Interdisciplinary Description of Complex Systems 24(5), 664-676, 2026

CLIMATE CHANGE RISK MANAGEMENT IN THE BANKING INDUSTRY – CASE STUDY OF SOUTH AFRICA AND KENYA

Janos Besenyo, Tamas Somogyi* and Rudolf Nagy

Óbuda University
Budapest, Hungary

DOI: 10.7906/indecs.24.5.10
Regular article

Received: 14 May 2024.
Accepted: 30 June 2026.

ABSTRACT

Climate change is recognised as a serious concern that jeopardise the essential services. Although the effects of climate change have been extensively studied, its impact on the banking industry has received scant attention. The aim of this article is to provide an overview of the climate change risk management in the banking industry in South Africa and Kenya through the lenses of the central banks. This paper analyses policy measures and approaches in these countries. Elements of content analysis were used within the qualitative research framework where relevant literature and sector-specific data was analysed.

The results demonstrate that the examined entities are aware of the risks and of their social responsibility. Banks are motivated to discover new types of activities, assets and products in order to support the effort of keeping the global temperatures within an acceptable range. However, the banking industry could do further work. Thus, recommendations are provided, which may be useful for the stakeholders and policymakers.

KEY WORDS

South Africa, Kenya, climate change, risk management, banking industry

CLASSIFICATION

JEL: G24, G32, Q54

*Corresponding author, η: somogyit588@gmail.com; -; -

INTRODUCTION

The banking sector has a crucial role to play in mitigating climate-related risks, both as a catalyst for transition to climate-friendly solutions and as a service provider of critical services to society. Through targeted funding for catalytic projects, banks can help accelerate bankable business proposals to come to fruition. However, it is also a service provider whose critical infrastructure could be adversely impacted by climate-related natural disasters. In this regard, it must put in place business continuity measures in order to ensure stability of the banking sector [1]. Central banks, as oversight bodies, are required to provide strategic and operational guidelines that mitigate climate risks, in the same manner as it does with risks such as market risk, credit risk and operational risks. Commercial banks and other financial sector actors, including insurance and investment houses, must determine the level of risk, based on those portfolios that are vulnerable to transition risks. This might have an impact on their pricing structure and capital adequacy provisions. At the same time, investors would need to be reassured that banks are doing enough to mitigate climate risks which would require the amendment of national and international reporting and accounting standards for better transparency [2].

According to the widely accepted theory, the increasing amount of the so-called greenhouse gases in the atmosphere cause an increase in the global temperature by the adsorption of the heat that tries to leave the Earth after being heated by the Sun [3]. No doubt, the Earth is warming up in an accelerating way: in the last decades it has been hotter than any other time in the last millennium [4]. Among the effects of this global warming are the rising sea levels, the more frequent floods, severe storms, tornadoes and hurricanes, the droughts and heatwaves [5]. Africa is also impacted by the climate change. In the eastern and southern part of Africa extreme rainfall events [6], heatwaves [7], droughts [8] are likely to become more frequent. The latest report of the United Nations' Intergovernmental Panel on Climate Change states that Africa is experiencing widespread impacts from human-induced climate change despite the low greenhouse gas emissions of this continent [9]. These extreme weather events negatively affect the life of people, especially rural livelihoods, therefore increasing the risk of an armed conflict [10]. Moreover, extreme weather events have been found to advance migration [11], which is considered to be maleficent to the African countries. Beside the fact that life and livelihoods are threatened by these extreme weather events [12], the infrastructure is also in danger [13]. It has been demonstrated that natural hazards are one of the most relevant threats to infrastructure resilience [14]. Some infrastructure can be considered critical, as it is essential for the maintenance of societal functions and for the social well-being of people. Natural hazards are threatening the smooth operation of critical infrastructures [15], which may threaten national security (considered critical in Africa) [16], and the banking industry's infrastructure (considered critical for the well-being of people and stability) [17]. No doubt, floods and heavy storms can cause serious damage to the built environment, making buildings inaccessible, cutting off electricity while heatwaves may result in power outages. In addition to this, terrorist groups are present in Africa [18, 19] and targeting critical infrastructure. For instance, terrorists may take advantage of drought periods and use fire to cause damage to (critical) infrastructure [20]. Infrastructure of the healthcare system [21] and the banking services, or accessing to food [22] are in danger, just to name a few. These examples underpin that critical infrastructure protection in the 21st century requires appropriate controls and risk management [23]. Undoubtedly, without incorporating climate risks into the risk management framework, climate change risks cannot be properly identified, assessed and mitigated.

Hence the importance of enhancing risk management by adding climate change related risks to the existing risk portfolio, which has been found as a key factor in reducing disaster risks by enabling the decision makers to consider different types of extreme events [24]. This research

examines the management of climate change related risks in the banking industry of South Africa and Kenya, thus helps the operators of (critical) infrastructure to be more prepared for the extreme weather events.

METHOD

The primary goal of this study is to examine those sector specific regulations that aim to manage the climate change related risks applicable to the banking industry. This exploratory study used elements of content analysis within the qualitative research framework where relevant literature was explored and sector-specific data analysed. Given the availability of extensive literature on climate change, the study sought to relate such literature with the banking environments in the selected countries, namely, Kenya and South Africa. Central banks from both countries have issued strategic guidelines for their national commercial banks in an effort to ensure preparedness and resilience towards climate risks. The comparative analysis of this study is limited only to central banks and does not delve into performance of commercial banks. In summary, this study used the methodology content analysis, where collected data was regulations issued by the central banks of the selected countries.

For the purpose of assessing and comparing regulations in the above-mentioned countries, the following research questions were posed:

RQ_1: Are climate change risks managed in a risk management framework?
RQ_2: Is there a risk assessment on partners relating to climate change risks?
RQ_3: Is there a sector-wide test aiming to improve the already existing strategies and mitigating plans?
RQ_4: How does the banking industry support the effort of keeping the global temperatures within an acceptable range?

Although the first research question may seem obvious, appropriate risk management framework is paramount, thus this should be examined at first. Naturally, climate change affects the partners of the banking industry as well, thus, it is essential to assess risks stemming from partnerships. Having examined the internal and external aspects of risk management, the cooperation within the banking industry should be investigated. What finally will be explored is the efforts made by the banking industry to struggle against global warming.

POTENTIAL IMPACT OF CLIMATE CHANGE ON BANKING INFRASTRUCTURE

Natural or environmental hazards may refer to all the potential threats facing human society by events that originate in, and are transmitted through the environment. These extreme geophysical events include geologic (earthquakes, volcanic eruptions, landslides, avalanches), atmospheric (tropical cyclones, tornadoes, hail, ice and snow) and hydrological (river floods, coastal floods, drought) events as well [25]. These extreme events – fostered by the climate change – jeopardise the smooth operation of essential services by threatening the critical infrastructure. Geologic, atmospheric and hydrological events may cause service disruption by making the bank's headquarters, branches and data centre buildings inaccessible or by cutting off the energy. Heatwaves can seriously impact digital banking services through service disruption or outages: data centres may face lack of power, since the higher the temperature, the higher the energy consumption [17]. Moreover, as it has been demonstrated, climate change has an economic and social impact by affecting macroeconomic indicators, such as employment, gross output, and structural changes in national economic sectors [26]. For example, extreme weather events greatly affect the rural life and livestock in Africa [27]. Hence the increasing importance of addressing climate change risks appropriately, especially in the field of critical infrastructure protection.

As generally accepted, risk management is the formal process utilised to quantify, qualify, and mitigate specific concerns an organisation may identify [28]. Natural risks cannot be eliminated but can be assessed and managed in order to mitigate the potential impact by the changing climate. A typical risk assessment approach has three major parts: identifying the hazards, estimating the likelihood of the realisation of the hazards and estimating the consequences of the events [25]. Thus, risk is defined as the product of probability and loss. Therefore, in order to understand the environmental risks, it is essential to understand properly the probability of occurrence and the possible impacts. For natural disasters, scientific scales can be used to estimate the possible impact, e.g., the Richter scale for measuring the magnitude of earthquakes. However, proponents of risk assessment have pointed out that the possible impacts depend on the ever-changing vulnerability of the community threatened by the disastrous event. Moreover, the estimation of the probability, which includes the frequency of the natural disaster, relies on the history of previous disasters. Although the validity and the completeness of available dataset is debatable, using this method can be reasonable when assessing tectonic processes driven by large-scale geological forces. However, current literature suggests that this method is less suitable for the assessment of environmental hazards that are fostered by the climate change, thus changing over time e.g., floods. Expert judgement has been identified as a key element of risk assessment [29]. Location specific geographical data has been suggested as the basis of expert judgement and natural risk assessment [30]. Although some of the geographical data may be sensitive, publicly available data and sector specific data can be gathered to serve as the basis of assessing environmental risks. It must be noted that such geographical data may be used by more sectors, therefore this is a potential field of cooperation between sectors providing essential services. Preparedness with appropriate mitigating actions, continuity plans and all the other steps depend on the identification and assessment of risks. Consequently, it is essential to realise and properly assess the threats posed by climate change. It should be emphasised that it is the appropriate risk assessment that reveals the hazards and shows the level of exposure. Therefore it is the essential starting point of any steps towards preparedness and proper mitigating actions [31].

As already mentioned, risk management is to manage and mitigate the assessed risks. Natural risk management should be approached from a territorial perspective [32], meaning that the location of the infrastructure and its environment should be taken into consideration. Possibilities of local cooperation in the introduction of mitigating actions may be investigated as well. However, it is likely that such a cooperation has to be facilitated and coordinated. Traditionally, ensuring the proper risk management shall be a priority for governments, legislators, sector specific authorities and operators of essential services as well.

The following section explains the importance of the smooth operation of the banking services, then discusses how the banking industry in the chosen African countries manages natural risks fostered by climate change.

BANKING AND THE NEED FOR SECURE OPERATION

Banks are considered the central part of the financial system as they play a key role in acting as intermediaries between savers, investors, borrowers and governments. Without doubt, should the banking system operate efficiently, savers, investors, borrowers and governments are able to prosper. However, the way of modern banking is fragile (banks use deposits to finance loans), meaning banks would definitely collapse if they could not perform to the satisfaction of their depositors [33]. Moreover, a distressed bank can cause a loss of confidence in the other banks as well. Therefore, the financial sector is rigorously regulated. Central banks have a crucial role in maintaining the sector's stability by having regulatory and supervisory responsibilities. They regularly issue sector specific regulations and recommendations which are enforced via regular reports, compliance requirements and even threats of punitive

sanctions such as penalties, suspensions and even cancellation of banking licence. Such regulations could include prescribing standards for information and communication technology, capital adequacy and reporting requirements. Generally, regulations represent the minimum mandatory level of requirements, while recommendations rather serve as a basis in the supervisory discussion process. It is noteworthy that the absence or poor quality of the banking industry regulations may foster the shadow banking or illicit financial activities which jeopardise the financial and political stability of the country [34].

Banking services not only play an essential role in the growth of economy and well-being of people, but also vital for the states. Therefore, services of the banking industry should be considered essential services. Financial institutions offer a wide array of services and products to individuals and large corporations as well. Beyond dispute, any significant disruption of these services would have economic, social and political effect. The result of such disruptions may be propagated to other sectors causing liquidity problem and failure of supply chains [35]. The stability of the banking industry is particularly important in Africa, as it may enhance the development of the whole continent. Taking into consideration the global networks of parent companies and subsidiary companies in the banking industry, this kind of effect can potentially cross the borders and impinge on banking stability of other states.

CASE STUDIES: MANAGING CLIMATE CHANGE RISKS IN THE BANKING INDUSTRY OF SOUTH AFRICA AND KENYA

Climate-related and environmental risks in the banking industry have come to be used for two risk categories: physical risks and transition risks. Physical risk is comprised of risks that arise from extreme weather events threatening the physical infrastructure of the financial institutions or their clients' infrastructures, including real estates [36] or the infrastructure of suppliers. Transition risk refers to the possible financial loss that can result from the process of adjustment towards a lower-carbon and more sustainable economy. Since the characteristic of climate change related risks has a kind of uncertainty (the frequency and magnitude of extreme weather events are unpredictable), managing these risks is undoubtedly challenging. This section describes how the natural risks are managed in the banking industry of South Africa and Kenya. Remarks and recommendations will be provided in the Discussion part.

SOUTH AFRICA

Recognising the risks of climate change and understanding the threat of extreme weather events, regulatory responses have been made by South African Reserve Bank (SARB) that is the sector-specific authority in South Africa. With the coordination of SARB the members of the banking industry have developed an approach to support the climate change risk assessment [37]. A document titled as *Prudential Communication on Climate related risks* was issued in 2022 by SARB [38]. The purpose of this document is threefold. First, to provide an overview of the climate change; second, to highlight the important role of the boards of the financial institutions, and third, to describe how the climate related risks shall be approached by the banks of South Africa. The management of the climate change related risks in South Africa will be described along these three logical aspects.

SARB's *Prudential Communication on Climate related risks* provides an overview of the climate change by describing the effects of climate change on banking. It defines a potential loss as the result of either physical risks or transitional risks. It should be emphasised that both represent significant financial risk for the sector members in the form of credit risk, market risk, operational risk, liquidity risk and reputation risk [38]. Due to the above-mentioned fragile nature of the banking industry, all the financial and operational risks have to be managed appropriately. SARB has underlined that enhancing the knowledge and understanding of climate change risks and their impact on banking is essential.

The important role played by the board of directors in risk management has also been defined by SARB [38]. Climate related risks have been recommended to be part of the banks' governance and risk management, and their reporting frameworks. Discussing these risks at the highest decision-making level ensures that banks may adapt their business strategy to enhance financial resilience. SARB has reminded banks, insurance companies, and operators of financial infrastructure that they have a huge responsibility in the well-being of people and political and financial stability of the state. New opportunities in terms of new types of activities, assets and financial products should be discovered in order to support the effort of the keeping global temperatures within an acceptable range. Global and local initiatives to lower greenhouse gases shall be sponsored by financial institutions. In the nutshell, SARB has emphasised the critical role played by the boards of directors in the financial sector [38].

The same SARB document aims to incentivise some sector-specific initiatives regarding to the appropriate management of the climate related risks [38]. But first of all, the importance of understanding the climate change risks and the impacts on business strategies has been underlined by SARB. Although the initiatives aiming to reduce the emission of greenhouse gases may result in changes to the return of certain economic activities, assets and liabilities, these initiatives can be considered opportunities for the banking industry, e.g., new types of assets and financial products can be introduced. Valuation, pricing, business strategy may be harmonised to the effects of climate change and to respective initiatives and regulations. Moreover, financial institutions are expected to deal with climate change risks within their risk management framework and are also expected to communicate climate related information and their achievements to stakeholders.

In conclusion, climate change related risks are managed by the banking industry in South Africa based on the sector-specific authority's expectations. The key points of the central bank's expectations are i) to put a focus on the impact of the inevitable effects of climate change, ii) examining the critical role of the board of directors in the mitigation these impacts and iii) providing an approach of managing transitional and physical risks. Perhaps the third is the most important as it underlines the need to change the mind and incentivise the banking sector to harmonise its business strategy to the reality of global warming. This may be considered the crucial role of the sector.

KENYA

In the latest stability report of the financial sector, climate change has been identified as a risk within the whole sector of Kenya: results of extreme weather events represent e.g., credit risk in Agriculture, insurance risk and operational risk [39]. Having understood the importance of this threat, Central Bank of Kenya (CBK) as the sector-specific authority has issued a *Guidance on climate-related risk management* [40]. Due to the unique characteristics of climate change related risks, special attention is needed to reduce their possible impacts. Therefore, minimum requirements have been defined in this guidance to have these risks effectively managed by the banking industry in Kenya. The need for an effective risk governance structure has been emphasised by CBK's guidance. Within the required governance, focus has been put on four areas: responsibilities of the board and senior management; oversight; strategy; and risk management.

CBK's *Guidance on climate-related risk management* makes the board of directors to be responsible for creating and implementing proper business strategies and policies related to climate change risks [40]. Therefore, reporting to the board is explicitly required in order to have the knowledge and understanding of the exposure to the climate change related risks when making strategical decisions. Within the expected framework the board's primary responsibility has been clearly defined when: i) assessing the financial institution's exposure

to climate change related risks; ii) developing climate risk strategy in line with the institution's risk profile; and iii) allocating resources within the organisational structure.

Beside the definition of these high-level and strategy making roles, duties of the senior management has also been defined in CBK's guidance. Senior management is expected to be responsible for implementing the climate change business strategy defined by the board of directors, and incorporating the climate change risks into the institution's risk management framework. So, the involvement of the management is clearly required and their responsibility is defined.

The second topic within governance is the issue of oversight. To ensure the introduction of its strategy, the board is required to oversee the development and if necessary, to correct the implementation. In order to have an effective oversight, the board should play an active role in:

- approving the financial institution's strategy that is in line with its vision and nationally or internationally agreed climate goals;
- setting the institution's risk appetite that covers the climate change related risks as well;
- ensuring the availability of all the necessary resources and processes;
- developing an appropriate risk culture within the organisation, so climate change considerations can be present in all business activities.

The board has to be supported with appropriate Key Risk Indicators and with other quantitative data. Taking into consideration the evolving impacts of physical and transitional risks fostered by the changing climate, risk appetite is required to be reviewed on a yearly basis. It is important that climate change related risks be reflected in the institution's risk appetite, since this document serves as the basis of the whole risk management framework.

Strategy is the third pillar of the governance in CBK's *Guidance on climate-related risk management.* An appropriate strategy is required to address the potential impact of the physical risks and transitional risks. Therefore understanding the impact of climate change risks on the banking industry and formulating business strategy accordingly is essential. When identifying and assessing risks, banks have to consider their critical role in the economy and well-being of people. This critical role should be reflected in the strategy that addresses the climate change related issues in the short, medium and long term. Involving investors, partners and peers in making up the strategy is recommended by CBK's guidance. Moreover, when formulating the strategy, opportunities are to be explored, since the transitional risks can also represent opportunities. Once an appropriate strategy has been formulated, financial institutions have to ensure its effective implementation. The above-mentioned development of an appropriate risk culture is important in the implementation phase as well. CBK's guidance has underlined that business units have to take part in climate strategy implementation: roles and responsibilities have to be clearly defined, resources have to be allocated appropriately, and all the strategic goals have to be reflected in relevant policies.

The fourth part of the expected governance in CBK's *Guidance on climate-related risk management*, is risk management. The main goal of the sector-specific authority is to incorporate the management of climate change related risks into the risk management framework so these risks can properly be identified, measured, controlled, monitored and reported. The first step of risk identification is the assessment of the material and non material effect of climate change on business e.g., on liquidity, operation or reputation. Conducting risk assessment of partners and suppliers has also been recommended. Controls have to be applied by banks to mitigate the climate change related risks. Among the many possible mitigating actions, limitations and threshold settings and business continuity planning are recommended by CBK. Control measures regarding to the infrastructure are also expected, as the possibility of a disruptive event is increasing. Processes have to be introduced in order to monitor and report the applied controls. Risk reports are particularly important for the board that are responsible for creating the appropriate strategy. Effective data management is also expected with appropriate metrics, data quality and timely warning. It is worth to mention that banks are

encouraged to publicly share information on climate change related questions. This perhaps is in line with the social responsibility of the whole sector and the transparency which is an important element of the trust in the banking. Reporting to the sector-specific authority in Kenya is compulsory. Banks have to report their compliance with the requirements of CBK's *Guidance on climate-related risk management* on a quarterly basis.

In summary, these requirements were defined by CBK to ensure that climate change related risks are managed in the whole sector. Focus has been put on four areas: responsibilities of the board and senior management; oversight; strategy; and risk management. It is clear that the in the heart of these requirements is the role of banking industry as financial facilitator: banks are urged to concentrate on transitional risks by developing appropriate business strategies and financial products.

DISCUSSION

Central banks are demonstrating growing awareness of the climate change and the social responsibility of the financial institutions. These sector-specific authorities have highlighted this issue and through their regulatory processes have introduced requirements. Perhaps the most important finding is the fact that sector-wide regulations have been issued, so the banking industry in South Africa and Kenya are aware of the increasing risks fostered by climate change (both transitional risk and physical risk). However, there is abundant room to further progress in this field, as we show it based on our four questions.

RQ_1: ARE CLIMATE CHANGE RISKS MANAGED IN A RISK MANAGEMENT FRAMEWORK?

At first, we asked if the banking industry has a risk management framework that manages climate change risks. As already mentioned, risk management is to manage and mitigate the assessed risks. Due to the unique characteristics of climate change related risks, special attention is needed to reduce their possible impacts. Hence the importance of the proper management of climate change risks.

CBK has defined minimum requirements in its related guidance to have these risks effectively managed by the banking industry. The main goal of the sector-specific authority is to incorporate the management of climate change related risks into the risk management framework so these risks can properly be identified, measured, controlled, monitored and reported. Within the expected framework the board's primary responsibility has been clearly defined when i) assessing the financial institution's exposure to climate change related risks; ii) developing climate risk strategy in line with the institution's risk profile; and iii) allocating resources within the organisational structure. It should be underlined that focus has been put on the responsibility of the board of directors when managing climate change risks. This clearly shows the priority of the issue of climate change risk management.

Climate related risks have been recommended to be part of the banks' governance and risk management, and their reporting frameworks in South Africa, as well. The important role played by the board of directors in risk management has been defined by SARB. However, the Central Bank of South Africa has not described how climate risks should be integrated into the financial institutions' risk management processes. Surprisingly, SARB's relevant document is only a four-page long paper.

Recommendation 1

Sector-wide regulations could be improved further. The publication of a more detailed guidance can be recommended to support the banking industry in integrating climate risks into the financial institutions' risk management, governance and reporting processes. It may lead to

a more appropriate risk management framework to efficiently deal with climate change risks. Risk management is essential [41], therefore it should be assessed and improved with the feedbacks and gained experience.

RQ$_2$: IS THERE A RISK ASSESSMENT ON PARTNERS RELATING TO CLIMATE CHANGE RISKS?

The second question asks if the banking industry does risk assessments on partners relating to climate change risks? As it has been discussed above, physical risks arise from the extreme weather events that threats the infrastructure and operation of the suppliers and partners as well. A severe outage of the outsourced activities or supplies can cause disruption of the banking services which are considered essential services. Therefore, it is important to manage the risk of possible outage of the outsourced activities and services of partners.

CBK expects the risk assessment on partners as well, since it has been understood that extreme weather events pose a threat on the outsourced activities and services by threatening the infrastructure of partners. However, this question is not discussed in detail. Turning to South Africa, it can be seen that no regulatory expectation has been defined regarding to the climate change risk management of partners. This is a somewhat disappointing result, because we believe that focus should be put on this question as well in Kenya and in South Africa.

Recommendation 2

The importance of the risk management of partners has already been identified [42]. Therefore, dealing with this significant issue should be clearly expected by central banks. This may be achieved by the issuance of a recommendation or guidance for the whole sector that describes and discusses this kind of risk in detail and provides the minimum requirements on how to manage them.

RQ$_3$: IS THERE A SECTOR-WIDE TEST AIMING TO IMPROVE THE ALREADY EXISTING STRATEGIES AND MITIGATING PLANS?

The third question asks whether or not exists a sector-wide test aiming to improve the strategies and mitigating plans? Sector-wide tests are considered to help the industry to better understand the impacts of the climate change, develop their continuity plans and shape their risk mitigating actions. This is particularly important for both kind of risks. In case of physical risks that threaten the operation of essential financial services, simulating extreme weather events with disaster management bodies might help to practice the crisis communication and to test and redesign the relevant disaster recovery plans. The dialogue and collaboration between the relevant parties have already been emphasised [43] in order to deepen the understanding of climate risks and improve the already existing strategies and mitigating plans, moreover, to find out new possible ways to cope with the inevitable impact of the changing climate. Should an extreme weather event occur, it would obviously affect all the members of the banking industry. No doubt, exploring the impacts on IT infrastructure and finding improved solution for the smooth operation together is essential in keeping the banking industry safe.

On the other hand, transitional risks shall also be managed on sector-level as well, therefore sector-wide stress tests may be urged. In the EU, sector-wide stress test has been organised by the European Central Bank and the results clearly show the need for the regular tests [17]. Although it is clear that banks in South Africa and in Kenya are required to take actions to mitigate the potential impacts of the climate change, our investigation could not find any evidence of a sector-wide test. Testing the individual plans together with other members of the sector may have valuable benefits, therefore it can be urged.

Recommendation 3

Central Banks should organise sector-wide tests simulating extreme weather events in order to enhance the banking industry's climate change strategies and mitigating plans of physical and transitional risks.

RQ_4: HOW DOES THE BANKING INDUSTRY SUPPORT THE EFFORT OF KEEPING THE GLOBAL TEMPERATURES WITHIN AN ACCEPTABLE RANGE?

The banking industry can make efforts in the field of climate change. Being aware of their social responsibility, banks discover methods of financing sustainable projects and support green solutions, often under regulatory guidance [44]. Hence the relevance and importance of the last question.

First of all, our investigation clearly shows that banks do have a role for dealing with climate change. First, to be prepared by managing the physical and transitional risks. Second, banks in the examined countries are encouraged to consider the climate change not only as a risk but also as an opportunity. Financial institutions are motivated to discover new types of activities, assets and financial products in order to support the effort of keeping the global temperatures within an acceptable range. Reassuringly, the social responsibility of the banking industry has been underlined by CBK. The expectation of public reports on climate change related actions and achievements in South Africa and in Kenya is a remarkable result. However, further work can be encouraged. Having explored the publicly available sector-specific documents, we could not find the banking industry's vision and strategy neither in Kenya, nor in South Africa. Sector members may define a strategy regarding to climate change. the process of setting a common target and monitoring the improvement of the whole sector may be orchestrated by central banks. In addition to this, members of the banking industry may provide public reports regularly on their achievements in the field of climate change to show their commitment.

Recommendation 4

The banking industry should define a common goal to reach together in order to join the worldwide effort of keeping the global temperatures within an acceptable range. Central banks and members of the banking industry may provide public reports regularly on their achievements in the field of climate change in order to maintain the trust in the whole sector, which is undoubtedly essential.

CONCLUSION

There is an urgent need to address the climate change related risks in critical infrastructure protection. Extreme weather events are predicted to become more frequent and more dangerous. This has been realised by legislators and sector-specific authorities in the financial sector as well, so the banking industry is also facilitated to manage climate change risks appropriately.

In this article the importance of the proper management of climate change related risks has been supported by presenting the relevant theoretical basis. This study has also provided an interesting insight into the current practice of the banking industry in South Africa and in Kenya. Banks in these countries are aware of the increasing risks fostered by climate change and of their social responsibility and are motivated to discover new types of activities, assets and financial products in order to support the effort of keeping the global temperatures within an acceptable range. However, by making some observations and recommending some actions, we have found that the banking industry could do further work in order to enhance climate change risk management and critical infrastructure protection. Our findings should prove to be particularly valuable to both members of the banking industry and policy-makers.

REFERENCES

[1] Stolbova, V.; Monasterolo, I. and Battiston, S.: *Financial Macro-Network Approach to Climate Policy Evolution*.
Ecological Economics **149**, 239-253, 2018,
http://dx.doi.org/10.1016/j.ecolecon.2018.03.013,

[2] Chiba, Y.; Mori, N. and Shimizu, N.: *Strengthening the Integration of Climate Risks in the Banking Sector*.
IGES Policy Brief No. 38. Institute for Global Environmental Strategies, 2017,
http://dx.doi.org/10.57405/iges-5984,

[3] Letcher, T.M.: *Global warming - a complex situation*.
In: Letcher, T.M., ed.: *Climate change*. 3rd edition. Elsevier, pp.3-17, 2021,
http://dx.doi.org/10.1016/B978-0-12-821575-3.00001-3,

[4] McGuire, B.: *Global catastrophes*.
Oxford University Press, 2014,

[5] Fletcher, W.D. and Smith, C.B.: *Reaching net zero*.
Elsevier, 2020,

[6] McBride, C.M.; Kruger, A.C. and Dyson, L.: *Changes in extreme daily rainfall characteristics in South Africa: 1921–2020*.
Weather and Climate Extremes **38**, No.100517, 2022,
http://dx.doi.org/10.1016/j.wace.2022.100517,

[7] Meque, A.; Pinto, I.; Maúre, G. and Beleza, A.: *Understanding the variability of heatwave characteristics in southern Africa*.
Weather and Climate Extremes **38**, No. 100498, 2022,
http://dx.doi.org/10.1016/j.wace.2022.100498,

[8] Chikoore, H. and Jury, M.: *South African drought, deconstructed*.
Weather and Climate Extremes **33**, No. 100334, 2021,
http://dx.doi.org/10.1016/j.wace.2021.100334,

[9] IPCC: *Climate Change 2022: Impacts, Adaptation, and Vulnerability*.
https://www.ipcc.ch/report/ar6/wg2, accessed 12th July, 2023,

[10] Ide, T., et al.: *The Future of Environmental Peace and Conflict Research*.
Environmental Politics **32**(6), 1077-1103, 2023,
http://dx.doi.org/10.1080/09644016.2022.2156174,

[11] Sáfár, B. and Kállai, B.: *Resilience-based approach and management of human trafficking at the regions of natural disasters in Africa*.
Journal of Central and Eastern European African Studies **1**(1-2), 139-155, 2021,
http://dx.doi.org/10.59569/jceeas.2021.1.1-2.8,

[12] Romanello, M., et al.: *The 2021 report of the Lancet Countdown on health and climate change: code red for a healthy future*.
The Lancet **398**(10311), 1619-1662, 2021,
http://dx.doi.org/10.1016/S0140-6736(21)01787-6,

[13] Forzieri, G., et al.: *Escalating impacts of climate extremes on critical infrastructures in Europe*.
Global Environmental Change **48**, 97-107, 2018,
http://dx.doi.org/10.1016/j.gloenvcha.2017.11.007,

[14] Osei-Kyei, R.; Tam, V.; Ma, M. and Mashiri, F.: *Critical review of the threats affecting the building of critical infrastructure resilience*.
International Journal of Disaster Risk Reduction **60**, No. 102316, 2021,
http://dx.doi.org/10.1016/j.ijdrr.2021.102316,

[15] Zio, E.: *Challenges in the vulnerability and risk analysis of critical infrastructures*.
Reliability Engineering & System Safety **152**, 137-150, 2016,
http://dx.doi.org/10.1016/j.ress.2016.02.009,

[16] Földi, L. and Padányi, J.: *Climate change as a challenge to the armed forces*.
Contemporary Military Challenges **24**(4), 37-48, 2022,
http://dx.doi.org/10.33179/bsv.99.svi.11.cmc.24.4.2,

[17] Somogyi, T. and Nagy, R.: *Some impacts of global warming on critical infrastructure protection - heat waves and the European financial sector*.
Insights into Regional Development **4**(4), 11-20, 2022,
http://dx.doi.org/10.9770/IRD.2022.4.4(1),
[18] Botha, S. and Graham, S.E.: *(Counter-) terrorism in Africa: Reflections for a new decade*.
South African Journal of International Affairs **28**(2), 127-143, 2021,
http://dx.doi.org/10.1080/10220461.2021.1927823,
[19] Asongu, S.A. and Somé, J.: *Corruption, terrorism and illicit financial flows related to extractive commodity trade in Africa*.
Resources Policy **103**, No. 105569, 2025,
http://dx.doi.org/10.1016/j.resourpol.2025.105569,
[20] Besenyő, J.: *Inferno Terror: forest fires as the new form of terrorism*.
Terrorism and Political Violence **31**(6), 1229-1241, 2017,
http://dx.doi.org/10.1080/09546553.2017.1341876,
[21] Besenyő, J.; Márton, K. and Shaffer, R.: *Hospital Attacks Since 9/11: An Analysis of Terrorism Targeting Healthcare Facilities and Workers*.
Studies in Conflict & Terrorism **47**(1), 36-59, 2021,
http://dx.doi.org/10.1080/1057610X.2021.1937821,
[22] Adeoye, P.A., et al.: *Food and water access predictors of food security among rural households in Langai district, North-Central Nigeria*.
Interdisciplinary Description of Complex Systems **22**(2), 198-211, 2024,
http://dx.doi.org/10.7906/indecs.22.2.4,
[23] Alcaraz, C. and Zeadally, S.: *Critical infrastructure protection: Requirements and challenges for the 21st century*.
International Journal of Critical Infrastructure Protection **8**, 53-66, 2015,
http://dx.doi.org/10.1016/j.ijcip.2014.12.002,
[24] Urlainis, A.; Ornai, D.; Levy, R.; Vilnay, O. and Shohet, I.M.: *Loss and damage assessment in critical infrastructures due to extreme events*.
Safety Science **147**, No. 105587, 2022,
http://dx.doi.org/10.1016/j.ssci.2021.105587,
[25] Smith, K. and Petley, D.N.: *Environmental hazards*. 5th edition.
Routledge, 2009,
[26] Spirkova, D.; Hruska, R.; Stehlikova, B. and Mura, L.: *Quantification of Economic, Ecological and Social Impacts of Climate Change in the EU*.
European Journal of Interdisciplinary Studies **14**(2), 63-81, 2022,
http://dx.doi.org/10.24818/ejis.2022.21,
[27] Lamega, S.A., et al.: *It depends on the rain: Smallholder farmers' perceptions on the seasonality of feed gaps and how it affects livestock in semi-arid and arid regions in Southern Africa*.
Climate Risk Management **34**, No. 100362, 2021,
http://dx.doi.org/10.1016/j.crm.2021.100362,
[28] Broder, J.; Sennewald, C.C. and Baille, C.: *What is Risk*?
In: Fennelly, L.J., ed.: *Handbook of Loss Prevention and Crime Prevention*. 6th edition. Butterworth-Heinemann, pp.105-110, 2020,
http://dx.doi.org/10.1016/B978-0-12-817273-5.00011-9,
[29] Khodadadyan, A.; Mythen, G.; Bishop, B. and Assa, H.: *Grasping the nettle? Considering the contemporary challenges of risk assessment*.
Journal of Risk Research **24**(12), 1605-1618, 2021,
http://dx.doi.org/10.1080/13669877.2021.1894472,
[30] Hawchar, L.; Naughton, O.; Nolan, P.; Stewart, M.G. and Ryan, P.C.: *A GIS-based framework for high-level climate change risk assessment of critical infrastructure.*
Climate Risk Management **29**, No. 100235, 2020,
http://dx.doi.org/10.1016/j.crm.2020.100235,

[31] Krausmann, E. and Necci, A.: *Thinking the unthinkable: A perspective on Natech risks and Black Swans*.
Safety Science **139**, No. 105255, 2021,
http://dx.doi.org/10.1016/j.ssci.2021.105255,
[32] Krausmann, E.; Girgin, S. and Necci, A.: *Natural hazard impacts on industry and critical infrastructure: Natech risk drivers and risk management performance indicators*.
International Journal of Disaster Risk Reduction **40**, No. 101163, 2019,
http://dx.doi.org/10.1016/j.ijdrr.2019.101163,
[33] Goddard, J. and Wilson, O.S.J.: *Banking*.
Oxford University Press. 2016,
[34] Ilesanmi, K.; Tewari, D.D. and Nsiah, C.: *Management of shadow banks for economic and financial stability in South Africa*.
Cogent Economics & Finance **7**(1), No. 1568859, 2019,
http://dx.doi.org/10.1080/23322039.2019.1568849,
[35] Macaulay, T.: *Assessing operational risk in the financial sector, using interdependency metrics*.
International Journal of Critical Infrastructure Protection **1**, 45-52, 2008,
http://dx.doi.org/10.1016/j.ijcip.2008.08.008,
[36] Attoh, E.M.N.A.N.; de Burin, K.; Goosen, H.; van Veldhoven, F. and Ludwig, F.: *Making physical climate risk assessments relevant to the financial sector – Lessons learned from real estate cases in the Netherlands*.
Climate Risk Management **37**, No. 100447, 2022,
http://dx.doi.org/10.1016/j.crm.2022.100447,
[37] SARB: *Prudential Authority Annual Report 2021/22*.
https://www.resbank.co.za/content/dam/sarb/publications/reports/pa-annual-reports/2022/Prudential%20Authority%20Annual%20Report%202021%202022.pdf, accessed 4th January, 2024,
[38] SARB: *Prudential Communication 10 of 2022. Climate-related risks*.
https://www.resbank.co.za/content/dam/sarb/publications/prudential-authority/pa-public-awareness/covid-19-response/2022/Prudential%20Communication%2010%20of%202022%20-%20Climate-related%20Risks.pdf, accessed 4th January, 2024,
[39] CBK: *Kenya Financial Sector Stability Report*.
https://www.centralbank.go.ke/uploads/financial_sector_stability/1075698866_FSR%20July%202022_published.pdf, accessed 27th October, 2023,
[40] CBK: *Guidance on climate-related risk management*.
https://www.centralbank.go.ke/wp-content/uploads/2021/10/Guidance-on-Climate-Related-Risk-Management.pdf, accessed 12th December, 2023,
[41] Shrivastava, V.; Balasubramanian, J.; Katyal, A.; Yadav, A. and Yogananthan, S.: *Understanding the significance of risk management in enterprise management dynamics*.
Multidisciplinary Reviews **6**, No. e2023ss093, 2024,
http://dx.doi.org/10.31893/multirev.2023ss093,
[42] Emrouznejad, A.; Abbasi, S. and Sıcakyüz, C.: *Supply chain risk management: A content analysis-based review of existing and emerging topics*.
Supply Chain Analytics **3**, No. 100031, 2023,
http://dx.doi.org/10.1016/j.sca.2023.100031,
[43] Hewitt, C. and Stone, R.: *Climate services for managing societal risks and opportunities*.
Climate Services **23**, No. 100240, 2021,
http://dx.doi.org/10.1016/j.cliser.2021.100240,
[44] Lentner, C. and Zsamóczai, S.J.: *Sustainability and environmental conservation in strategy of National Bank of Hungary in 2020s*.
In: 2022 IEEE 26th International Conference on Intelligent Engineering Systems (INES). Georgioupolis Chania, pp.000213-000218, 2022,
http://dx.doi.org/10.1109/INES56734.2022.9922646.