the long run implications of sea level rise to these regions are substantial and might require severe adaptation.

4. CONCLUSION AND OUTLOOK

This report shows that **sea-level rise poses a significant threat to Vietnam's delta regions**, which are among the most economically important and densely populated areas of the country. In particular, the Mekong River Delta and other low-lying coastal areas face substantial risks from permanent inundation and coastal flooding under projected sea-level rise scenarios.

At present, **land use in Vietnam is dominated by agriculture, forestry, and related activities**, which occupy the majority of the country's land area. These sectors are therefore particularly exposed to climate-related land loss. The analysis indicates that **future sea-level rise could substantially alter current land-use patterns**, especially in low-elevation delta regions where large shares of agricultural land are concentrated.

The results presented in this report primarily focus on current land-use patterns and their exposure to sea-level rise. However, it is important to recognize that adaptation and structural economic changes may alter these outcomes over time. Households, firms, and governments can respond to climate risks through a variety of measures, including coastal protection, improved infrastructure, changes in land use, and relocation of economic activity.

To better understand these long-term adjustment processes, **dynamic general equilibrium models provide a useful analytical framework** (Desmet et al. 2021; Drygalla, Heinisch, and Schult 2023). Such models allow for spatial adjustment mechanisms, including migration, capital reallocation, and shifts in production across regions. Over the long run, economic activity in Vietnam may increasingly **move inland toward regions that are less vulnerable to sea-level rise**, leading to gradual changes in the spatial distribution of production and population.

Nevertheless, while economic models can capture many adjustment mechanisms, they may **not fully account for cultural, social, and historical losses** associated with the displacement of communities and changes in traditional land use. Many coastal and delta regions have deep cultural and historical significance, and relocation or transformation of these areas may involve costs that are difficult to quantify in purely economic terms.

Future research should therefore aim to **combine economic modeling approaches with broader assessments of social and cultural impacts**, as well as improved data on land use, coastal protection, and climate adaptation strategies. Such integrated analyses can support more comprehensive policy responses to climate risks and help guide long-term development planning in Vietnam under rising sea levels.

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Appendix

Table A1: Land use and value added by economic activity.

ECONOMIC ACTIVITY	Value Added (Trillion VND)	Value Added Share (%)	Land Use (km2)	Land Use Share (%)
AGRICULTURE, FORESTRY AND FISHING	935.000	15.000	272,686.000	82.000
PRODUCING INDUSTRIES AND SERVICES	4,742.000	75.000	58,550.000	18.000
TAXES LESS SUBSIDIES	617.000	10.000	0.000	0.000

Sources: General Statistical Office of Vietnam and own computation.

Table A2: Regional land use by economic activity (km^2).

ECONOMIC ACTIVITY	Red River Delta	Central Region	Southern region	Mekong River Delta	Northern Midland and Mountain Area	Central Highlands
AGRICULTURE, FORESTRY AND FISHING	7,917.000	21,950.000	13,598.000	26,181.000	21,210.000	24,213.000
FORESTRY	4,937.000	57,508.000	5,027.000	2,536.000	53,967.000	24,895.000
PRODUCING INDUSTRIES AND SERVICES	8,401.000	16,197.000	4,895.000	12,097.000	20,026.000	5,401.000

Sources: General Statistical Office of Vietnam and own computation.

Table A3: Sea-level-rise regional land loss series for agriculture and non-agriculture (percent).

SLR	RED RIVER DELTA	CENTRAL REGION	SOUTHERN REGION	MEKONG RIVER DELTA	VIETNAM
Agriculture, Forestry and Fishing (in percent)					
0 to 5	0.010	0.010	0.000	0.110	0.120
5 to 10	0.080	0.020	0.000	0.340	0.450
10 to 15	0.110	0.030	0.010	0.390	0.540
15 to 20	0.180	0.050	0.010	0.470	0.710
20 to 25	0.250	0.060	0.020	0.560	0.880
25 to 30	0.310	0.070	0.020	0.710	1.120
30 to 35	0.370	0.080	0.020	0.770	1.240
35 to 40	0.430	0.100	0.030	0.860	1.400
40 to 45	0.490	0.110	0.030	1.050	1.680
45 to 50	0.560	0.120	0.030	1.160	1.870
50 to 55	0.670	0.140	0.040	1.510	2.360
55 to 60	0.840	0.170	0.040	2.410	3.450

SLR	RED RIVER DELTA	CENTRAL REGION	SOUTHERN REGION	MEKONG RIVER DELTA	VIETNAM
60 to 65	0.840	0.170	0.040	2.410	3.450
65 to 70	0.840	0.170	0.040	2.410	3.450
70 to 75	0.940	0.190	0.040	2.760	3.930
75 to 80	1.040	0.210	0.050	3.270	4.570
80 to 85	1.150	0.230	0.050	3.690	5.120
85 to 90	1.260	0.250	0.060	4.110	5.680
90 to 95	1.380	0.270	0.060	4.480	6.200
95 to 100	1.500	0.330	0.160	4.760	6.750
Producing Industries, Services and Housing (in percent)					
0 to 5	0.040	0.050	0.000	0.160	0.250
5 to 10	0.150	0.090	0.010	0.570	0.820
10 to 15	0.190	0.110	0.020	0.680	1.000
15 to 20	0.320	0.150	0.030	0.910	1.410
20 to 25	0.420	0.170	0.040	1.140	1.770
25 to 30	0.520	0.210	0.050	1.610	2.390
30 to 35	0.610	0.230	0.060	1.740	2.640
35 to 40	0.700	0.270	0.070	1.930	2.970
40 to 45	0.810	0.300	0.070	2.280	3.460
45 to 50	0.900	0.330	0.080	2.490	3.800
50 to 55	1.080	0.370	0.090	3.130	4.670
55 to 60	1.330	0.430	0.110	4.480	6.350
60 to 65	1.330	0.430	0.110	4.480	6.350
65 to 70	1.330	0.430	0.110	4.480	6.350
70 to 75	1.480	0.470	0.110	5.100	7.160
75 to 80	1.640	0.500	0.120	5.920	8.180
80 to 85	1.810	0.540	0.130	6.640	9.120
85 to 90	1.990	0.590	0.140	7.400	10.120
90 to 95	2.170	0.630	0.160	8.080	11.040
95 to 100	2.360	0.760	0.360	8.520	12.000

Sources: General Statistical Office of Vietnam, Đỗ et al. 2021 and own computation.