TECHNICAL ASSISTANCE REPORT

SEYCHELLES

Macroprudential Stress Test and Climate Risk Analysis

January 2025

Prepared By

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Glossary

BCSD	Bias Correction and Spatial Downscaling
CAR	Capital Adequacy Ratio
CBC	Counter Balancing Capacity
CBS	Central Bank of Seychelles
CIS	Credit Information System
CPI	Consumer Price Index
CRA	Climate risk analysis
CMIP	Coupled Model Intercomparison Project
DAA	Deposit Auction Arrangement
ECB	European Central Bank
EUR	Euro
FC	Foreign Currency
FRS	Financial Regulation Section
FSA	Financial Services Authority
FSD	Financial Surveillance Division
FSS	Financial Stability Section
FX	Foreign exchange rate
GCMs	General Circulation Models
HHI	Herfindahl Hirschman Index
IMF	International Monetary Fund
l.h.s.	left hand side
MACCE	Ministry of Agriculture Climate Change and Energy
MCM	Monetary and Capital Markets Department
MLH	Ministry of Lands and Housing
NBS	National Bureau of Statistics
NPLs	Nonperforming loans
P&L	Profit and Loss
ROA	Return on Assets
ROE	Return on Equity
RWAs	Risk-Weighted Assets
SCR	Seychelles Rupee
SMA	Seychelles Meteorological Authority
SPA	Seychelles Planning Authority

SSP	Shared Socioeconomic Pathway
ST	Macroprudential stress test
STA	Standardized Approach
RCP	Representative Concentration Pathway
r.h.s.	right hand side
TA	Technical Assistance
USD	United States Dollar
US Fed	United States Federal Reserve
WB	IMF stress testing tool, Workbox
WEO	World Economic Outlook

Preface

At the request of the Central Bank of Seychelles (CBS), a Monetary and Capital Markets (MCM) Department mission visited Victoria, Seychelles, from May 2 to 17 to assist the authorities in Macroprudential stress test (ST) and Climate risk analysis (CRA). The team for the mission included Mr. Cyril Pouvelle for the ST (STX, head of the research unit of the French banking and insurance supervisory authority), Mr. Shuai Wang for the climate data for the CRAs (STX, professor of meteorology and climate science at the University of Delaware), and Javier Urunuela Lopez (MCMFS).

The mission met with Mr. Brian Commettant First Deputy Governor CBS, Mr. Naddy Marie Director Financial Surveillance Division (FSD) CBS, and staff from Financial Stability Section (FSS) FSD (Ms. Diandra Cedras, Ms. Nadine Boniface, Ms. Sammia Marchesseau), Financial Regulation Section (FRS) FSD (Ms. Amela Antoine, Mr. Cyril Benoiton), Micro Prudential Supervision Section FSD, Financial Inclusion and Market Conduct Division, Research and Statistics Division (RSD) from CBS, Ms. Li Fa Cheung Kai Suet CEO National Bureau of Statistics (NBS), Mr. Kevin Bistoquet Counterpart to the CEO NBS, Mr. Vincent Amelie CEO Seychelles Meteorological Authority (SMA), Ms. Annie Simeon Principal Climate Adaptation Officer Ministry of Agriculture Climate Change and Energy (MACCE), Mr. Randolf Samson CEO Financial Services Authority (FSA), Absa Bank Seychelles Limited, MCB (Seychelles) Limited. The mission wishes to thank CBS and other agencies, for their cooperation, productive discussions, and their hospitality.

Executive Summary

The Central Bank of Seychelles is enhancing its scenario-based macroprudential stress testing framework, aiming to better understand the risks and include physical climate-related risk therein. The current Macroprudential stress testing framework of CBS is scenario-based but does not rely on satellite models that would allow them to statistically estimate the effect of the projected macroeconomic variables on credit risk parameters or income statement items. The authorities are currently aiming to improve their framework, underlying models and data granularity, allowing them to integrate consideration of currency and sectors that would enhance their current approach. Strengthening their current stress testing framework would also allow the CBS to develop a Climate risk analysis framework, for which data and a stress testing framework are prerequisites. Improving the framework, would then enable them to integrate physical climate-related risks considerations.

On the stress testing component, this TA mission assisted in improving the solvency and liquidity frameworks. For the solvency stress test, the IMF team reviewed the two main sources of risks for the Seychelles banking system, credit risk and foreign exchange risk, which were considered in a scenario design; then, using econometric techniques, estimated diverse satellite models for risk parameters and bank balance sheet items, and used them in the solvency stress test in a top-down fashion. For the liquidity stress test, the mission covered a cash flow-based analysis by maturity bucket on a pre-defined set of liquidity parameters. The mission showcased and discussed the process with CBS personnel, allowing them to take from this work to improve their framework.

For the Climate risk analysis, the TA aimed to build the Central Bank of Seychelles' capacity to set up a Climate risk analysis framework for physical risk. The mission reviewed the key components of a physical risk Climate risk analysis in IMF approaches for physical risk, gave an overview of the required data, and conducted a detailed review of climate data. The mission held conversations with different agencies to identify country-specific data sources. Last, the mission walked the authorities through hands-on Climate risk analysis, covering climate diagnosis and one damage estimation for tropical cyclones.

The mission recommendations focused on enhancing the ST framework and setting the base for the CRA. On the ST, developing collaboration between divisions to use macro models for stress testing, better exploiting historical data on NPL ratios, including foreign exchange risk assessments, and improving collateral valuation would enhance the current framework. The credit risk component would benefit from using historical provisioning rates, individualized shocks to NPL ratios, monitoring credit concentration, and further developing satellite models, while liquidity from conducting stress tests by currency and linking it to solvency. For the CRA, the recommendations emphasize identifying country-specific data, closing data gaps related to banking exposures and the impact of climate-related events, setting a clear timeline for establishing a framework, further developing data understanding and usage capacity, and fostering interagency collaborations.

The Central Bank of Seychelles is expected to move forward in improving its Macroprudential stress test framework and start its Climate risk analysis work. Addressing data issues and getting familiar with the models would allow the CBS to consistently design stress testing scenarios, improve their solvency stress test, and conduct a more robust liquidity stress test. Regarding climate risk analysis, authorities must start exploring further data options and define an initial framework. The mission's recommendations, tools, codes, and data would allow the CBS to start work on both workstreams.

Recommendations

Table 1. Key recommendations

Recommendations and Authority Responsible for Implementation	Priority	Timeframe 1/
Macroprudential stress test		
a) Scenario design		
Develop the collaboration between the CBS - FSD and the Research and Statistics Division to use macro models for stress testing purposes **– CBS (Para. 26)**	High	Short term
b) Data		
Exploit better the historical data available at the CBS on the time series and panel data of NPL ratios broken down by sector and currency to better consider foreign exchange rate risks **– CBS (Para. 40)**	High	Short term
Explore the possibility with the NBS to build a real estate index for stress testing purposes and collateral valuation projection **– CBS and NBS (Para. 26 and 40)**	Low	Medium term
Consider collecting data on loan write-offs and cure rates to calculate default rates **– CBS (Para. 40)**	Low	Long term
Collect data on the quality of collateral held by banks for credit risk **– CBS (Para. 16)**	Medium	Medium term
c) Credit risk		
Exploit the provisioning rate historical data for projecting the provisions' coverage ratio **– CBS (Para. 40)**	High	Medium term
Once additional data are collected, work further on satellite models to link macrofinancial variables with banks' loan losses for solvency risk **– CBS (Para. 21)**	High	Medium term
Use individualized shocks to credit risk for each bank by assuming a particular increase in the NPL ratio of the two to three largest sectors of exposure **– CBS (Para. 9)**	Medium	Short term
Increase monitoring of credit concentration data by stress testing large exposures, assuming the default of the two to three largest exposures, and collateral valuation **– CBS (Para. 13)**	Medium	Short term

Recommendations and Authority Responsible for Implementation	Priority	Timeframe 1/
Once the CBS top-down stress testing framework has been upgraded, launch a bottom-up ST process with the banks and prepare relevant guidelines to be shared with the banks **– CBS (Para. 21)**	Low	Long term
d) Liquidity risk		
Conduct liquidity stress test by currency **– CBS (Para. 59)**	High	Short term
Design liquidity risk parameters (such as outflow rates) for stress tests based on historical data specific to the Seychelles banking system**– CBS (Para. 63)**	Medium	Medium term
Climate risk analysis		
a) Data		
Identify options of country-specific data that can be used for Climate risk analysis exposures, and timelines for the data to be available – **CBS (Para. 81)**	High	Short term
Define the data on hazards projections, exposures, and vulnerability for a Climate risk analysis – **CBS (Para. 87)**	High	Short term
Close the identified data gaps on (i) exposures from the banking system, and (ii) impact of climate-related events – **CBS and FSA (Para. 83)**	Medium	Medium term
Develop further capacity in understanding and using the data required for Climate risk analysis – **CBS (Para. 84)**	Medium	Short term
b) Set a climate risk analysis framework		
Define a clear timeline to set a framework, that considers the deadlines to identify and define the data – **CBS (Para. 91)**	High	Short term
Develop a climate diagnosis and define the framework to be implemented among the set of options – **CBS (Para. 91)**	High	Short term
c) Interagency collaborations		
Establish collaborations or leverage existing forums to align their climate-related work with other agencies – **CBS (Para. 77)**	Medium	Short term
Establish collaboration mechanisms to share data and integrate country-specific climate considerations in the Climate risk analysis – **CBS, MACCE and SMA (Para. 76)**	High	Long term

1/ Short term: < 12 months; Medium term: 12 to 24 months; Long term > 24 months.

Introduction

1. **The mission aimed to retake from previous TA and work with authorities to enhance their actual ST framework.** One of the objectives of the 2015 mission on macroprudential policy framework was to improve their stress test framework. While authorities have made progress on institutional recommendations, specifically on setting up a Financial Stability Section, further support is required to strengthen their solvency stress testing framework and to build a more robust liquidity stress test.

2. **CBS' solvency assessment would benefit from considering models that link financial variables to macroeconomic conditions and integrating currency considerations in liquidity.** Although scenario-based, the CBS solvency stress testing framework does not rely on satellite models that would allow them to statistically estimate the effect of the projected macroeconomic variables on credit risk parameters or income statement items. Considering these models and improving data granularity, allowing the consideration of currency and sectors would enhance the current approach. Distinguishing liquidity in domestic currency and liquidity in foreign currency as well as better documenting the liquidity stress parameters would strengthen the liquidity stress test.

3. **Strengthening their current ST framework would also allow the authorities to develop a CRA framework.** CRA requires both data and a ST framework. Improving CBS' current approach to stress test, would allow them to assess the most appropriate way to integrate physical climate-related risks considerations. Depending on the available data, authorities would be able to define if they can integrate climate considerations at a macro or micro level.

4. **The authorities planned to use the ST and CRA to foster a climate-resilient financial sector.** Authorities are committed to implementing a climate stress testing for the overall financial system. The first step is to strengthen their ST framework, allowing them to better incorporate climate-related risk consideration and later conduct a CRA exercise, starting with physical risk.

Background

5. **Seychelles has recovered quickly to pre-pandemic levels, with normalized growth in 2023 after the rebound.** The tourism sector, the largest sectoral exposure of banks, regained its pre-pandemic number of tourist arrivals almost entirely in 2022. The GDP in constant prices exceeded its 2019 level in 2022, thanks to a 15 percent annual growth rate before registering a normalized growth rate of 3.2 percent in 2023. Medium-term prospects point to a stabilization of the GDP growth rate slightly below 4 percent as tourism growth steadies.

6. **However, as a small island developing state, large ocean state and a small open economy, the country remains highly vulnerable to external shocks.** Key vulnerabilities result from the country's heavy dependence on tourism earnings, food and energy imports, and external financing through foreign direct investment, remittances, and other financial flows. As an island state with a tourism-driven economy, the country is exposed to climate change, where deterioration of climate conditions can be homogenous across the Seychelles geography.

7. **Future climate conditions could lead to more extreme events that could impact the Seychelles economy.** Rising sea levels and an increase in the severity of storms could damage coastal and inland infrastructure, through coastal or flash flooding, and possibly deter tourism development. Future climates can also bring other effects, such as water shortages and further coral bleaching events that could threaten the economy. Under future climate scenarios, there is a clear trend of increasing

temperatures in the region for the different scenarios, which could exacerbate extreme conditions, such as the intensity of the storms in the South Indian basin, leading to extreme wind and precipitation events.

Banking system

A. Characteristics

8. **The Seychelles banking sector is large, concentrated, and open to foreign banks.** The total banking sector assets amount to 118 percent of GDP in 2023 (based on the nominal GDP forecast from the April 2024 World Economic Outlook (WEO)), a high level compared to peers, while the number of banks is small (seven). The three largest banks account for 86 percent of the banking sector's total assets, with a Herfindahl Hirschman Index (HHI) of 0.26 in 2023, denoting a concentrated system.[1] Moreover, foreign penetration is large, with the presence of five banks with foreign capital, making up 58 percent of total banking assets.

9. **The banking system is based on traditional lending and is highly exposed to tourism.** Loans represent the largest part of banking sector assets, 32 percent of the total assets, with loans to non-financial corporations representing 57 percent of total loans in December 2023. The mortgage sector represents the largest exposure of banks, with 17 percent of total loans, followed by private households, with 14 percent of total loans, and tourism, with 13 percent of total loans. On the liability side, banks fund themselves mainly through deposits, making up 95 percent of total liabilities (Figure 12).

10. **Interest income is the main source of banks' profit, with a significant interest rate margin.** Interest income constitutes about two-thirds of banks' income, while non-interest income derives mostly from foreign exchange dealings and fees and commissions. The interest rate margin of banks is very large. The interest rate spread amounted to 8.7 percentage points in December 2023, with lending rates averaging 9.7 percent and customer deposit rates averaging 1.5 percent.

B. Soundness analysis

11. **Seychelles' banking system is well-capitalized, profitable, and liquid.** With a capital adequacy ratio, regulatory capital to Risk-weighted Assets (RWAs), of 21.80 percent in December 2023 (18.60 percent for Basel II considered for showcasing the stress test), the average capitalization of banks had been displaying a rising trend since 2020, thanks to the supervisory restrictions on dividend distributions during the COVID-19 pandemic and an increase in undistributed profits, standing at an average level compared to similar countries (Figure 1, a). Tier 1 capital makes up 73 percent of total capital, which denotes a high quality of capital (Figure 1, b). The profitability of banks is remarkably high when measured against banks' equity (28 percent) and average measured against total assets (2.8 percent), on the back of a large interest rate margin (Figure 1, e and f). The liquidity position appears comfortable, with a ratio of liquid assets to short-term liabilities amounting to 69 percent, a similar level to that of the Maldives (Figure 1, g).

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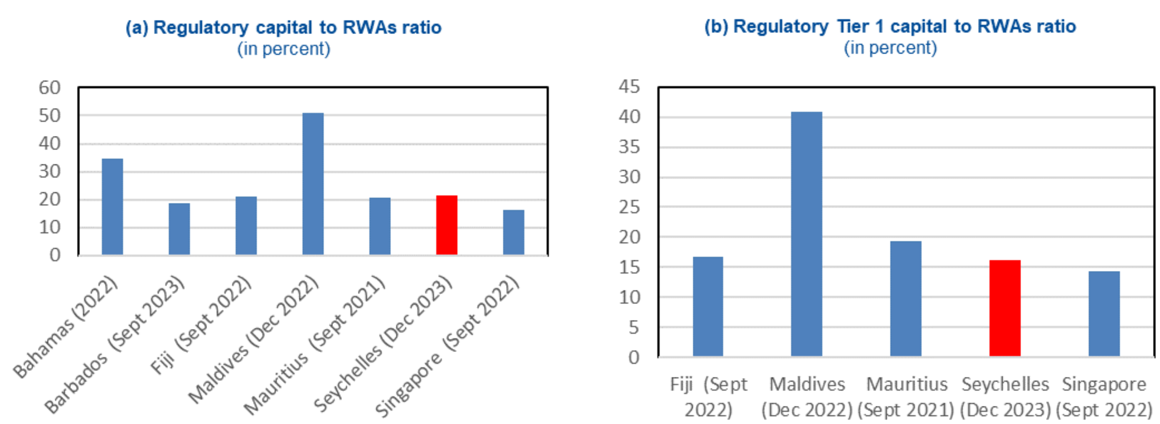
[1] The HHI is calculated as the sum of the squares of banks' market shares and ranges from 0 to 1. Higher index values denote higher concentration; a system with an index above 0.25 is considered highly concentrated.

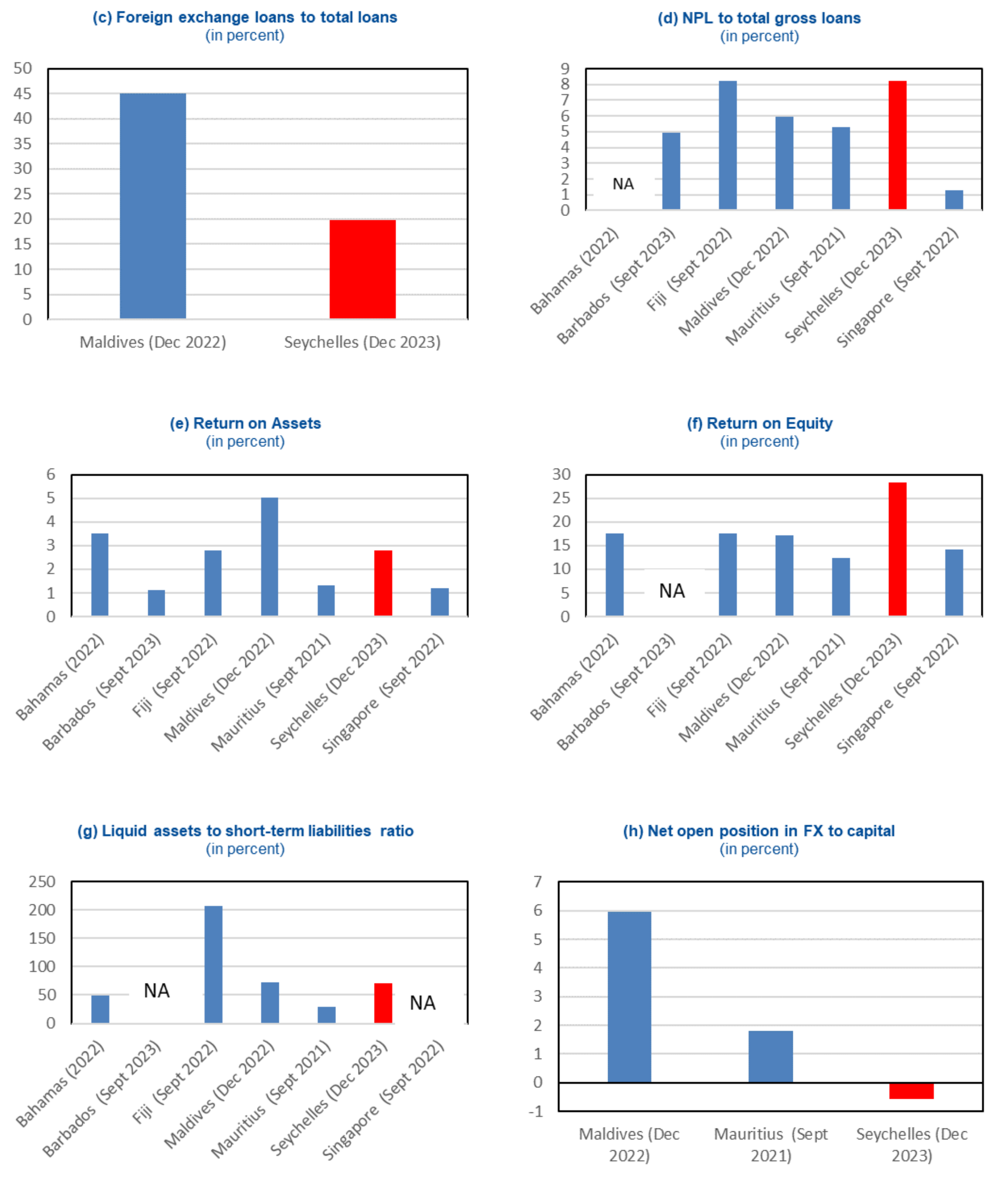
12. **However, credit risks are elevated due to the high and rising level of NPLs, credit concentration, and the size of large exposures.** At 8.1 percent in December 2023, the Nonperforming loan (NPL) ratio has risen since 2019. It stands more than 5 percentage points higher than during the pre-pandemic period, possibly reflecting the gradual lifting of the forbearance measures introduced.[2] Moreover, this level is the second highest among a sample of similar countries, just behind Fiji (Figure 1, d). Credit risks are exacerbated by (i) the low provision coverage ratio of NPLs (less than 20 percent), reflecting a large reliance of banks on collateral, (ii) the extent of loans in foreign currency (FC), still reaching 20 percent of total loans, and (iii) the level of credit concentration.

13. **Credit concentration is particularly high for two banks, driving up credit concentration in the system.** Jointly considering the most concentrated banks, the credit concentration reached 141 percent of their Tier 1 capital as of December 2023, with a regulatory limit of 600 percent of Tier 1 capital. Excess credit concentration mostly concerns exposures to the tourism sector, and CBS needs to approve these concentrations. At the banking system level, credit concentration reached 73 percent of banks' Tier 1 capital in December 2023.

Figure 1. Financial Soundness Indicators: Seychelles, and similar countries



[2] These measures included a suspension to CBS' credit classification and provisioning regulations, which prevented banks from automatically downgrading restructured or renegotiated loan facilities that were performing pre-pandemic, as well as other support mechanisms such as moratoriums and loan restructuring put in place by financial institutions.



Source: Central Bank of Seychelles; IMF staff calculations

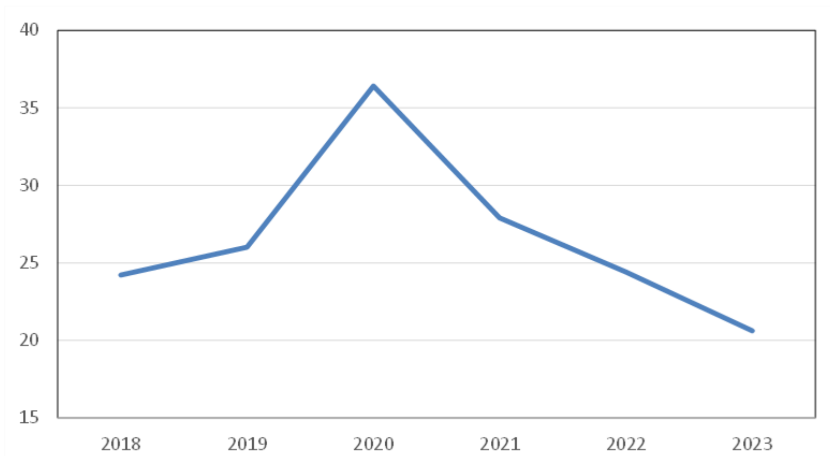
14. **A sovereign-bank nexus arises from banks' large holdings of government securities.** The portfolio of domestic debt securities (Treasury bills and bonds) held by banks made up 13 percent of their total assets and 142 percent of their regulatory capital in December 2023, and is heterogenous between

banks. Every security is held to maturity. Therefore, these securities are not exposed to interest rate risk but to the issuer's default risk.

C. Risks from high share of loans in foreign currency

15. **Seychelles' banking system still displays a high share of loans in foreign currency, concentrated in the tourism sector.** Despite a pronounced declining trend in the share of FC denominated loans since the peak reached in 2020, loan "euroization" in Seychelles still amounts to 20 percent of total loans (Figure 2), remaining at a much lower level than in Maldives (Figure 1, c). FC-denominated liabilities make up 50 percent of total deposits. As a result, banks' total net open currency position was negative in 2023, making up (-0.6) percent of their equity (Figure 1, h).

Figure 2. Evolution of FC loans in the Seychelles banking system



Source: Central Bank of Seychelles; IMF staff calculations
Note: Measured at current exchange rates

16. **The high share of FC loans creates a range of risks in the economy.** The recourse to FC loans is still mainly motivated by lending rate differentials on the part of customers; this creates credit risks and indirect foreign exchange rate risks for the banks in case of rupee depreciation or an increase in foreign interest rates. However, the indirect foreign exchange rate (FX) risk is limited for the banks by the fact that FC-denominated loans are mostly granted to corporations in the tourism sector whose earnings are largely in FC (EUR or USD), thus providing them with a natural hedge against a depreciation of the SCR. Whereas banks' internal credit policy states that FC lending should be limited to customers earning steady FC income, prudential regulation currently has no provisions on the conditions for granting FC loans nor differences in risk weights for retail and business loans in SCR and FC. Differentiated risk weights on exposures in SCR and FC are applied to exposures to government and public sector entities, banks, credit institutions, and securities firms only. Moreover, CBS does not have information on the recovery rates associated with the different types of collateral held by banks against the FC-denominated loans they grant, nor does it have information on the hedges borrowers might have against FX risk.

D. Credit risk from households and corporates

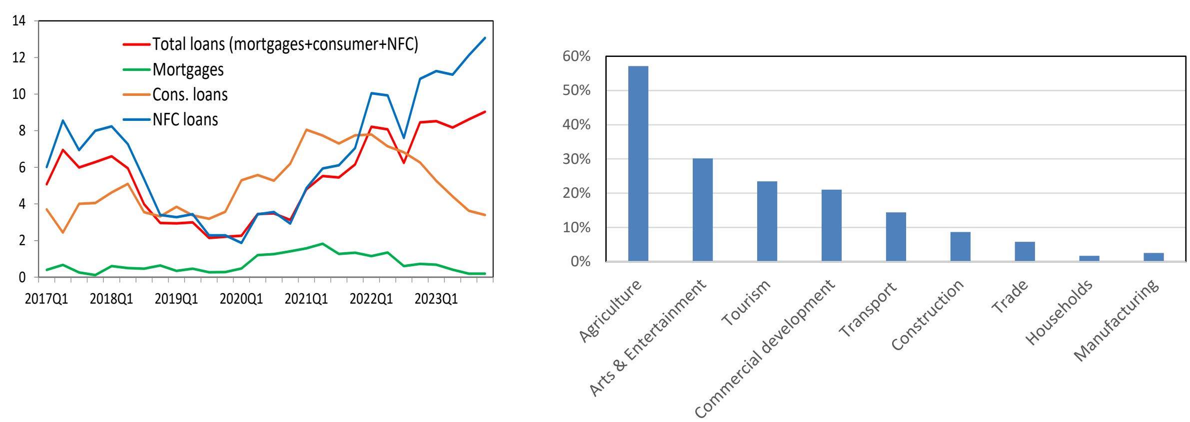
17. **The aggregate NPLs ratio is high and rising, driven by the corporate sector.** With an aggregate NPLs ratio of 8.1 percent at the end of December 2023, the corporate sector displays a lower credit quality than the household sector, with an NPL ratio of 1.7 percent. The recent upward trend in the level of the NPL ratio that started during the COVID-19 pandemic has been particularly marked for loans to the non-financial corporate sector (Figure 3, l.h.s.). Moreover, there is a high heterogeneity between banks, with NPL ratios ranging from a minimum of 0 percent at one bank to a maximum of 13.5 percent at another as of December 2023. The NPL ratio could rise further in the coming years due to the protracted effects of the economic slowdown associated with the current worldwide inflationary context.

18. Credit risks are heterogeneous across economic sectors and much higher for loans denominated in foreign currency. The agriculture sector displays the highest NPL ratio (57 percent of gross agricultural loans), resulting from one credit facility, followed by arts & entertainment, tourism, commercial development, and transport. (Figure 3, r.h.s.). The aggregate NPLs ratio in FC stood at 16.2 percent at the end of December 2023, compared with 6.2 percent for the NPLs ratio in SCR; this indicates that some borrowers in FC are unhedged against FX risk and are very vulnerable to a depreciation of the domestic currency or an increase in external interest rates**.**

Figure 3. NPL ratios in Seychelles banking system

NPLs ratio by type of loans (in percent)

NPLs ratio by economic sector, 2023 Q4 (in percent)



Source: Central Bank of Seychelles, and IMF staff calculations

E. Climate physical risk

19. Long-term climate conditions could affect repayment capacity, while more extreme events could impact collateral-securing loans. The different sectors served by the banking sector are exposed to the deterioration of the climate conditions. As for the whole economy, climate deterioration could deter tourism, impacting the income of the sector and related ones, as well as increasing the operational costs, affecting the capacity to repay the loans. Moreover, the banking system heavily relies on physical collateral, which could be affected by more severe climate events, with major sectors such as mortgages and construction backed by immovable collaterals.

I. Macroprudential stress test

20. The macroprudential stress test component focused on solvency and liquidity. The mission covered both solvency and liquidity stress tests considering the following: (i) for the solvency stress test, the IMF team reviewed the two main sources of risks for the Seychelles banking system, credit risk and FX risk, for which the IMF team started with scenario design, then estimated diverse satellite models regarding risk parameters and bank balance sheet items, and used them in the solvency stress test in a top-down fashion, on a consolidated basis, for the seven banks of the Seychelles banking system; (ii) for the liquidity stress test, the mission covered a cash flow-based analysis by maturity bucket on a pre-defined set of liquidity parameters.

A. Scenario design

21. So far, the solvency stress test carried out by the CBS has relied on a scenario analysis. The narrative remains succinct, and the scenario does not include a full set of projections for a range of meaningful macroeconomic variables and each year of the scenario. Instead, the CBS assesses the effect of ad hoc assumptions on the inflation rate, the FX, and collateral depreciation on loan migration and NPL ratio increases. Banks conduct internal stress tests for the budgeting process, but there is no particular interaction with CBS nor a national bottom-up stress testing framework.

22. The solvency stress test used by the TA mission examined a baseline macroeconomic scenario and an adverse scenario. The mission used two scenarios to illustrate the application of the enhanced framework and the satellite models by currency. Both scenarios stretched over a three-year forecasting period. The first year of the shock was 2024, and the scenario ran until 2026. The baseline macroeconomic scenario was based on the projections of the IMF staff included in the April 2024 WEO. It forecasts that GDP growth will slow down in 2024 to 3.2 percent after the post-pandemic rebound in 2022, driven by the tourism sector. Medium-term prospects remain moderate, with an annual growth of around 3.6 percent, on the back of persistent economic weakness in Europe.

23. The illustrative adverse scenario considered a simple model estimated for this purpose and of expert judgment. The scenario would be driven by two downside external risks to the Seychelles economy: a rebound in global commodity prices and external shocks to tourism demand, and would feature a severe recessionary scenario coupled with an inflationary shock. This scenario, based on the Risk Assessment Matrix published in the December 2023 Article IV report (see Appendix I), assumes three external shocks: (i) an intensification of regional conflicts disrupting trade, remittances, foreign direct investment, financial flows, (ii) an abrupt global recession with spillovers through trade, tourism inflows and financial flows and (iii) commodity price volatility resulting from international tensions and global uncertainty. For Seychelles, the worsening current account deficit resulting from the rise in the oil bill and the collapse of tourism earning would cause a very large depreciation of the rupee. The ensuing fiscal stress would cause a one-notch downgrade on the Seychelles sovereign debt.

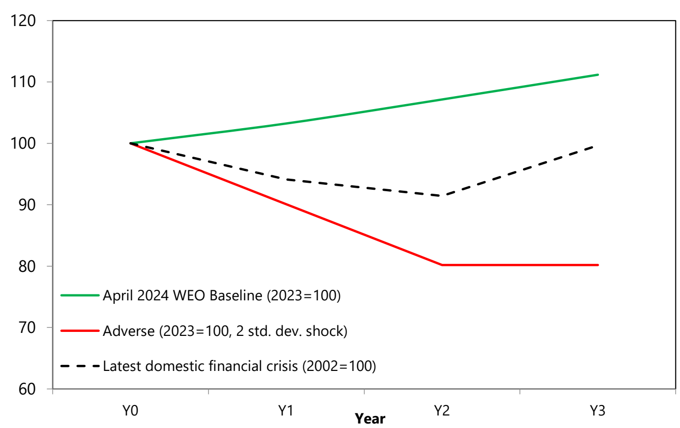
24. The TA mission used two benchmarks to calibrate the severity of the adverse scenario:

i. Apply at least a 2 standard deviation shock in terms of Seychelles 2-year GDP growth, taking the 2000-2023 period as the benchmark for GDP growth. The cumulative decline of GDP relative to the baseline over two years would then reach 12.7 percentage points, and the cumulative drop in GDP level compared to 2023 would reach 19.8 percent.[3]

ii. Use of the latest domestic financial crisis experienced by the country in 2003/2004, caused by a shortage of foreign exchange. The cumulative drop in GDP reached (-8.6) percent over two years before a strong recovery in the third year.

25. The adverse scenario projections consider a suite of models, and the scenario is severe but plausible. These models were the IMF Global Macro-Financial Model (GFM) for the external variables and a Bayesian VAR (BVAR) developed for the domestic variables for this TA, including real GDP growth, CPI inflation rate, and 1-year Treasury bill rate.[4] The choice of explanatory variables was based on the structure of the Seychelles economy: (i) its status as a small open economy, (ii) its dependence on the flow of tourists from Europe and on consumption, and (iii) the degree of FC in the financial system. The explanatory variables include the euro area GDP growth rate, the 3-month Euribor rate, the oil price inflation rate, and the change in the EUR/SCR exchange rate. The adverse shock envisaged a 20 percent cumulative drop in GDP over 2024-26 (Figures 4 and 5).[5] The GDP shock would be 28 percentage points lower than the baseline output level and 2 standard deviations from the mean of the historical distribution. By comparison with the previous crises the country experienced, the severity of the scenario appears to be on the high side (i.e., a very severe scenario). Still, it might reflect the outcome of the materialization of external shocks without government and other public support.

Figure 4. Scenario severity from a historical perspective
(Real GDP in year Y0=100)



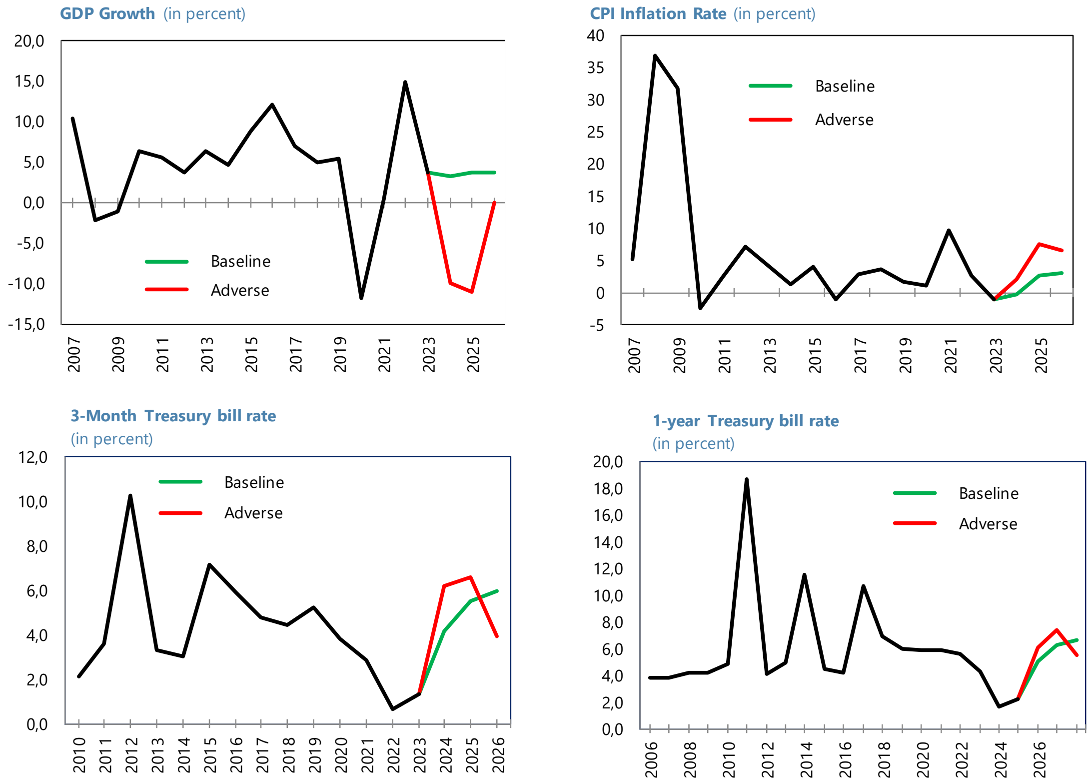
Source: Central Bank of Seychelles, IMF-WEO, and IMF staff calculations

[3] If the COVID-19 period 2020/21 and the subsequent rebound 2022/23 were excluded from the period of observation on account of their exceptional character, the standard deviation of the 2-year growth rate would be reduced from 9.9 percent to 8.7 percent and the 2 standard deviations from 19.8 percent to 17.4 percent.

[4] Annex I. Scenario calibration technical details

[5] Annex II. Macroeconomic scenarios for stress test

Figure 5. Macroeconomic baseline and adverse scenarios



Source: Central Bank of Seychelles, IMF-WEO, and IMF staff calculations

26. The TA mission encourages the FSS to further collaborate with the RSD to enrich the stress test macro projections or to request a dedicated TA on macroeconomic modeling. Currently, the FSS does not use any macroeconomic model to design the adverse scenario of the stress test. Using an integrated and comprehensive macroeconomic model, in tandem with building a Seychelles-specific real estate price index, would allow the FSS staff to fill their projection needs. For the projections of the external variables in an adverse scenario (worldwide or specific to the euro area or the US economy), the CBS could use the adverse scenarios published by the European authorities or the US Federal Reserve as part of their periodic ST exercises. [6]

[6] European Banking Authority European Systemic Risk Board; the adverse scenario of the latest European-wide stress test can be found at the following address: [Macro-financial scenario for the 2023 EU-wide banking sector stress test (updated on 17 March 2023) (europa.eu)]

B. Satellite model estimation

27. A range of satellite models had to be estimated to project income statement items in the stress-testing scenarios. The model estimates were embedded in the IMF stress testing tool, Workbox (WB), so that scenarios could be entered as inputs into the WB and translated there. To this end, the CBS staff shared several datasets, including monthly data: a dataset of aggregated time series on lending rates and deposit rates over 2010-2023 broken down by currency and a panel dataset covering the seven banks of the system over 2017-2023 with income statement items and NPL by currency and economic sectors. Both time series and panel data models were estimated at quarterly frequency after the conversion of monthly data to a quarterly frequency, corresponding to the frequency of GDP data. Depending on the dependent variables, the final dataset for the satellite model estimation comprised between 50 and 130 observations per model.

28. CBS staff's needs guided the choice of satellite models and estimation methods. Per their request, the mission focused on credit and foreign exchange rate risk, as well as the estimation of robust satellite models for credit risks and several income statement items.

29. The initial conduct of a range of unit root tests indicated that none of the dependent variables was non-stationary. This result confirmed the possibility of estimating models in levels and not with first differences. Therefore, there was no need to transform the dependent variables for model estimation purposes. Three criteria were used for the choice of the explanatory variables: (i) expected sign on the coefficient of the explanatory variables, in line with economic theory, (ii) level of the R-squared of the model, reflecting the capacity of the model to explain the variance of the dependent variable, and (iii) the statistical significance of the individual coefficients.

30. The TA estimated eight satellite models for the relevant variables. The mission estimated models for the following variables: lending rates on loans in SCR and FC, deposit rates for deposits in SCR and FC currency, growth in net fee and commission income, and credit risk (NPLs ratio) by economic sector. For each variable, we carried out a two-step process: (i) choice of the variable and (ii) structuring and estimation of models. Still, as data is collected and assessed, CBB should work further on the satellite models, leveraging the codes provided.

1. Lending rates

31. Lending rate estimation and projections are needed for two purposes. Net interest rate income is the largest source of profit for banks. Therefore, it is important to project lending rates accurately in a stress test adverse scenario. First, it is used for the projection of banks' net interest income in a stress scenario. Second, interest rate variables may be used as explanatory variables in credit risk satellite models. However, the source of the variable might differ between the two uses. While bank-by-bank panel data are needed for net interest income projections in a stress testing scenario, an aggregated interest rate series might be used to estimate credit risk satellite models to avoid endogeneity issues. It has to be noted that loans are mostly denominated with an adjustable interest rate in the Seychelles; therefore, an interest rate shock would be transmitted immediately to all borrowers.

32. The lending rates time series were used with a breakdown by currency. Descriptive statistics reveal a very high average level of lending rates on SCR loans over the period of estimation (Table 2). There is a 5 percentage point difference on average with the lending rate on loans in FC. However, there has been a marked narrowing of the spread between lending rates in SCR and FC since the monetary tightening engaged by large central banks (US Fed and the ECB) in 2022, with a current spread of 2.2 percentage points only in December 2023 (Figure 6). Lending rates in FC adjusted upwards sharply, while lending rates in SCR have remained flat. The difference between SCR deposit rates and FC deposit rates is smaller, with even a negative spread since the start of 2023 (Figure 7).

Table 2. Descriptive statistics: lending and deposit rates

Variable	Obs	Mean	Std. dev.	Min	Max
Lending rate (loans in rupee)	57	12.8	1.6	10.0	16.0
Lending rate (loans in FX)	57	7.5	.7	5.6	8.6
Rupee time deposit rate	57	3.7	.8	2.4	5.8
FX time deposit rate	57	1.7	.8	.99	4.3

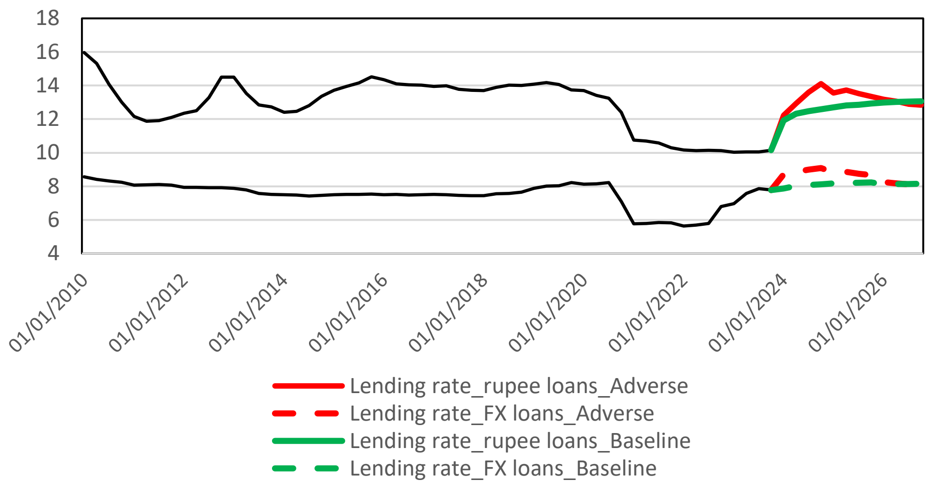
Source: Central Bank of Seychelles, and IMF staff calculations

33. The models for lending rates used different explanatory variables, with a better performance of the model estimating lending rates on loans in SCR. The explanatory variables of the model estimating the lending rate on loans in SCR included the lagged three-month Treasury bill rate, the CBS Deposit Auction Arrangement (DAA) rate, and the percentage change in the EUR/SCR, as the latter has an impact on the bank's cost of funding. The explanatory variables of the model estimating the lending rate on loans in FC included the lagged one-year Treasury bill rate and the three-month Euribor rate, i.e., the interbank market rate in the euro area. Every explanatory variable was found to have a positive effect on banks' lending rates. The R-squared of the model in SCR was significantly higher than the R-squared of the model in FC, reflecting the better performance of the former model in explaining the variance of lending rates on loans in SCR.

34. The lending rates are projected to increase more in the adverse than in the baseline scenario. In the adverse scenario, the lending rate on loans in SCR would increase by 4 percentage points to reach a peak of 14 percent at the end-2024, close to the level of 2019 and by 1.3 percentage points for the lending rate on loans in FC to 9.1 percent (Figure 6). The increase would be more moderate in the baseline.

Figure 6. Lending rate projections under the baseline and adverse scenarios

(in percent)



Source: Central Bank of Seychelles, and IMF staff calculations

2. Funding costs and deposit rates

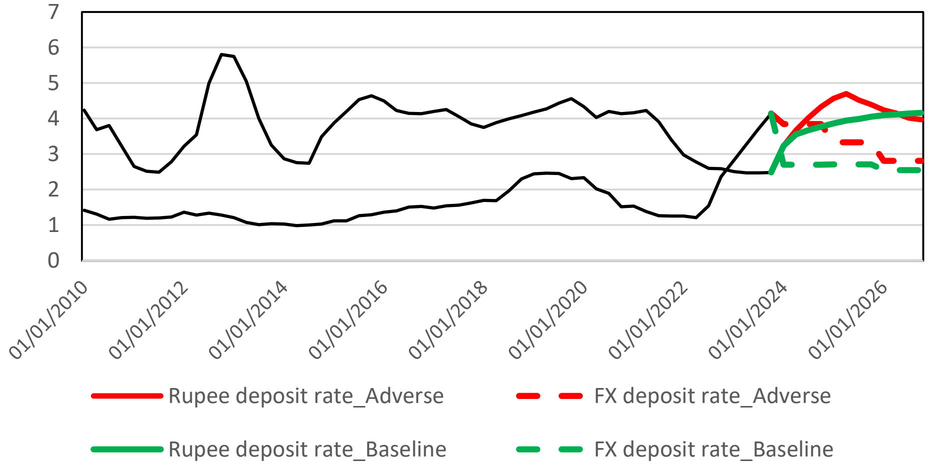
35. Time deposit rate time series were used with a breakdown by currency. The descriptive statistics show that deposit rates are on average significantly lower than lending rates, allowing banks to extract a large net interest margin (Table 2).

36. The methodology for estimating deposit rates in SCR and FC was the same as for lending rates. The explanatory variables included the lagged three-month Treasury bill rate for the SCR time deposit rate, and the three-month Euribor rate for the FC time deposit rate, with a pass-through comprised between 0.2 and 0.4, depending on the model. The coefficients of the explanatory variables were found to have a positive effect on banks' deposit rates.

37. Deposit rate projections in the adverse scenario display a diverging trend between SCR time deposits and FC time deposits. While the SCR deposit rate is projected to increase by 2.2 percentage points to 4.7 percent in 2025, FC deposit rates will start declining in 2024 (Figure 7).

Figure 7. Funding costs and deposit rates under the baseline and adverse scenarios

(in percent)



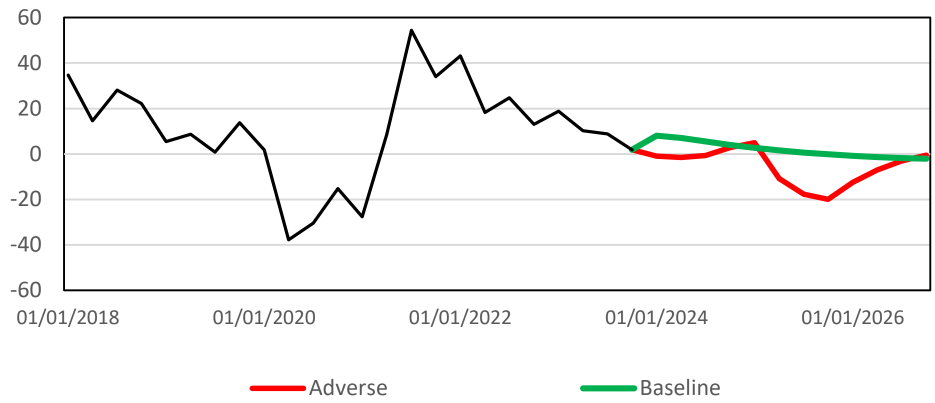
Source: Central Bank of Seychelles, and IMF staff calculations

3. Net fee and commission income

38. The year-on-year growth rate of the net fee and commission income was estimated with a dynamic fixed effect panel data model. The explanatory variables included the lagged dependent variable, the real GDP growth rate, the lagged 365-day Treasury bill rate, and the change in the EUR/SCR exchange rate. The latter variable was meant to capture a source of FX commissions for banks, such as currency conversion fees, resulting in FX volatility. The signs of coefficients are in line with expectations, with a positive effect on the GDP growth rate and on the change in the exchange rate. By contrast, the Treasury bill rate negatively affects the growth in the net fee and commission income.

39. The net fee and commission income growth projections show a decline equivalent to half of the decline experienced during the COVID-19 crisis. The trough of the average net fee and commission income growth would be reached in 2025, (-20) percent year-on-year, and the growth would remain negative until 2026 (Figure 8).

Figure 8. Net fee and commission income under the baseline and adverse scenarios
(in percent)



Source: Central Bank of Seychelles, and IMF staff calculations

4. Credit risk

40. The Seychelles banking system has just transitioned from Basel I to a Basel II standardized approach. All the figures used for this mission and results were based on the Basel II standardized approach. This means that the banks and the CBS use NPL ratios as the main credit risk variable and the national accounting standards to project provision flows. Although the NPLs ratio is a stock variable and is a rather backward-looking measure of credit risk, it was not possible to use or compute a more forward-looking or flow measure, such as default rate, due to the absence of data on loan write-offs and cure rates (Box 1).

Box 1. Default rate definition and calculation

The default rate is a flow concept. It is defined as the percentage of all outstanding loans that a lender has written off as unpaid after a prolonged period of missed payments.

Conceptually, the default rate can be derived from NPL stocks, gross loan stocks (*L*), write-off rates, and cure flows, according to the following formula:

$$dr_t = \frac{NPL_t - NPL_{t-1}(1-w_t) + CURE_t}{PL_{t-1}} = \frac{NPL_t - NPL_{t-1} + w_t NPL_{t-1} + CURE_t}{PL_{t-1}} \quad (1)$$

where dr_t is the default rate, PL_t the performing loan stock dynamics, $CURE_t$ the quarterly cure flow, and w_t the quarterly write-off rate, defined as write-off flows through *t* over NPL stocks at end of *t-1*.

However, in the Seychelles, there is no data on total cure flows and write-offs. Therefore, improving data availability would be a prerequisite for computing and using default rate series.

41. The TA mission made a request for a panel dataset, including a distinction between NPL ratios by economic sector and by currency, loans in SCR and FC. The CBS computed panel data at a quarterly frequency over 2017-2023 of outstanding loans and NPLs, broken down between 4 types of loans: mortgages, consumer loans, loans to financial institutions, and loans to non-financial corporations, differentiated between loans in SCR and loans in FC. However, the corresponding outstanding amount of loans in SCR or in FC were not provided, which prevented the IMF team from computing an NPLs ratio time series by currency. The possible breakdown was thus just by the economic sector. The CBS also provided a panel data set of specific provisions. Given the low level of the provisioning rate in Seychelles and the absence of time series on real estate prices, an ad hoc assumption had to be made under the adverse scenario whereby the provisioning rate would increase to 50 percent of new NPLs.

42. The NPL ratio was modeled as a function of the macroeconomic and financial variables that were included in the stress test scenarios.[7] As a result, the determinants of NPL ratios included the year-on-year real GDP growth rate and the lending rate. Although loans in FC made up 20 percent of total loans on average in the banking system and could create an indirect credit risk resulting from FX risk, the change in the exchange rate of the SCR against the EUR or the USD was not found significant on any of the NPL ratios. A panel data model was estimated with individual bank fixed effects to capture the effect of potential unobserved heterogeneity between banks.

43. Theoretical relationships between the credit risk variables and the macrofinancial variables guided the interpretation of the results. The year-on-year GDP growth rate is expected to reduce the credit risk of borrowers because it is associated with higher income, which increases borrowers' debt payment capacity. Lending rates are expected to have a positive effect on the NPLs ratio as they increase the debt burden for new loans or old loans with a floating interest rate, deteriorate loan quality, and slow down the production of new loans. Finally, the change in the FX rate was expected to have a positive effect on credit risk variables as an increase in the EUR/SCR exchange rate means a depreciation of the SCR, which increases the debt burden in SCR of the borrowers indebted in FC.

44. The model provided results that were in line with the predictions of economic theory. A set of macro variables yielded significant coefficients for that subset of variables. The real GDP growth rate was found to have a significantly negative effect on the NPLs ratio, as expected (the NPL ratio increases when the GDP growth declines), except for NPL ratios on consumer loans. The change in the lending rate was found to have a significant and positive impact on the NPLs ratio, as most loans in the Seychelles have an adjustable lending rate. Therefore, an increase in the lending rate would increase the debt burden associated with both new loans and the stock of existing loans. As regards the effect of the FX fluctuations with the EUR, in contrast to the team's expectations, a depreciation of the SCR was not found to have any significant and positive effect on the NPLs ratio, which includes the loans in FX.

45. The change in the NPL ratios was translated into flows of provisions for loan losses. The impact of the change in the NPLs ratio on the profit account depends on the provisioning rate of the inflows of NPLs and on the loss of interest income. To that end, the TA mission estimated a model that included the provisioning rate of the inflows of new NPLs as the dependent variable. The coefficients of the explanatory variables showed a weak correlation between provisioning rates and macrofinancial variables, a low statistical significance, and a low R-squared. Moreover, the estimated provisioning rate remained consistently low throughout the estimation period. That may be explained by the structural breaks brought about by the changes in regulation and forbearance measures, as well as banks' large reliance on collateral. Therefore, this model was not considered for the WB. No data was available to estimate a transition matrix presenting the probability of transition of NPLs from one category to another: substandard, doubtful, and loss. Instead, it was decided to apply an ad hoc assumption of a 50 percent provisioning rate of new NPLs in the adverse scenario. Given the average provisioning rate of total NPLs of 20 percent as of December 2023, this assumption was severe and implied a 30 percent decline in the valuation of banks' collateral.

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[7] Annex IV. Credit risk estimation technical details

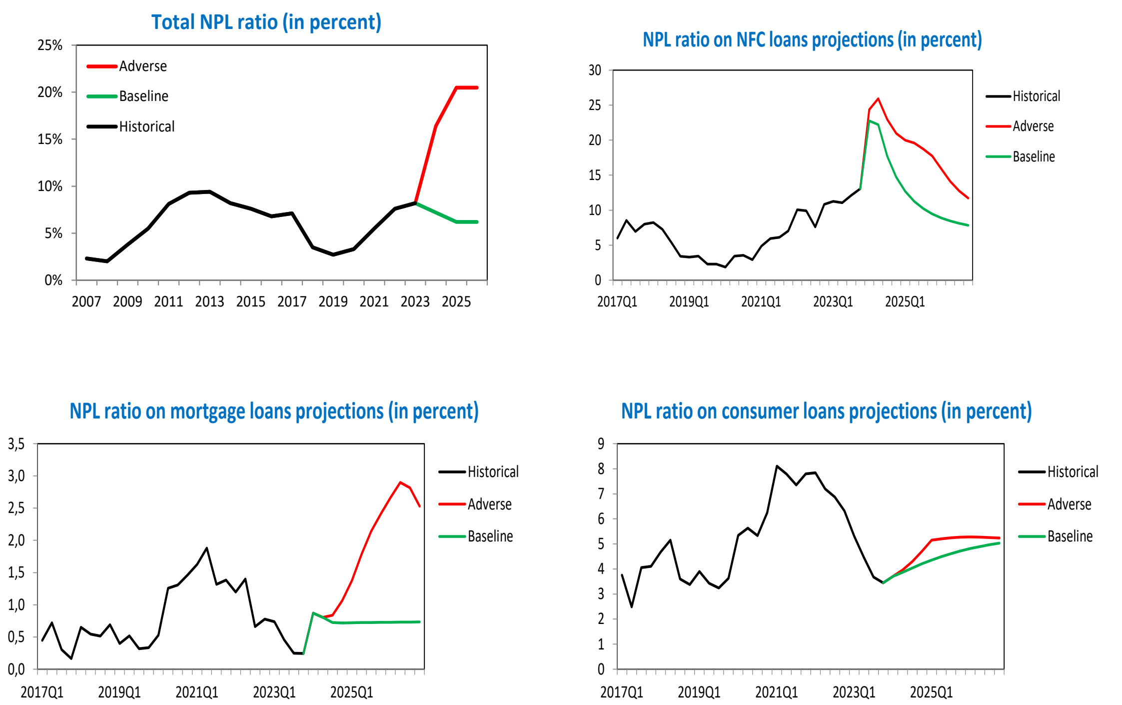
46. The link between the credit risk satellite models and the WB is ensured through the projections of new provision flows in the stress scenario. The annual change in the NPLs ratio times the provision rate times the amount of loans is used as an input in the WB to project monetary flows of new provisions in SCR for each year of the scenarios. Moreover, it was assumed that interest income from nonperforming loans was not accrued.

47. The TA mission stress test showed that banks would likely experience large increases in NPLs under the adverse scenario, impacting banks' profitability. The combined effects of the decline in real GDP growth and higher lending rates would double the level of the banking system's NPLs ratio from 8.2 percent in 2023 to 16.4 percent in 2024, and cause a further increase to 20.5 percent in 2025, a very high level compared to recent crises (Figure 9). The rise in NPL ratios would require additional provisions that would deteriorate bank profitability in the adverse scenario.

48. The mission also discussed how to conduct a reverse stress test. In a reverse stress test, the NPL ratio would have to increase by a factor of 2.6 to cause the banking system to become undercapitalized in the first year of the scenario with regard to the total CAR minimum requirement of 12 percent.

Figure 9. NPLs projections under baseline and adverse scenarios

(in percent)



Source: Central Bank of Seychelles, and IMF staff calculations

5. RWAs projections

49. A solvency stress test requires a robust projection of RWAs. As every bank in Seychelles implements the Basel II standardized approach, RWAs changes in a stress scenario depend on four factors: the growth in assets, the change in specific provisions, the increase in non-performing exposures, and the possible deterioration of the credit quality of performing exposures, subject to external rating.

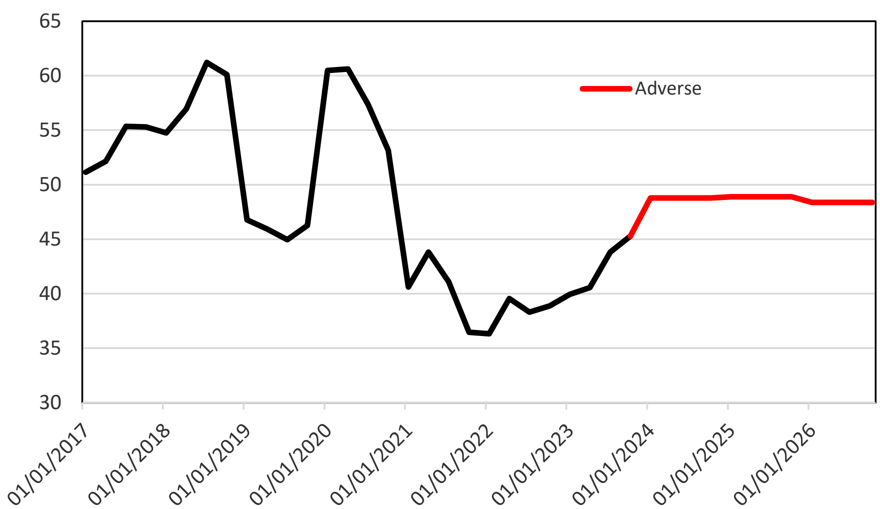
However, in Seychelles, no company has an external credit rating. As for the growth of assets, an assumption of a freeze in the size of banks' balance sheet size was applied in the adverse scenario, as banks would not be allowed to deleverage in the scenario.

50. An increase in the NPL ratio can have two opposite effects on RWAs. On the one hand, the specific provisions on the new defaulted loans are deducted from the stock of RWAs. On the other hand, according to the Basel framework regarding retail exposures, the switch to default should increase the risk weight depending on the exposure nature and the amount of specific provisions, e.g., from a risk weight of 35 percent to 100 percent for defaulted mortgage exposures net of specific provisions.

51. The mission estimated a panel data fixed effect model as a cross-check and applied the increase in risk weight to calculate the RWAs. This model's dependent variable is the RWA-to-total asset ratio, i.e., the risk density. The explanatory variable was simply the real GDP growth rate. A negative relationship is expected between the GDP growth rate and the risk density, as an improving economic situation should enhance asset quality and lower the associated risk weight. Based on the estimation, there would be an increase in the average risk density from 44 percent as of December 2023 to 49 percent in 2024 in the adverse scenario to capture loan migrations (Figure 10). The estimated increase in the risk weight was then applied to the projected assets in the adverse scenario. In addition, it was decided to apply the assumption of an increase in the risk weight of new defaulted mortgage loans net of specific provisions in the adverse scenario from an initial level of 35 percent to 100 percent. As shown in Figure 11, the impact of GDP growth on the average risk density was more than offset in the adverse scenario by the deduction of new provisions from the stock of RWAs in the adverse scenario, as the impact of the change in RWAs on the solvency ratio was found to be positive on a net basis. Moreover, loan migration was considered to be too small in the baseline scenario to have a significant impact on the average risk density.

Figure 10. Average risk density under adverse scenario

(in percent)



Source: Central Bank of Seychelles, and IMF staff calculations

C. Solvency stress test

52. The mission considered adjustments to the initial level of capital of banks to correct for potential excess in related party lending and uncertainty of collateral valuation. The adjustment for excess in credit concentration lending concerned two banks, whose total amount of credit concentration largely exceeds the national ceiling of 25 percent of Tier 1 regulatory capital. A negligible adjustment had to be made for a bank displaying a small provisioning shortfall.[8] These adjustments caused a decline in the initial aggregate CAR of the seven banks by 2.7 percentage points, from 18.6 percent to 15.9 percent in December 2023.

53. The showcased exercise considered three hurdle rates. First, two hurdle rates from the Credit Classification and Provisioning Regulations: (i) a Total Capital minimum requirement of 12 percent of RWAs, and (ii) a Tier 1 Capital minimum requirement of 6 percent of RWAs. In addition, the IMF mission used a leverage ratio (Tier 1/Total assets) minimum requirement of 3 percent as a backstop. The pre-tax profit of the banks projected in the adverse stress test was subjected to the effective tax year of the base year (2023), and banks were allowed to distribute 50 percent of their after-tax profit of the year in the form of dividends if they were projected to maintain a level of CAR above the minimum requirement across the scenario. Non-interest expenses, such as administrative costs, were assumed to grow in line with the national CPI inflation rate in both scenarios.

54. Credit risk in the loan book constitutes the largest risk factor for the banking system. In the adverse scenario, loss provisions are the largest contributor to the change in the banking system's capital ratio adequacy, with a (-8.4) percentage point contribution over the whole adverse scenario (Figure 11). It was not possible to isolate the part of credit risk increase resulting from indirect FX risk and the share of FX loans due to data constraints (see ¶41).

55. The impact of interest rate risk would be the second risk factor. Although banks are not supposed to accrue interest rate income on their NPLs in the adverse scenario, net interest income remains positive due to the interest rate margin. However, it would narrow compared to the initial period: the annual flow of net interest income would shrink by 27 percent between 2023 and 2025. Interest rate risk was assessed using time-to-repricing buckets. Different interest rate-sensitive assets and liabilities were lumped together in different buckets depending on their time-to-repricing. For instance, a loan and a deposit whose effective interest rate can change within the next month would be placed in the same bucket. Their difference would represent the "time-to-repricing gap." However, due to the limited size of this "time-to-repricing" gap and the absence of any trading book, the interest rate risk and repricing risk contributions to the change in CAR would be limited in the adverse scenario, at respectively (-0.4) percentage point and 0 percentage point of RWAs over the whole scenario.

56. The direct FX risk was limited in the adverse scenario mainly due to the limited net open FX position. In the adverse scenario, its contribution would reach (-0.1) percentage point of RWAs in 2024. This result would come from the small negative net FX position at the banking system level: (-24) Mn SCR in December 2023, equivalent to (-0.1) percent of assets and (-0.8) percent of capital; this means that the banking system would experience small direct market losses in the adverse scenario due to the SCR depreciation projection.

57. Banks do not have to set provisions against their domestic sovereign exposures per the Credit Classification and Provisioning Regulations. However, for stress testing purposes, the analysis assumes that the banks would have to set provisions against the credit risk increase associated with the

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[8] Based on the Financial Institutions (Credit Classification and Provisioning) Regulations 2010 as amended (hereafter referred to as Credit Classification and Provisioning Regulations), the required provisioning provision coverage rate is 1 percent for the pass category, 5 percent for special mention, 25 percent for substandard loans, 50 percent for doubtful loans, and 100 percent for loss loans.

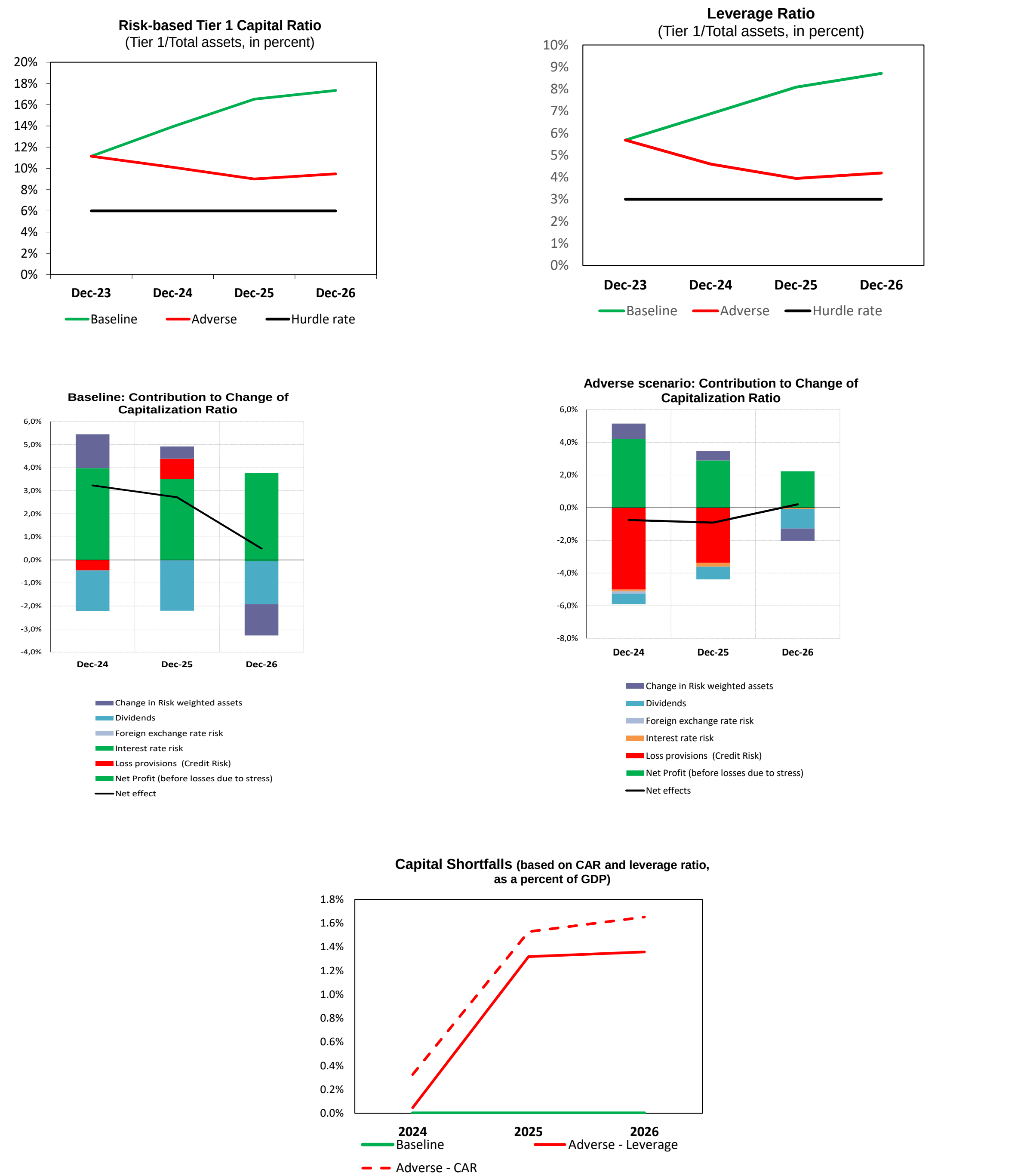
Seychelles' exposures reflected in the one-notch sovereign rating downgrade assumed in the scenario. Then, the provisions would have to increase by 39 Mn SCR, aggravating the undercapitalization of one bank in the adverse scenario.[9] This impact was not reflected in the final results presented below.

58. The TA reviewed with the authorities the WB's output, which showed that the CAR would decline by 1.7 percentage points in the adverse scenario between 2023 and 2025. The aggregate capital ratio would fall from 15.9 percent at the end-2023 (after the initial capital adjustments) to 14.2 percent in 2025 before stabilizing in 2026 (Figure 11). The decline in the Tier 1 ratio would be slightly more pronounced, with a fall by 2.1 percentage points between 2023 and 2025, from 11.2 percent to 9 percent. Two banks would become undercapitalized in this scenario with regard to the total capital adequacy ratio, with a total amount of needed recapitalization of 424 Mn SCR, equivalent to 1.7 percent of GDP. The results of the two weaker banks reflected their lower initial capital buffer compared to the minimum requirements. The foreign banks, with a Tier 1 ratio of 7 percent at the end of end-2025, are much more impacted than the domestic ones due to a different business model, larger exposure to the non-financial corporate sector, and a negative net open FX position for most of them. By contrast, the Tier 1 ratio of domestic banks would increase to 12.1 percent of RWAs in 2025, thanks either to a positive net open FX position or their exposure to the retail sector, which is less affected by the adverse scenario.[10]

[9] Basel II internal rating-based approach $Expected\ losses\ =\ PD\ *\ LGD\ *\ Exposure\ at\ default$, where PD stands for Probability of Default, and LGD stands for Loss given default, assumed to be 45 percent in this case, a standard assumption.

[10] Annex V. Solvency stress test results details

Figure 11. Solvency stress test, WB selected output



Source: IMF staff calculations
Note: Total adjustment to Tier II capital due to FX effect corresponds to the depreciation effect on subordinated liabilities denominated in foreign currency due to FX shock under stress; it is expected that this would only affect Tier II and total capital.

D. Liquidity stress test

59. The CBS staff will have to replicate and update the liquidity stress test when the liquidity data by currency becomes available. Liquidity risks are limited in the Seychelles banking system due to the banks' large reliance on stable deposits for their funding. However, some risks can materialize with liquidity in FC, which deserves close monitoring.

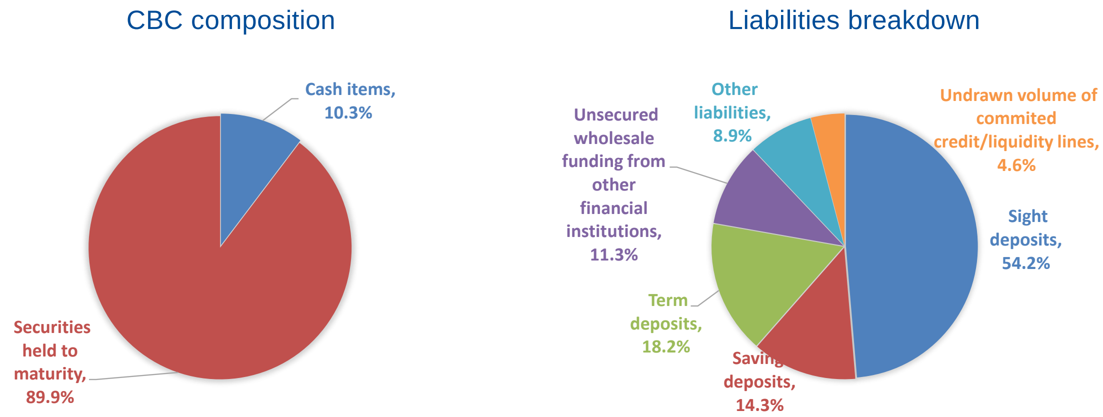
60. For this mission, a cash flow-based analysis was carried out on an aggregate basis. The currency breakdown was not available before or during the mission. The IMF mission shared a maturity ladder template that CBS staff members filled in for the seven banks comprising the banking system. The analysis did not use Liquidity Coverage Ratio (LCR) or Net Stable Funding Ratio (NSFR) templates because Seychelles has not implemented either. The cash-flow-based stress test leverages information on maturity profiles over a wide range of time buckets, from overnight to more than six months, to investigate potential maturity mismatches and assess the availability of bank counterbalancing capacity to offset net cash outflows. In this TA mission, December 2023 data was used in the analysis.

61. The outflow analysis was based on six maturity buckets aimed at capturing the comprehensive time structure of banks' cash in- and outflows. The maturity ladder was composed of the following buckets: 1 to 7 days, 8 to 15 days, 16 to 30 days, 31 to 90 days, 91 to 180 days, and more than 180 days. These tests assess banks' resilience to severe shocks characterized by run-off rates on funding sources calibrated by type and liquidation of assets subject to valuation haircuts. Specifically, the exercise captured (i) banks' liquidity needs derived from outflows, (ii) available standby liquidity from inflows, and (iii) buffers available to counterbalance liquidity gaps; the pace of deposit outflows slows down as the time horizon increases.[11] For each bucket, the amount of net outflows was compared to the amount of liquid assets available for sale to counterbalance funding gaps in the so called "counterbalancing capacity" (CBC), with cash subject to no haircut and held-to-maturity securities that would be eligible as collateral for central bank refinancing to a haircut of 20 percent.

62. The bulk of the banks' CBC is made of held-to-maturity securities, while sight deposits constitute most of their liabilities. Held-to-maturity securities make up 90 percent of their CBC, with the 10 remaining percent made of cash, as banks do not hold any trading portfolio (Figure 12, l.h.s.). On the liability side, sight deposits constitute more than 50 percent of their liabilities, followed by term deposits (Figure 12, r.h.s.). Therefore, banks do not rely a lot on wholesale funding. Despite this fact, descriptive analysis suggests that the volatility of the year-on-year growth in their total liabilities has been high since 2012, with a standard deviation of 133 percent.

[11] Annex VI. Liquidity stress test assumptions

Figure 12. Composition of assets and liabilities



Source: IMF staff calculations

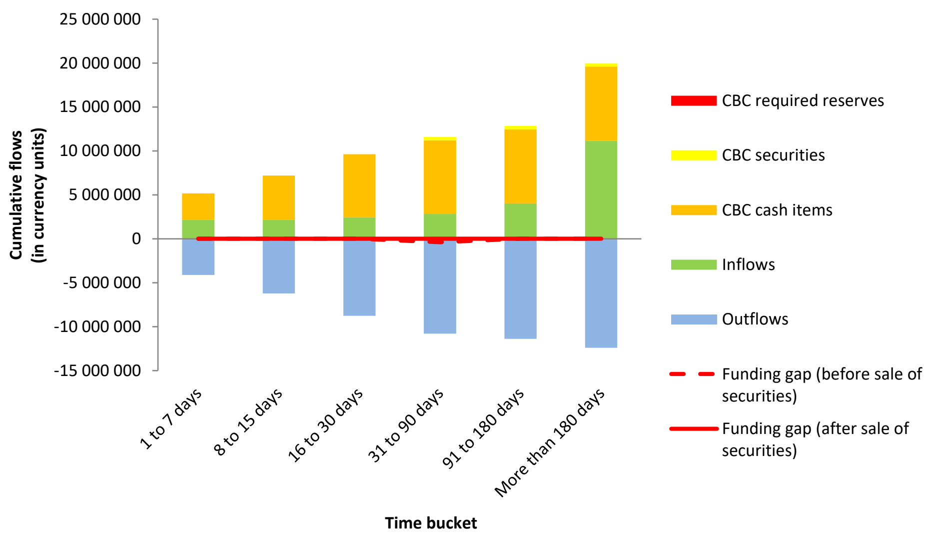
63. Deposit run-off rates and haircuts on liquid assets were set to be in line with international benchmarks. The exercise did not consider the recent bank liquidity crisis episodes in advanced countries such as the United States or Switzerland, given the large difference in the liquidity structure between banks in Seychelles and banks in advanced economies. Due to data constraints, the TA mission did not have access to liquidity parameters, such as deposit outflows, based on historical data specific to Seychelles. Therefore, for the cash-flow analysis, the parameters, in particular run-off rates for deposits, credit, and liquidity facilities, as well as haircuts on assets, were set in in line with the baseline scenario considered by the ECB, while assuming outflows of a period of six months and 40 percent of the total outflows happen in the first five days.[12] The existence and credibility of a Deposit Guarantee scheme must also be considered when calibrating the deposit outflow parameters. In the Seychelles, deposits are covered up to an amount of SCR 10,000 per account.

64. The results of the outflow analysis suggest that banks would be resilient to significant funding gaps in the short term, but one bank would have to sell a large amount of securities. Six banks would be able to meet substantial funding gaps at different maturity buckets from 1 day to more than 180 days by using their cash (SCR 8.4 bn). In addition to cash, one bank would have to sell its liquid assets for an amount of SCR 376 Mn, equivalent to 3.6 percent of its total assets (Figures 13 and 14). The sale of securities would take place between one and three months. This result suggests a solid liquidity position of banks. However, the reliance on held-to-maturity securities to fund short-term gaps for one bank could become a source of vulnerability in times of distress when banks might have to recourse to fire sales and register trading losses or go to the central bank for refinancing with a haircut. This factor can cause a negative feedback loop between liquidity and solvency risks in a crisis, even though the lack of active financial markets in Seychelles and the absence of large trading books at banks make this scenario implausible. As a high-level exploration exercise, in the case of the bank having to sell part of its security portfolio, the 20 percent haircut on its Held-to-Maturity portfolio would entail a market loss of SCR 94 Mn, equivalent to 0.9 percent of its total assets. This loss would deteriorate the Tier 1 ratio of this bank by 1.8 percentage points and would aggravate its undercapitalization in the first-year adverse scenario (Figure 15).

Figure 13. Cash inflows and outflows, and use of CBC in stress scenario, all Banks

[12] European Central Bank (2019), "ECB Sensitivity analysis of Liquidity Risk – Stress Test 2019 Methodological note".

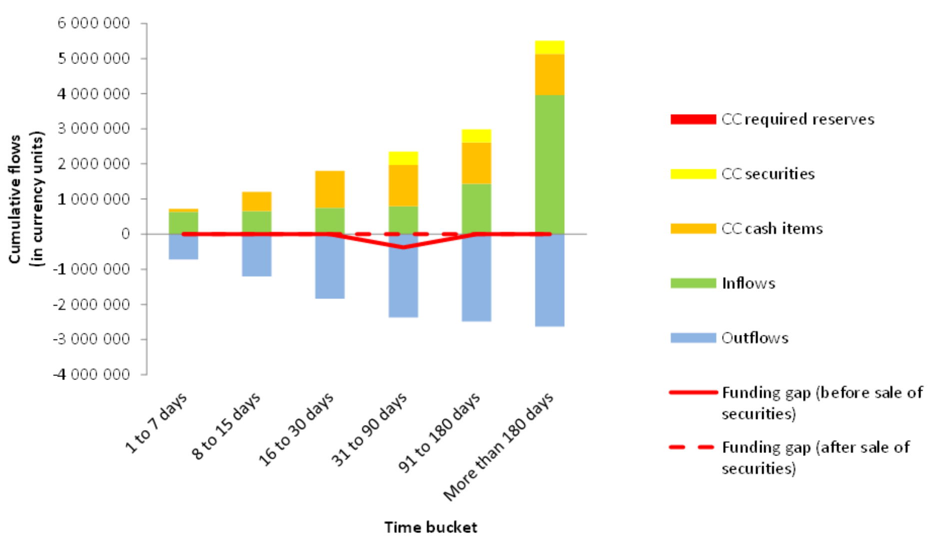
(in thousands SCR)



Source: Central Bank of Seychelles, IMF staff calculations
Note: A positive number indicates a liquidity surplus.

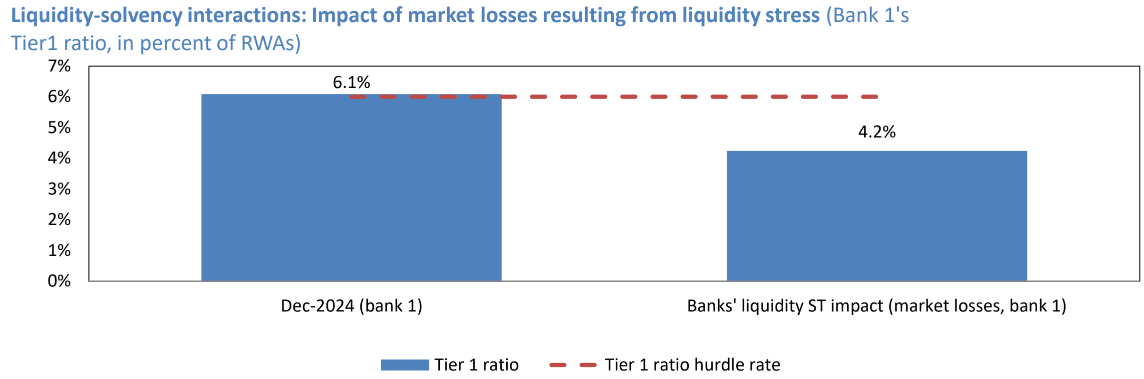
Figure 14. Cash inflows and outflows, and use of CBC in stress scenario, Bank 1

(in thousands SCR)



Source: Central Bank of Seychelles, IMF staff calculations
Note: A positive number indicates a liquidity surplus.

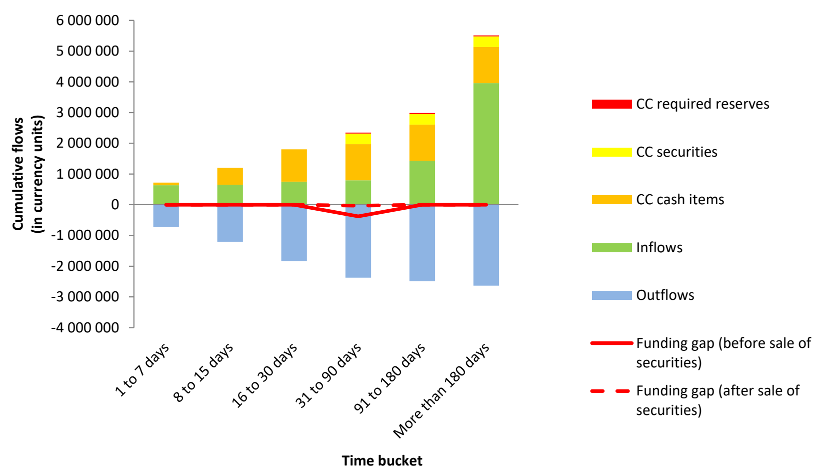
Figure 15. High-level exploration: Link between liquidity and solvency stress test results



Source: Central Bank of Seychelles, IMF staff calculations
Note: A positive number indicates a liquidity surplus.

65. **In a reverse stress test fashion, the TA mission calculated the level of the haircut on the amount of banks' held-to-maturity securities needed to force at least one bank to recourse to its required reserves to cover its funding gap.** The level of haircut was estimated to be 45 percent. At this level, the most vulnerable bank would have to sell the whole of its liquid security portfolio of SCR 631 Mn (6.1 percent of its total assets) for a market price after a haircut of SCR 347 Mn and to use part of its required reserves for an amount of SCR 29 Mn (Figure 16). For this bank, the 45 percent haircut on its Held-to-Maturity portfolio would entail a market loss of SCR 284 Mn, equivalent to 2.8 percent of its total assets. This loss would aggravate the undercapitalization of this bank in the adverse scenario.

Figure 16. Cash inflows and outflows, and use of CBC in stress scenario, Bank 1
(in thousands SCR)



Source: Central Bank of Seychelles, IMF staff calculations
Note: A positive number indicates a liquidity surplus.

II. Climate risk analysis

66. The TA mission aimed to build authorities' capacity to set up a CRA framework focused on physical risk. The mission covered the following topics: (i) introducing authorities to CRA and the reviewed IMF CRA framework for physical climate risk; (ii) an overview of the required data, with a detailed review of climate data, and held conversations with personnel from CBS and other agencies to identify possible country-specific data sources to consider in the analysis; (iii) reviewed a hands-on CRA analysis example using the programming language R, covering a climate diagnosis and a first damage estimation for tropical cyclones; (iv) considering the available data, set possible options for a CRA framework for Seychelles.

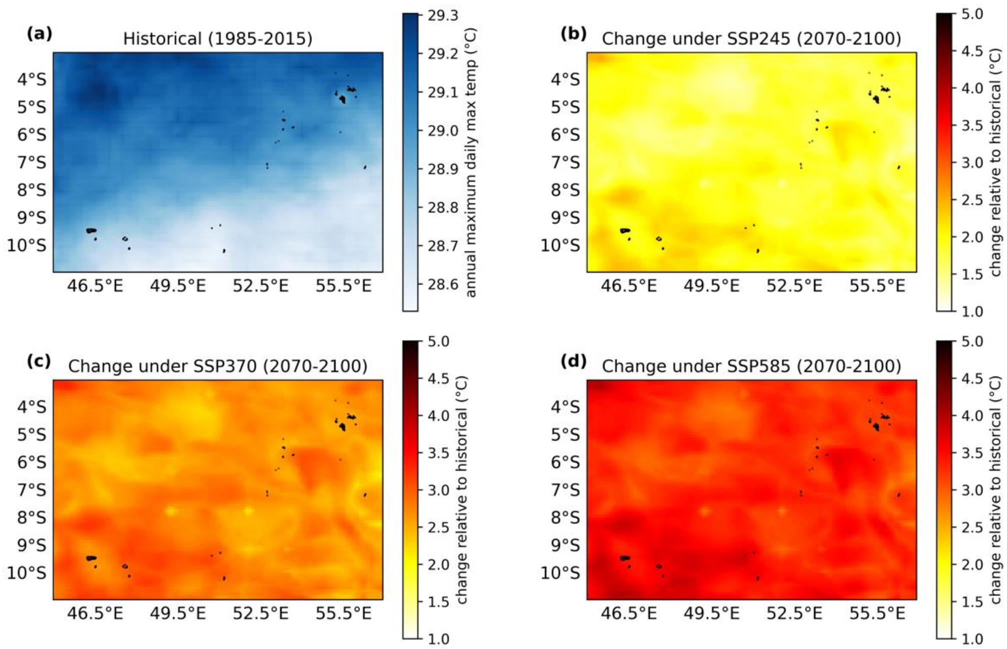
67. The TA work should allow the CBS to start work on a climate diagnosis and define the options for a first CRA framework. The first step for CRA should be conducting a climate diagnosis or exposure assessment; this process involves considering different climate hazard parameters and exposures, as well as other data sources and reports, and defining which are the most suitable for a CRA. The hazard projections and exposure are the main input, together with the damage function, to estimate damages; with these three components, considering data constraints and modeling capabilities, the authorities would be able to define CRA as a framework. The mission considered options for covering all three of the components required for the CRA.

A. Future climate scenarios in Seychelles

68. Future climate projections indicate that temperatures in Seychelles will increase significantly by 2070-2100. Future climate conditions in the region were analyzed using data from the Coupled Model Intercomparison Project (CMIP) for selected General Circulation Models (GCMs). The analysis shows that the temperature would increase in Seychelles under the different climate scenarios, SSP2-4.5, SSP3-7.0, and SSP5-8.5; where the scenarios denote the combination of the Shared Socioeconomic Pathway (SSP) and the Representative Concentration Pathway (RCP). The downscaled temperature data shows a spatially homogeneous rise at the end of the century (averaged over 2070-2100) for the Seychelles region in all three future scenarios (Figure 17) with respect to the historical period (1985-2015). In all scenarios, the average maximum temperature in the region would climb (Figure 18); considering the mean temperature increase for 2070-2100 with respect to the historical period, the temperature rise would be 1.9°C under SSP2-4.5, 2.7°C under SSP3-7.0, and 3.3°C under SSP5-8.5, respectively.

Figure 17. Historical temperature and change for end-century

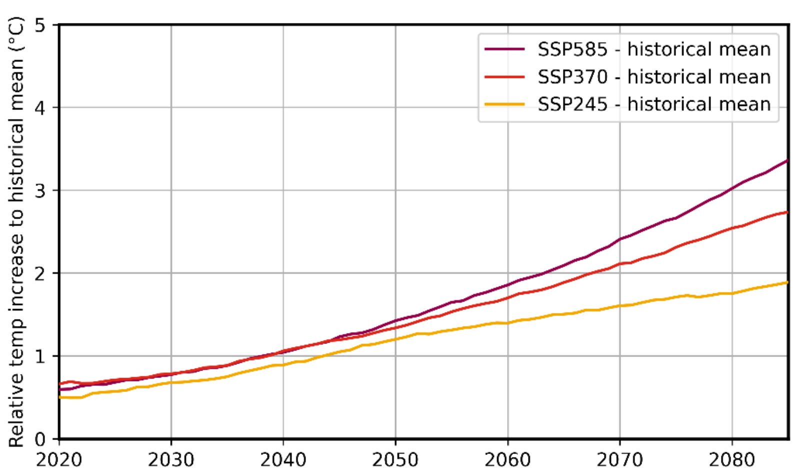
Degree Celsius, annual max. of daily max. temperature



Source: CMIP6, IMF staff calculations

Figure 18. Relative temperature increase

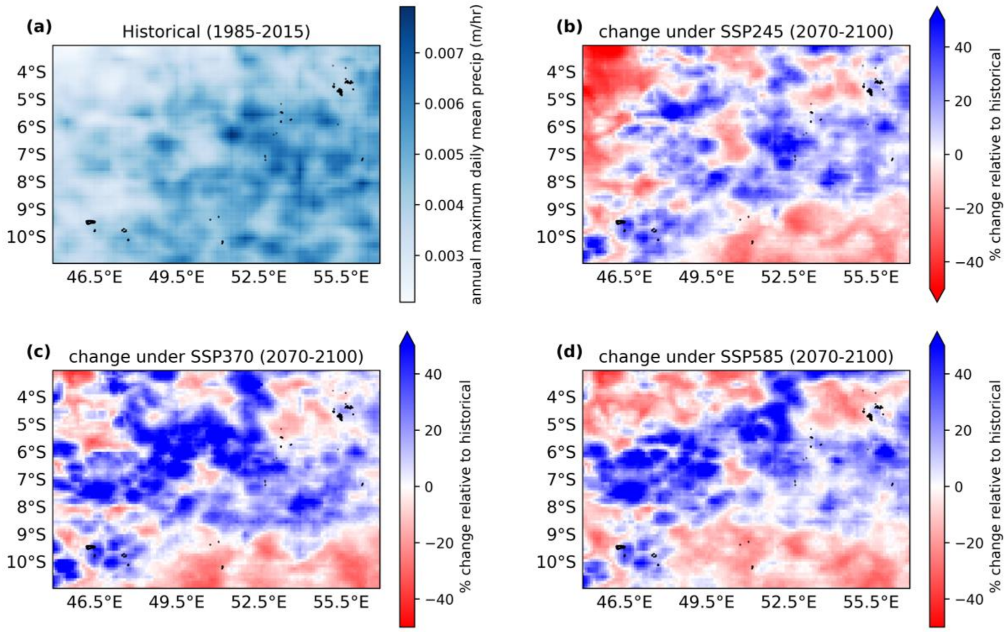
Degree Celsius, annual max. of daily max. temperature 30-year avg.



Source: CMIP6; IMF staff calculations

Figure 19. Historical precipitation and change for end-century

Meters per hour, annual max. of daily mean precipitation



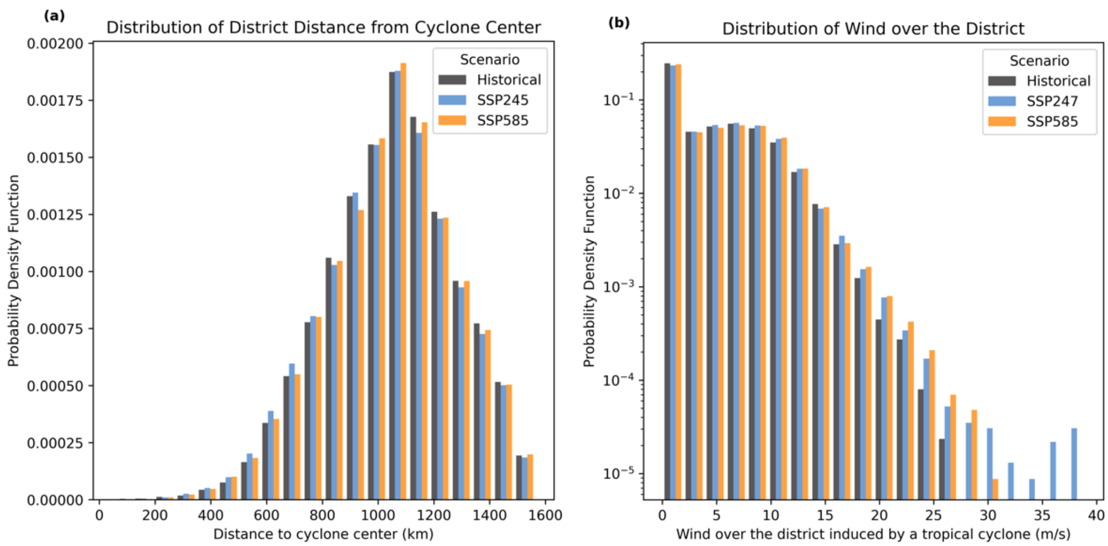
Source: CMIP6; IMF staff calculations

69. Future precipitation in Seychelles is projected to increase significantly maintaining a scattered pattern, while storm surge projections show no significant change. Regarding precipitation, historical downscaling shows a patchy pattern, with slightly enhanced precipitation in the region's eastern part; the downscaled future precipitation maintains the scattered pattern (Figure 19). The future precipitation change becomes clear with statistical significance (at the 10 percent level) when examining the mean relative change by taking the mean over the country for 2070-2100. The data shows an increase in precipitation rate (m/hr) by 12 percent under SSP2-4.5, 16 percent under SSP3-7.0, and 22 percent under SSP5-8.5. This increase is consistent with the rise in temperature based on the Clausius-Clapeyron relationship. The storm surge projections from the downscaled data are based solely on the projected wind speed from GCMs, and did not show any statistically significant change by the end of the century around Mahé.

70. Future projections indicate an increased probability of gale-force and potentially tropical-cyclone-force winds in Seychelles. The Imperial College Storm Model (ImpeRIal College Storm Model, IRIS) dataset of synthetic tropical cyclones was considered to explore further extreme storm implications. Figure 20 shows the tropical cyclone-related statistics using the District "English River" as an example. The average distance between this District and tropical cyclones is above 1,000 km, with the mean not changing in future scenarios. While the historical wind speed over the District induced by tropical cyclones is below damaging-force wind (26 m/s), under both SSP2-4.5 and SSP5-8.5, the probability of having gale-force winds (17 m/s) over the District increases. In particular, some tropical-cyclone-force winds above (33 m/s) may be seen in the future, not observed in the past; this holds for the whole country.

Figure 20. Comparison of the change in tropical cyclones statistics

Distance from tropical cyclone center to District in km (r.h.s.); Induced wind speed in m/s (l.h.s.)



Source: IRIS; IMF staff calculations

71. Engaging in collaborative efforts to integrate climate and financial expertise into a CRA is crucial. For future climate scenarios, the mission leveraged available data from CMIP and IRIS, which was interpreted, processed, and analyzed by the involved meteorologist. Furthermore, the interaction between mission members, authorities, and our climate expert was key to defining the inputs and options of analysis, i.e., a co-development between climate and financial experts, further enriched by the mission interactions with the local climate experts. Climate expertise is extensive and relevant in that the financial sector works on understanding their climate counterparts, as well as other fields that could be relevant, such as those linked to geographical information and disaster management.

B. Overview and identifying data for climate risk analysis

72. The mission showed the publicly available sources for conducting a CRA and explored possible country-specific data alternatives. The CRA requires data on hazard projections, exposures, and vulnerability, such as impact or damage functions. For hazard projections, the TA covered data downscaled from GCMs and identified data from SMA and MACCE that could also be used. For exposure, the TA covered global datasets and explored options for bank-specific exposure from CBS' Credit Information System (CIS) or NBS. On vulnerability, the mission explored data options from FSA and alternatives using global damage functions available from the literature.

73. Two datasets were used to explain climate data to authorities and showcase options for CRA. The downscaled data from CMIP6 models focused on Seychelles, encompassing the whole country (10 km) and Mahé for storm surge (1 km). Nine GCMs were utilized for downscaling projections, covering historical data from 1985 to 2015 and future scenarios up to 2100 for SSP2-4.5, SSP3-7.0, and SSP5-8.5. The downscaled variables included daily maximum temperature, daily mean precipitation, daily mean wind speed, and daily mean storm surge height. The second dataset from IRIS considers more than 6,000 synthetic tropical cyclones for historical and future scenarios (SSP2-4.5 and SSP5-8.5). Each tropical cyclone's wind profile was reconstructed, and the distance between the cyclone center and each of the 26 Districts[13] in Seychelles was calculated, along with the estimated wind speed in all Districts induced by the cyclone.

74. Country-specific climate projections are available in the country. The SMA is the country's main agency handling climate-related data. While their main focus has been on gathering historical climate data (with 30 years of observations available from the airport weather station and less information for other stations); the SMA has already produced climate projections for the country, which are included in the UNFCCC Third National Communication for different climate scenarios (SSP1-2.6, SSP2-4.5, and SSP5-8.5), and have additional studies with climate downscaling for Mahé that integrate country-specific considerations.

75. There are efforts from other agencies to understand the effects of climate change in the country, which can be used for a CRA. From MACCE, there is an opportunity to explore if data backing reports (e.g., Seychelles Coastal Management Plan 2019-2024) are available in an exploitable way, such that CBS is available to assign climate hazard risk factors to relevant exposures. Both authorities highlighted that coastal and flash flooding are among the most common phenomena; data on astronomical tides, sea level rise, and extreme precipitation indicators could be used to explore this type of event, together with future climate projections.

76. CBS should establish collaboration mechanisms to integrate country-specific hazards considerations from other agencies in the CRA. Given the available data from SMA, and similar efforts from MACCE, CBS should explore using these data for a CRA, which would require further collaboration between authorities. Incorporating country-specific projections, or other hazard assessments, would enhance the CRA framework and avoid shortcomings of using global datasets; although this might not be feasible in a first exercise, it should be aimed as the framework and collaborations mature.

77. CBS needs to establish collaboration or leverage existing forums to align the climate work with a broader climate perspective across the relevant agencies. SMA and MACCE pointed to several ongoing efforts, among them enhancing climate risk monitoring and developing hazard maps, which involves other agencies, such as the Disaster Risk Management Division. Other climate-related documents, such as the Nationally Determined Contribution, also state relevant physical risk climate implications. Therefore, it’s relevant for CBS to leverage and consider these ongoing works in their climate diagnosis and CRA framework.

78. The exposure component can leverage global publicly available datasets, country-specific or a mix of them. The mission reviewed possible datasets for estimating exposures to climate risk in the country, explaining the LitPop[14] dataset and the residential property building-level values dataset from the IMF[15] (Figure 21). On country-specific datasets, there are alternatives from NBS and other agencies for country-wise exposures and from the CIS in CBS for bank-specific exposures, which can be used alone or integrated to better represent the relevant exposures.

79. While NBS has limited geographical information for exposures, other sources might be available to refine a country-wise exposure. NBS does not account for great granularity in economic indicators, with geographical population distribution being the main one and surveys for which not all data

[13] The dataset also considers an estimate for "Other Islands". However, due to the high geographical dispersion within this group, the mission did not advise considering this in an analysis unless further geographical granularity becomes available.

[14] Eberenz, S., Stocker, D., Röösli, T., & Bresch, D. N. (2019). LitPop: Global Exposure Data for Disaster Risk Assessment: Asset exposure data for global physical risk assessment.

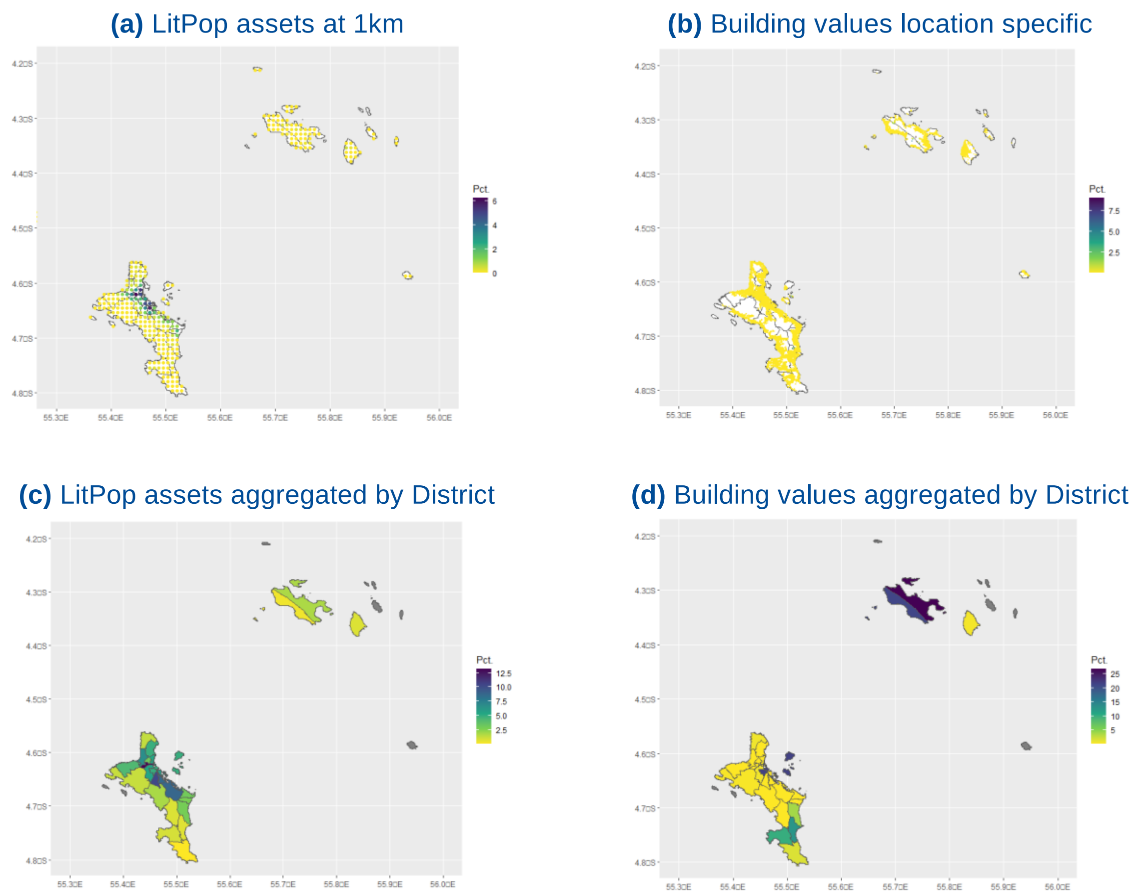
[15] Forthcoming IMF Working Paper: “Satellite-Based Mapping of Residential Properties for Climate Risk Assessment.”

covered might be representative at different administrative levels; this could be explored if no other alternatives are reasonable. NBS shared the District geographical delimitation (shapefiles), which can be used as the unit of exposure in an initial CRA, and pointed out to other possible sources to explore: (i) the Seychelles Planning Authority (SPA) for building values, and (ii) the Ministry of Lands and Housing (MLH), which holds WebGIS, which could be a relevant source to integrate further geographical considerations in a CRA.

80. The CIS could be a relevant source of information for exposures, but the data for CRA might not be available in the short term. From the CIS, the new data structure considers substantial granularity that could be used in a CRA, i.e., borrower, loan, and collateral data. The CBS personnel working with the CIS highlighted that some information might not be usable in the short-term and until the geographical optional fields become mandatory, and that there could be issues on fields related to geographical granularity from banks. If quality or volume prohibits using the geographical information from CIS, CBS could explore a specific request for banks on loans and collateral to appropriately characterize the exposure for relevant sectors.

Figure 21. Exposures geographical distribution for Seychelles

As percentage of the country total



Source: LitPop, Forthcoming IMF Working Paper: "Satellite-Based Mapping of Residential Properties for Climate Risk Assessment", and IMF staff calculations

81. CBS needs to identify options for country-specific data that can be used for the CRA. CBS should explore including country-specific exposures. On the one hand, CBS should assess (i) the timeline and concerns on CIS data and (ii) a possible request to the banks and compare against their timeline. On the other, CBS needs to explore alternatives mentioned in conversations with other agencies, such as the SPA, MLH, or survey data from NBS. This will allow us to identify if there is an opportunity to integrate country-specific considerations in a first assessment or in the future.

82. A CRA can use the available global damage functions in an initial stage. The mission discussed two damage functions: one that relates the flood depth to damages to physical assets and a second that relates wind speed to damage. These damage functions have been widely used in different studies and can be leveraged for an initial assessment; still, these damage functions might not capture country-specific considerations, such as building codes or past exposure to specific events. The insurance claims data from FSA should be useful for understanding or calibrating these impacts, as well as other possible registries on damages from climate events in other agencies. Further information on insurance claims from bank-related exposures could help to understand the links between these financial institutions.

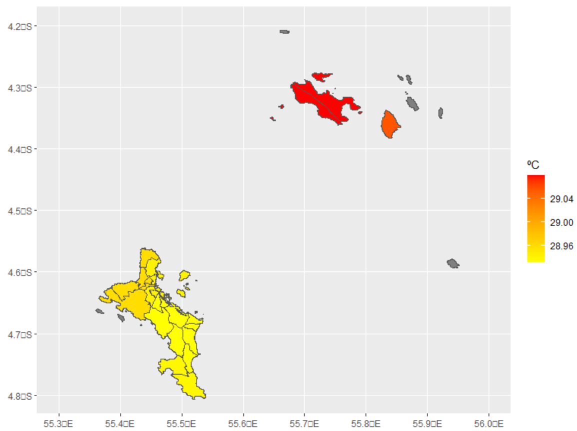
83. CBS should close data gaps on bank exposures and impacts of climate-related events. The CIS new structure and the CBS capacity to use this data make it an attractive source for the CRA. CBS should guarantee that as the data matures, the relevant geographical components, which are not mandatory, are accurate. In the long term, this could even be explored for a more granular assessment of individual borrowers' assessment. Similarly, insurance claims and other damage information registries would allow integration of country-specific considerations on damages and avoid using global studies; this could be explored at a regional level with peer countries to exacerbate the available data.

C. Conducting a climate risk analysis diagnosis

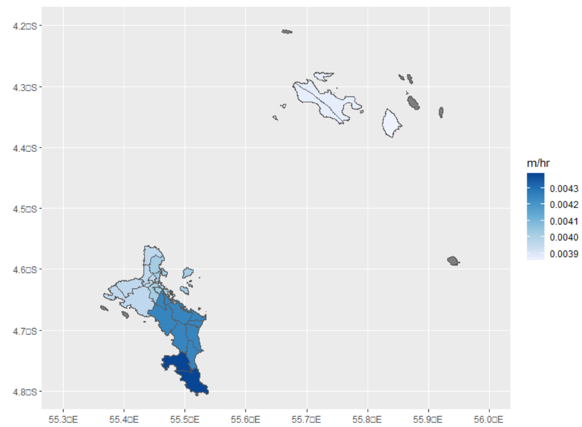
84. The TA explained the different geospatial data structures for climate and exposure data and how to handle them. Central banks or banks do not typically use the data required for a CRA, which usually integrates a geospatial component for hazard projections and exposures. The mission generally explained this type of data and how to deal with different formats, as well as specific characteristics that should be considered in the analysis, such as the Coordinate Reference System (CRS) of the data. While CBS should develop further capabilities in using software to handle geospatial data, preferably open source one such as R or Python, understanding the data structures should allow it to engage in meaningful collaborations with other agencies.

Figure 22. Historical (1985-2015) temperature and precipitation by District

(a) Degree Celsius, annual max. of daily max. temperature



(b) Meters per hour, annual max. of daily mean precipitation



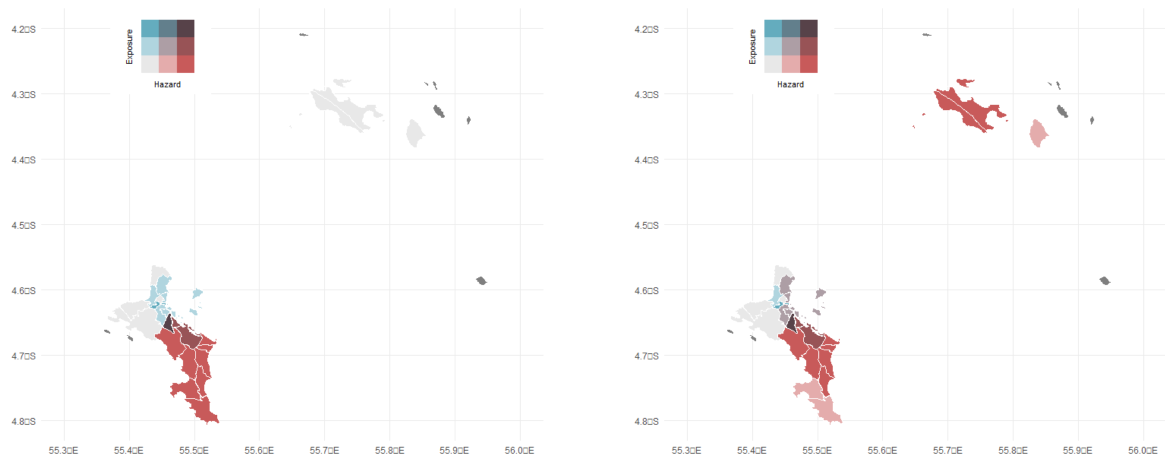
Source: CMIP6, and IMF staff calculations

85. The mission showcased the quantitative component of a climate diagnosis to be used as a starting point for estimating damages. The mission showed how to match climate and exposure data in a District-level analysis using publicly available datasets and the software R. The TA selected a District level as a geographical unit, given that country-specific data from banks, NBS, and other agencies is available at this level. For computing the parameters, the analysis focused on aggregating the data at the District level by matching lower resolutions to specific areas, identifying the lower resolution data within an area, or matching it to the nearest data point to the area (Figure 22 shows temperature and precipitation after aggregation). With both components in the same geographical granularity, CBS can conduct a diagnosis or exposure analysis (Figure 23), considering other reports and assessments, such as the ones available from SMA and MACCE. Although the mission's focus was at the District level, if there is data that adds value at a lower resolution, such as elevation or coastal flooding protections, a lower granularity is recommended.

Figure 23. Exposure assessment for precipitation by District

(a) Historical (1985-2015): Meters per hour, annual max. of daily mean precipitation

(b) SSP3-7.0 (2070-2100): Meters per hour, annual max. of daily mean precipitation

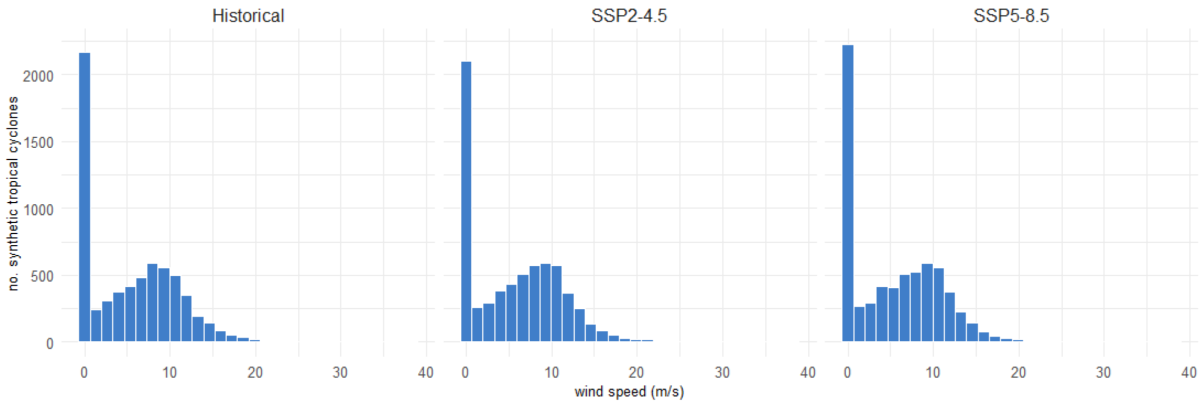


Source: LitPop, CMIP6, and IMF staff calculations

86. With data from tropical cyclones, the TA explained an option for estimating damages. Using the windspeed data from synthetic tropical cyclones from IRIS, the mission explained in R one possible approach to compute damages. For this, the approach considers computing the maximum wind speed for each tropical cyclone event in each District (Figure 24) and applying a wind speed damage function[16] to translate this into damages to physical assets or damage rates, i.e., the percentage damage of the total value of the exposed asset. Then, the approach incorporates the exposure to estimate the percentage damage for each event. Mean damages from all events and maximum damage go up with future climate conditions compared to historical conditions. The damage estimates should be complemented with historical events.

[16] Eberenz, S., Lüthi, S., & Bresch, D. N. (2021). Regional tropical cyclone impact functions for globally consistent risk assessments. Natural Hazards and Earth System Sciences, 21(1), 393-415.

Figure 24. Windspeed for historical and future conditions by event
Wind speed (m/s) mean of Districts



Source: CMIP6, and IMF staff calculations

87. CBS needs to define the hazards, exposure, and vulnerability to use in their CRA. The mission covered different datasets through the R code, provided the corresponding references, and included an example of how to integrate data at the District level using the data from NBS. Considering this, and after defining the other sources and relevant information from different agencies, the authorities should define which datasets are suitable for a first assessment.

88. Developing the capacity to use data would allow CBS to collaborate more leanly and innovate in its CRA. Understanding the data and developing expertise in using it would allow CBS to create meaningful collaborations with other agencies and improve its CRA approach. Financial sector experts and climate experts would collaborate more closely when they can speak on common terms. The mission's R analysis and the data details should allow CBS personnel to take the first step in this direction; to this end, CBS personnel would benefit from further assistance in using R or similar open software.

D. Set options for a climate risk analysis framework

89. The options for a CRA framework were contextualized with the available data and possible future data sources. The mission considered the possible options for a CRA framework, which, in a first exercise, should rely on data sources that are currently available or would become available in the short term from different agencies. These data sources covered the three components for estimating damages: hazard projections, exposures, and vulnerability. The mission showcased data alternatives for the three components, which, or similar, can be used if there is a lack of country-specific considerations. Some IMF recent approaches: Philippines FSAP considers a macro approach with 50,000 tropical cyclones; Mexico FSAP considers a macro approach with deterministic events for an extreme season; and Maldives FSAP considers a macro-micro from coastal flooding events. [17, 18, 19]

[17] Philippines: Financial Sector Assessment Program-Technical Note on Bank Stress Test for Climate Change Risks (imf.org)

[18] Mexico: Financial Sector Assessment Program-Technical Note on Climate Risk Analysis (imf.org)

[19] Maldives: Financial Sector Assessment Program-Technical Note on Bank Stress Testing and Climate Risk Analysis (imf.org)

90. A CRA macro or micro framework should consider the available data and modeling capabilities. Depending on the granularity of the exposures and the modeling capabilities to link impact into macro variables, the mission discussed two main approaches: (i) a macro approach, which considers country-wise exposures and leverages a macro model to link damages to macro variables, and (ii) a micro approach which considers bank-specific exposures which are impacted by the climate considerations. Depending on the data, the approach could be something in between when considering country and bank-specific assumptions to model the exposures.

91. There are options for the three components to estimate damages, and the CBS needs to consider this to define the framework. From the discussions with CBS and other agencies, the mission identified several options of data for a CRA: (i) For the hazards projections, an initial framework could consider the event-based considering synthetic tropical cyclones; still, authorities should explore other options, such as coastal flooding or flash flooding; (ii) for the exposures, the CIS could provide banking sector specific exposure, but the timeline and quality needs to be assessed, other options are global datasets or country-specific information that would fit into a macro approach; (iii) on vulnerability, in a first exercise the aim should be to use global damage functions, and incorporate country-specific considerations, as they become available.

Conclusion

92. While maintaining a commendable level of stability, the mission worked with CBS to display several vulnerabilities linked to credit risk, concentration risk, and FX risk. Despite a substantial projected decline in the aggregate Capital Adequacy Ratio under the adverse scenario, the amount of recapitalization needs would remain manageable due to a solid initial level of capitalization.

93. Moving forward, the CBS stress testing framework requires enhancements in several areas. The primary prerequisite would be to address data issues, including the breakdown of credit risk series by currency of denomination, as well as systematically compiling and assessing the required data; this would allow to improve the solvency stress, conduct of liquidity stress test by currency, and the design of adverse stress testing scenarios in a more consistent and integrated way.

94. The CBS must expedite the work on CRA. While the mission provided various elements for an initial CRA, authorities need to explore these options, establish timelines, and decide on data and framework choices. As progress is made on the recommendations, a follow-up mission could assist in moving the CRA towards implementation. The goal should be to establish an initial framework that can be refined over time.

95. The mission delivered tools and codes that would allow CBS to improve its ST framework and start with the CRA. On the ST, the mission discussed the WB for a solvency stress test, the different required satellite models, and the cash-flow template for liquidity, delivering the corresponding Excel-based tools and codes to authorities, which should allow CBB to develop and refine their assessment. On the CRA, the mission used publicly available data that would be provided to authorities in a granular and aggregate format, as well as R codes, to start with the CRA. In this regard, CBS personnel would benefit from additional support on using open software for both the ST and CRA. The mission foresees a CRA follow-up mission for implementation.

96. The TA mission discussed the recommendations and possible dissemination at the closing meeting. During the meeting, the mission discussed all the recommendations for both the ST and CRA. Also, the IMF dissemination for capacity development and the authorities could consider publishing the TA report and describing the process for this.

Annex I. Scenario calibration technical details

The stress scenario provides the basis of all the stress test exercise projections. The Seychelles, as a small open economy, is best modeled on the basis of a two-country framework with domestic (endogenous) and external (exogenous) variables. The details of the econometric analysis are outlined below.

The adverse scenario projections were obtained through the combination of external projections given by a world economy structural model and a specific model estimated by the mission for Seychelles. The adverse scenario would span over three years, starting in 2024. It corresponds to a "stagflationary" scenario. The projections concerning the euro area came from the latest update of the Global Macrofinancial Model (GFM). They imply a severe recession in the euro area in 2024, with a decline in GDP by close to 3 percent. However, GFM does not include Seychelles. That is why the TA mission had to estimate a Seychelles-specific Bayesian VAR model (BVAR), with Minnesota prior. The model included 4 endogenous domestic variables: Seychelles' year-on-year GDP growth, the CPI inflation rate, the 182-day Treasury bill rate, and the 365-day Treasury bill rate. The model included four explanatory variables: the euro area GDP growth, the 3-month Euribor rate, the oil price inflation in USD, and the change in the EUR/SCR foreign exchange rate. The model was estimated over the 2011-2023 period at a quarterly frequency (Table 3).

The projections given by the BVAR model are in line with the range given by the benchmarks in terms of degree of severity. The projected path of the Seychelles GDP growth obtained through the BVAR estimation would be equivalent to a 2 standard deviation shock, with a cumulative decline in GDP over two years by 20 percent (with the following GDP growth path: (-9.9) percent in 2024, (-11.0) percent in 2025, 0 percent in 2026 (Figure 25).

Table 3. Bayesian VAR Estimates

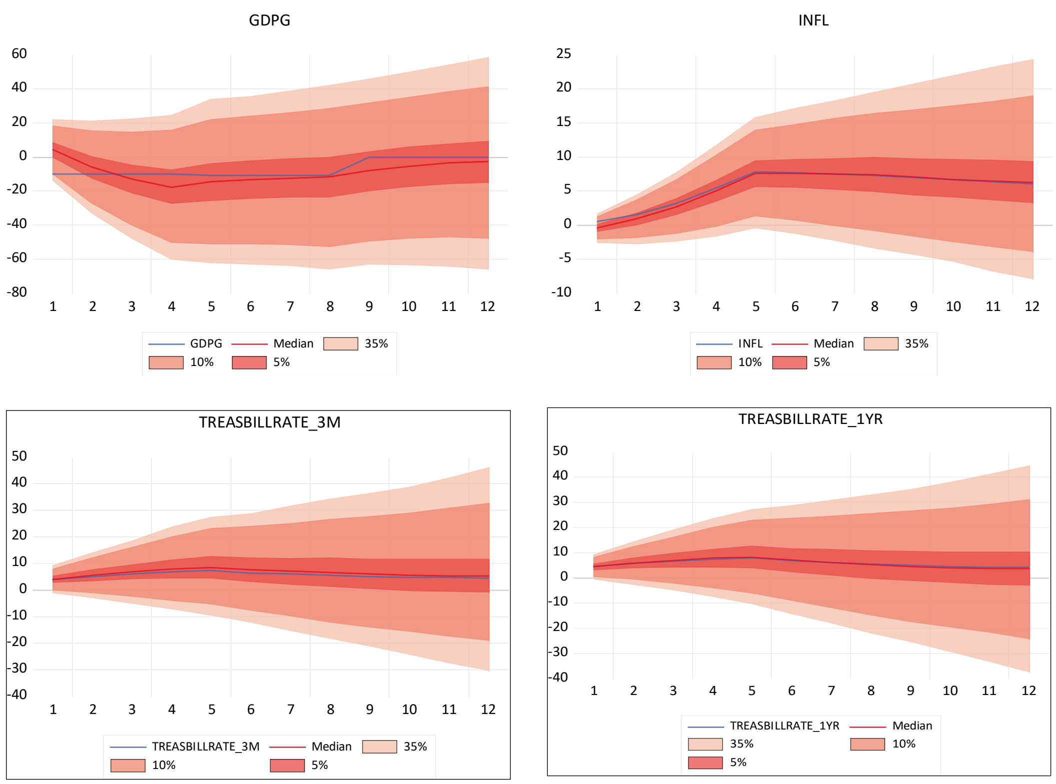
Bayesian VAR Estimates
Date: 05/07/24 Time: 10:58
Sample (adjusted): 2011Q2 2023Q3
Included observations: 50 after adjustments
Prior type: Litterman / Minnesota
Initial residual covariance: Univariate AR
Constant included in covariance calculation
Hyper-parameters: Mu1: 1, L1: 0.1, L2: 0.99, L3: 1, L4: inf
Standard errors in ( )

	GDPG	INFL	TREASBILLRATE_1YR	TREASBILLRATE_3M
GDPG(-1)	0.713564	0.003655	0.012793	0.014731
	(0.08177)	(0.00956)	(0.02270)	(0.02315)
INFL(-1)	-0.041111	0.921053	-0.118686	-0.102176
	(0.50572)	(0.05972)	(0.14132)	(0.14413)
TREASBILLRATE_1YR(-1)	0.020926	0.063442	0.906401	-0.070224
	(0.29228)	(0.03440)	(0.08225)	(0.08340)
TREASBILLRATE_3M(-1)	0.076071	0.035558	-0.109055	0.885599
	(0.29395)	(0.03459)	(0.08224)	(0.08439)
C	-0.891476	-0.425370	1.401127	1.207319
	(2.73734)	(0.32236)	(0.76586)	(0.78033)
EARGDPG	1.627483	0.024217	-0.041221	-0.023581
	(0.37849)	(0.04454)	(0.10578)	(0.10788)
OIL_INFL(-1)	-0.003438	0.010509	-0.003510	-0.002770
	(0.03385)	(0.00398)	(0.00946)	(0.00965)
SCREURG(-1)	0.012126	0.032418	0.019454	0.018260
	(0.08073)	(0.00950)	(0.02254)	(0.02299)
EURIBOR3M	-0.633261	0.060620	0.045491	0.090575
	(1.28529)	(0.15126)	(0.35928)	(0.36640)
R-squared	0.331808	0.896773	0.610040	0.503316
Adj. R-squared	0.201429	0.876631	0.533950	0.406402
Sum sq. resids	3724.209	28.32121	206.4841	227.8098
S.E. equation	9.530706	0.831120	2.244147	2.357188
F-statistic	2.544949	44.52281	8.017371	5.193431
Mean dependent	5.031007	3.211838	5.846200	4.473943
S.D. dependent	10.66518	2.366252	3.287269	3.059483

Source: IMF staff calculations

Note: EARGDPG denotes the year-on-year euro area GDP growth rate, OIL_INFL the year-on-year USD Brent price inflation rate, SCREURG the percentage change in the euro-rupee exchange rate and EURIBOR3M the level of the 3-month Euribor rate.

Figure 25. Bayesian VAR projections



Source: IMF team calculations

Note: GDPG denotes the year-on-year real GDP growth rate, INFL the year-on-year CPI inflation rate, TREASBILLRATE_3M the 182-day Treasury bill rate and TREASBILLRATE_1YR the 365-day Treasury bill rate.

Annex II. Macroeconomic scenarios for stress test

Table 4. Macroeconomic scenarios for stress test

Table 2a: External assumptions (in percent)

		Realized			Proj.	
	2021	2022	Y0=2023	Y1=2024	Y2=2025	Y3=2026
Euro area GDP growth						
Baseline	5.9	3.4	0.4	0.8	1.5	1.4
Adverse	5.9	3.4	0.4	-3.0	0.2	1.7
3-month Euribor rate						
Baseline	-0.5	0.3	3.4	2.9	2.9	2.5
Adverse	-0.5	0.3	3.4	6.0	4.7	3.3
US GDP growth rate						
Baseline	5.8	1.9	2.5	2.7	1.9	2.0
Adverse	5.8	1.9	2.5	-1.9	1.0	2.7
Oil price growth						
Baseline	65.8	39.2	-16.4	-2.5	-6.3	-4.2
Adverse	65.8	39.2	-16.4	20.1	0.2	2.1

Table 2b: (Seychelles-specific) domestic variables (in percent)

	Realized		Est.	Proj.		
	2021	2022	Y0=2023	Y1=2024	Y2=2025	Y3=2026
GDP growth						
Baseline	0.6	15.0	3.7	3.2	3.8	3.8
Adverse	0.6	15.0	3.7	-9.9	-11.0	0.0
CPI inflation rate						
Baseline	9.8	2.6	-1.0	-0.2	2.6	3.1
Adverse	9.8	2.6	-1.0	2.0	7.5	6.6
EUR/SCR exchange rate change (+ means depreciation of the Seychellois rupee)						
Baseline	20.1	15.1	15.2	0.0	0.0	0.0
Adverse	20.1	15.1	15.2	22.2	22.2	22.2
3-month Treasury bill rate						
Baseline	2.9	0.6	1.4	4.2	5.5	6.0
Adverse	2.9	0.6	1.4	6.2	6.6	4.0
1-year Treasury bill rate						
Baseline	4.3	1.7	2.2	5.0	6.2	6.7
Adverse	4.3	1.7	2.2	6.0	7.4	5.5

Source: Central Bank of Seychelles, IMF-WEO, and IMF staff calculations

Annex III. Satellite models estimations

Table 5. Estimation of models for lending rates

Item	Lending rate (loans in rupee)	Lending rate (loans in FX)
3-month Seychellois Treasury bill rate	0.28***	
(lagged by 1 period)	(5.08)	
Central bank deposit rate (DAAR)	0.14**	
	(2.32)	
1-yr Seychellois Treasury bill rate		0.09***
(lagged by 1 period)		(2.97)
3-month Euribor rate		0.26***
		(2.87)
EUR/SCR exchange rate change	0.01	
	(1.43)	
Constant	10.99***	6.89***
	(39.61)	(33.17)
R-square	0.54	0.19
# of banks	(aggregate data)	(aggregate data)
# of observations	50	56

Source: IMF staff calculations
t-statistics in parentheses.
* Denotes significance at the 10 percent level; ** at the 5 percent level; and *** at the 1 percent level.

Source: Central Bank of Seychelles, and IMF calculations

Table 6. Estimation of models for deposit rates

Item	Deposit rate (deposits in rupee)	Deposit rate (deposits in FX)
3-month Seychellois Treasury bill rate	0.23***	
(lagged by 1 period)	(11.03)	
3-month Euribor rate		0.42***
		(5.66)
Constant	2.74***	1.52***
	(25.31)	(17.84)
R-square	0.69	0.37
# of banks	(aggregate data)	(aggregate data)
# of observations	56	57

Source: IMF staff calculations

t-statistics in parentheses.

* Denotes significance at the 10 percent level; ** at the 5 percent level; and *** at the 1 percent level.

Source: Central Bank of Seychelles, and IMF calculations

Table 7. Estimation of model for net fee and commission income

Item	NFC income growth
Lagged dependent variable	0.56***
	(4.35)
Yoy real GDP growth	0.68**
	(2.21)
1-yr Seychellois Treasury bill rate	-1.68
(lagged by 1 period)	(-1.01)
EUR/SCR exchange rate change	0.25**
(lagged by 1 period)	(2.12)
Constant	10.19
	(1.25)
Bank fixed effects	Yes
R-square	0.54
# of banks	7
# of observations	130

Source: IMF staff calculations

t-statistics in parentheses.

* Denotes significance at the 10 percent level; ** at the 5 percent level; and *** at the 1 percent level.

Source: Central Bank of Seychelles, and IMF calculations

Table 8. Estimation of models for credit risk

(Dependent variable: Logit transform of NPLs ratio)

VARIABLES	(1) Tot NPLs	(2) NFC NPLs	(3) Mort. NPLs	(4) Cons. NPLs
Lagged dependent variable	0.84***	0.85***	0.89***	0.83***
	(16.55)	(16.00)	(21.98)	(6.10)
Yoy GDP growth rate	-0.01***	-0.01**	-0.01**	
(contemporaneous or lagged)	(-2.4644)	(-2.50)	(-2.38)	
Lending rate	0.02***	0.02***	0.04***	0.04***
(lagged by one or two periods)	(2.51)	(2.97)	(9.15)	(3.59)
Constant	-0.51***	-0.50***	-0.98***	-0.91***
	(-4.81)	(-3.53)	(-5.86)	(-2.93)
Bank Fixed effects	Yes	Yes	Yes	Yes
R-square	0.65	0.68	0.68	0.48
# of banks	7	7	7	6
# of observations	158	140	93	157

Source: IMF staff calculations

t-statistics in parentheses.

* Denotes significance at the 10 percent level; ** at the 5 percent level; and *** at the 1 percent level.

Source: Central Bank of Seychelles, and IMF calculations

Table 9. Estimation of model for RWAs

(Dependent variable: RWAs-to-total-asset ratio)

VARIABLES	(1) Risk density
Yoy GDP growth rate	-0.05
	(-1.17)
Constant	48.24***
	(360.78)
Bank Fixed effects	Yes
R-square	0.75
# of banks	7
# of observations	196

Source: Central Bank of Seychelles, and IMF calculations

Annex IV. Credit risk estimation technical details

In order to ensure that the credit risk model only produces predictions for the NPL ratio between 0 and 1 (or, equivalently, between 0 and 100 percent), the following logit transformation was applied to the original NPL ratio:

$$Y = \ln\left(\frac{NPL\ ratio_{it}}{1 - NPL\ ratio_{it}}\right) \quad (1)$$

The logit-transformed NPL ratio is then assumed to be a linear function of the different (exogenous) macroeconomic and financial factors mentioned above. Therefore, the estimated model can be expressed as:

$$Y_{i,t} = \alpha + \mu_i + \rho Y_{i,t-1} + \beta X_t + \epsilon_{i,t} \quad for\ t = 1, \ldots, T\ and\ i = 1, \ldots, N \quad (2)$$

where $Y_{i,t}$ is the logit transform of the NPL ratio for bank *i* at time *t*, X_t is a vector of macroeconomic and financial variables, μ_i denotes bank-specific but time-invariant fixed effects, $\varepsilon_{i,t}$ is an independent and identically distributed error-term, and α, the intercept, ρ and vector β are parameters to be estimated.

More specifically, as an example, the model of the NPL ratios for each type of loans had the following form:

$$Y_{loantype_{i,t}} = \alpha + \mu_i + \rho Y_{loantype_{i,t-1}} + \beta_1 \Delta GDP_t + \beta_2 lr_t + \varepsilon_{i,t} \quad (3)$$

where ΔGDP denotes the year-on-year real GDP growth rate, and *lr* the lending rate on loans. An auto-regressive term is introduced to capture the inertia in NPL ratios.

Then, the NPL ratio under stress in percent under stress for each type of borrowers was computed according to the following formula which corresponds to the inverse of the logit function:

$$NPL\ ratio_{type_{i,t}}^{stress} = \frac{1}{1 + \exp\{-(\alpha + \rho Y_{i,t-1} + \beta X_t + \mu_i)\}} * 100 \quad (4)$$

Annex V. Solvency stress test results details

Table 10. Solvency stress test results

(in percent)

	Banking system's Tier 1 Ratio (in percent)			Banking system's leverage ratio (in percent)	Number of undercapitalized banks (Tier 1 <6%)	Number of undercapitalized banks (leverage ratio<3%)	Capital shortfall with regard to total CAR (as a percent of GDP)
	All 7 banks	Domestic banks	Foreign banks				
Before stress and initial capital adjustments	13.9%	12.6%	14.6%	7.1%	0	0	0
Before stress but after capital adjustments	11.2%	9.7%	12.0%	5.7%	0	0	0
Baseline scenario (end of 2nd year)	16.5%	15.6%	17.1%	8.1%	0	0	0
Adverse scenario (end of 2nd year)	9.0%	12.0%	7.0%	3.9%	2	1	1.7%

Source: IMF staff calculations

Annex VI. Liquidity stress test assumptions

Table 11. Liquidity stress test assumptions on run-off, roll-off rates and haircuts

(in percent)

	1	2	3	4	5	6	7
	1 to 7 days	**Greater than 7 days up to 2 weeks**	**Greater than 2 weeks up to 4 weeks**	**Greater than 4 weeks up to 3 months**	**Greater than 3 months up to 6 months**	**Greater than 6 months**	**Greater than a year**
Run-off rates on potential outflows							
Retail funding: sight deposits							
Stable	2%	4%	4%	4%	0%	0%	0%
Unstable	8%	6%	6%	3%	0%	0%	0%
Retail funding: term deposits	5%	5%	5%	15%	10%	10%	10%
Other deposits	10%	10%	10%	10%	10%	10%	10%
Secured wholesale funding from other financial institutions	20%	20%	20%	20%	20%	20%	20%
Unsecured wholesale funding from other financial institutions	60%	60%	60%	60%	60%	60%	60%
Outflows from derivatives	NA	NA	NA	NA	NA	NA	NA
Other obligations	50%	50%	50%	50%	50%	50%	50%
Roll-off rates on cash inflows							
Securities in trading book	NA	NA	NA	NA	NA	NA	NA
Available for sale securities	NA	NA	NA	NA	NA	NA	NA
Held to maturity securities	100%	100%	100%	100%	100%	100%	100%
Inflows from derivatives	NA	NA	NA	NA	NA	NA	NA
Loans maturing	60%	60%	60%	60%	60%	60%	60%
Other	80%	80%	80%	80%	80%	80%	80%
Haircuts on liquid assets							
Cash items	0%						
Securities in trading book	NA						
Available for sale securities	NA						
Held to maturity securities	20%						

Annex VII. Climate data methodologies

The mission used two main data sets to explain climate data to authorities and showcase the options for the country's CRA: one downscaled data set from CMIP6 and another on synthetic tropical cyclones with historical and future climate conditions from the Imperial College Storm Model (ImpeRIal College Storm model, IRIS). [20] The downscaled data from CMIP6 is considered for a national level, with a 5 arcmin (around 10 km by 10 km) resolution, and for Mahé, 30 arcsec (around 1km by 1 km). For simplicity, the resolution is stated as 10 km and 1 km resolutions, although the exact resolution in km depends on the distance to the equator.

A. Downscaled data from CMIP 6

The 10 km resolution data considers nine general circulation models (GCMs) from the CMIP6 collection, downscaling for Seychelles latitude 3°S - 11°S and longitude 45°E - 57°E (Figure 26). The nine GCMs are GFDL-ESM4, MPI-ESM1-2-LR, CNRM-ESM2-1, MRI-ESM2-0, ACCESS-ESM1-5, IPSL-CM6A-LR, BCC-CSM2-MR, CESM2, and EC-Earth3. The data includes a historical period corresponding to 1985-2015 and three future climate scenarios: SSP2-4.5, SSP3-7.0, and SSP5-8.5. Considering the major natural hazard types in Seychelles, the downscaled data includes three basic meteorological measures: daily maximum temperature (°C), daily mean precipitation (m/hr), and daily mean wind speed (m/s). The daily mean storm surge height (m) was derived based solely on daily mean wind speed using an empirical relationship.[21] A Bias Correction and Spatial Downscaling (BCSD) approach was used for the climate downscaling, considering its ability to preserve trend-related statistics. The downscaled variables have a grid spacing of 10 km.[22] After obtaining the downscaled daily variables, we calculated each variable's annual values, including the maximum, minimum, mean, and standard deviation.

For Mahé and to achieve higher resolution for storm surge estimates, we replicated the processes for Mahé's geographical area (latitude 4.4°S - 4.9°S and longitude 55.2°E - 55.7°E), refining the downscaling grid spacing from 10 km to 1 km (Figure 27). The estimates can be integrated with astronomical tide, sea level rise, and geographical characteristics (e.g., elevation) to explore coastal flood hazard implications.

[20] Sparks, N. and Toumi, R., 2024. The Imperial College Storm Model (IRIS) Dataset. *Scientific data*, *11*(1), p.424.

[21] Biffis, E. and Wang, S., 2022. Downscaling of physical risks for climate scenario design. Singapore Green Finance Centre.

[22] Wood, A.W., Leung, L.R., Sridhar, V. and Lettenmaier, D.P., 2004. Hydrologic implications of dynamical and statistical approaches to downscaling climate model outputs. *Climatic change*, *62*, pp.189-216.

Figure 26. Model domain and grids at the national level

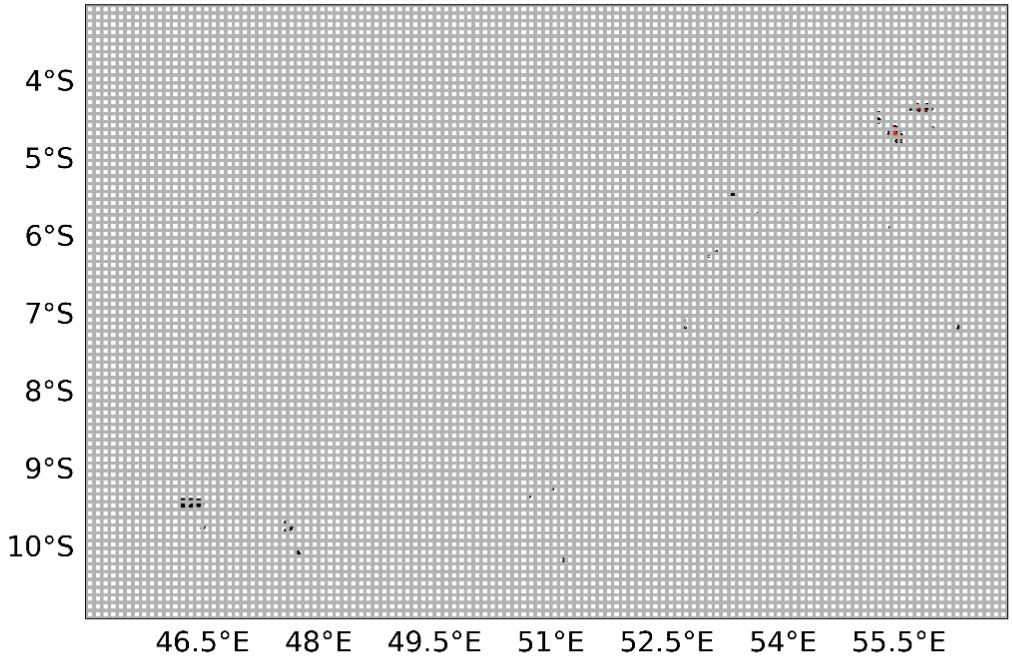
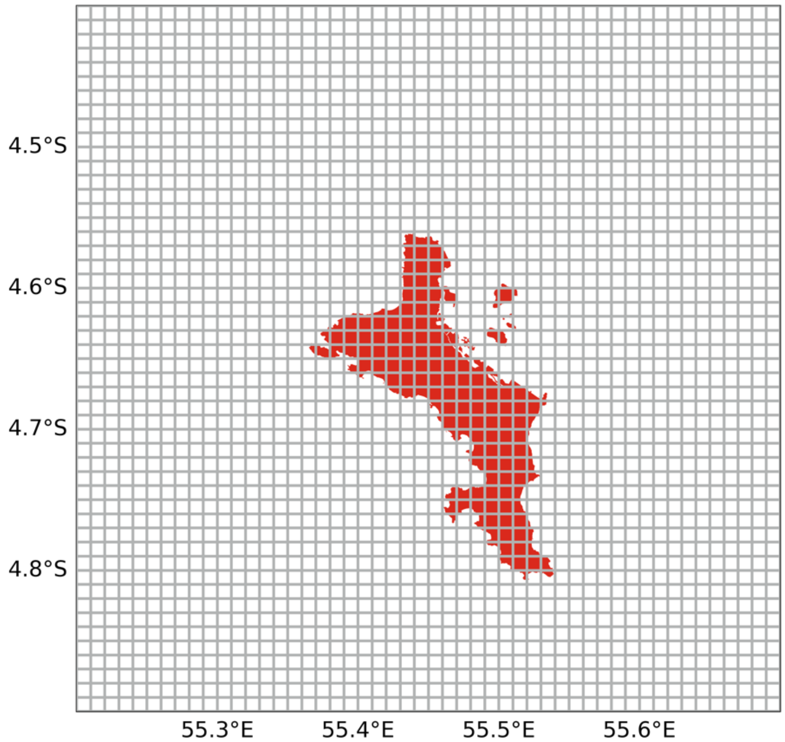


Figure 27. Model domain and grids for Mahé

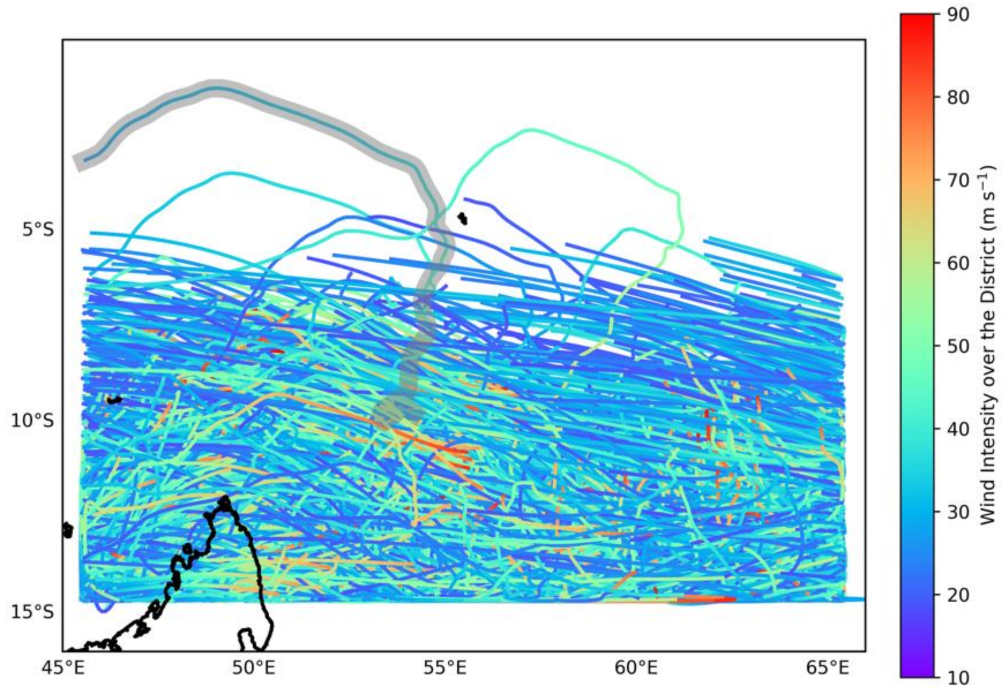


B. Tropical cyclones data from IRIS

The downscaling of tropical cyclone activity is obtained from IRIS dataset. The tropical cyclone area considered here is latitude 0°S - 16°S and longitude 45°E - 66°E (Figure 28). The tropical cyclone activity was downscaled following the historical climate status, and SSP2-4.5 and SSP5-8.5 scenarios. For the three epochs, there are more than 6,000 synthetic tropical cyclones generated within the region. We only kept the partial tropical cyclone tracks within the selected region. Multiple 6-hr records are available for one tropical cyclone. For each tropical cyclone record, we applied a complete tropical cyclone wind profile model [23] to reconstruct the wind footprint. For all 27 Districts, the distance between the cyclone center and each District was calculated, along with the estimated wind speed induced by a tropical cyclone over the District.

Figure 28. Synthetic tropical cyclone tracks under SSP2-4.5 scenario in Seychelles

Wind speed in m/s



Source: IRIS, IMF staff calculations

Note: The colors show the intensity of tropical cyclones along tracks; the thick gray line highlights a synthetic tropical cyclone that causes a high wind speed over the District of English River of 39 m/s.

[23] Wang, S., Lin, N. and Gori, A., 2022. Investigation of tropical cyclone wind models with application to storm tide simulations. *Journal of Geophysical Research: Atmospheres*, *127*(17), p.e2021JD036359.

C. Output data structure

Downscaled data from CMIP6

The downscaled data based on CMIP6 are in NetCDF format. There are four dimensions: latitude, longitude, year, and scenarios. There are four variables in each NetCDF file: annual maximum, annual mean, annual minimum, and annual standard deviation.

In addition to the NetCDF, the mission provided CSV format (3 files, one for each climate measure) with a climate measure for each of the 27 Districts for all years, and mid-century and end-century climate measures for each of the 27 Districts (4 files for each climate measure).

Tropical cyclone data from IRIS

The downscaled synthetic tropical cyclone tracks with IRIS are stored in CSV format (3 files, historical, SSP2-4.5, and SSP5-8.5). Some key cyclone-related variables are included, such as the latitude and longitude of the cyclone center, wind speed at the cyclone center, minimum central pressure, and the radius of maximum wind speed. In addition, the distance between each cyclone center and 27 Districts in Seychelles, along with the wind speed induced by each tropical cyclone over each District for each time step of the event.