Enhancing Risk Assessment for Improved Country Risk Financing Strategy

Thailand

A Policy Brief

Introduction and Context

Climate change is disrupting economies and livelihoods globally, with developing countries like Thailand among the hardest hit. Increasing extreme heat, flood, and drought events threaten Thailand's food security and economic stability. For example, under high-emissions (RCP8.5) climate scenarios, Thailand's agricultural output is projected to decline by up to 15% by 2050, with a corresponding decline in consumption of around 12%. Lower consumption means that people's wages are only just enough to pay for the cost of living, resulting in a lower quality of life.

Such climate pressures, combined with existing vulnerabilities, pose significant risks to poverty reduction and development gains. However, climate risk impacts, both direct and indirect, remain challenging to quantify. Direct impacts of climate risk events, such as the impact of adverse weather conditions on agriculture or the damage to productive assets and business interruptions, cause economic losses through loss of income, productivity, and employment, negatively impacting GDP. Indirect impacts are even more challenging to quantify. Consider, for example, the adverse health impact of heatwaves on the population and the associated costs, or the costs of students missing school due to a flood. Hence, planning effective adaptation and risk financing strategies is particularly challenging, as it requires a comprehensive understanding of both the direct economic losses and the broader non-monetary impacts on sectors such as health, education, and overall livelihoods.

The ERA Project in Thailand

To address these challenges, the *Enhancing Risk Assessments (ERA) Project for Improved Country Risk Financing Strategies* was initiated as a partnership between the Government of Thailand, represented by the Department of Agriculture (DoA), the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and United Nations University – Institute for Environment and Human Security (UNU-EHS)/Munich Climate Insurance Initiative (MCII).

The ERA project delivers a new generation of climate risk assessment to inform Thailand's climate change adaptation planning and disaster risk financing strategies. The project applied the *Economics of Climate Adaptation (ECA) analytical framework* together with the open-source *CLIMADA modeling platform*, providing a probabilistic outlook of current and future climate risks and evaluating the cost-effectiveness of adaptation options.

Importantly, the analysis was extended beyond economic losses to also quantify "non-economic" impacts as well. These were identified and selected by the stakeholders during the kick-

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off workshop and included impacts on religious services and health, reduced accessibility to education and reduced mobility. Additionally, as traditional risk models do not tend to account for economy-wide effects, a *Dynamic General Equilibrium model for Climate Resilient Economic Development (DGE-CRED)* was integrated into CLIMADA to assess how macroeconomic indicators are impacted by climate change.

Finally, the project developed a Graphical User Interface called RISK WISE as a tool to assist decision making, allowing stakeholders to interactively explore the results and visualize the outcomes (e.g., by selecting hazard scenarios, assets at risk, and adaptation measures).

This integrated approach – combining risk analytics with macroeconomic modeling and an accessible interface – provides a robust foundation for evidence-based climate resilience planning and risk financing in Thailand.

Trends in Climate Hazards and Exposure Patterns

The ERA assessment for Thailand focused on three major climate hazards: *floods, droughts, and heatwaves.* The analysis projected impacts up to 2050 under moderate-emissions (RCP4.5) and high-emissions (RCP8.5) climate scenarios.

- **Floods:** Increasingly threaten key river basins (Chao Phraya, Mekong, Mun, Chi) and urban centers like Bangkok, endangering major agricultural and economic assets. Annual losses are projected to rise from USD 122 million in 2024 to USD 791 million by 2050 under high-emissions (RCP8.5) climate scenarios. Due to the widespread nature of flooding in Thailand, which is generally the most destructive natural hazard, non-economic assets are also heavily impacted.
- **Droughts:** Growing in frequency and severity, affecting both rural agriculture and urban water supply. Annual losses are expected to increase from USD 354 million in 2024 to USD 764 million by 2050 under high-emissions climate scenarios.
- **Heatwaves:** Intensifying across urban areas, notably Bangkok, reducing overall productivity and crop yields. The number of people at risk, including 490,000 students and 15,000 monks in 2024, could rise to 1.07 million students and 34,000 monks by 2050.

These combined climate pressures are projected to *reduce Thailand's GDP by over 2% by 2050 under high-emissions (RCP8.5) climate scenarios,* underscoring the rising costs of climate change.

Climate Change and Socio-Economic Growth: A Compounding Risk

The ERA team used CLIMADA to simulate climate impacts under different future climate scenarios (up to 2050), both with and without socio-economic growth. The results show that while both drivers independently increase the risk, together they multiply it, which is a contributing factor in the sharp increase in projected damages.

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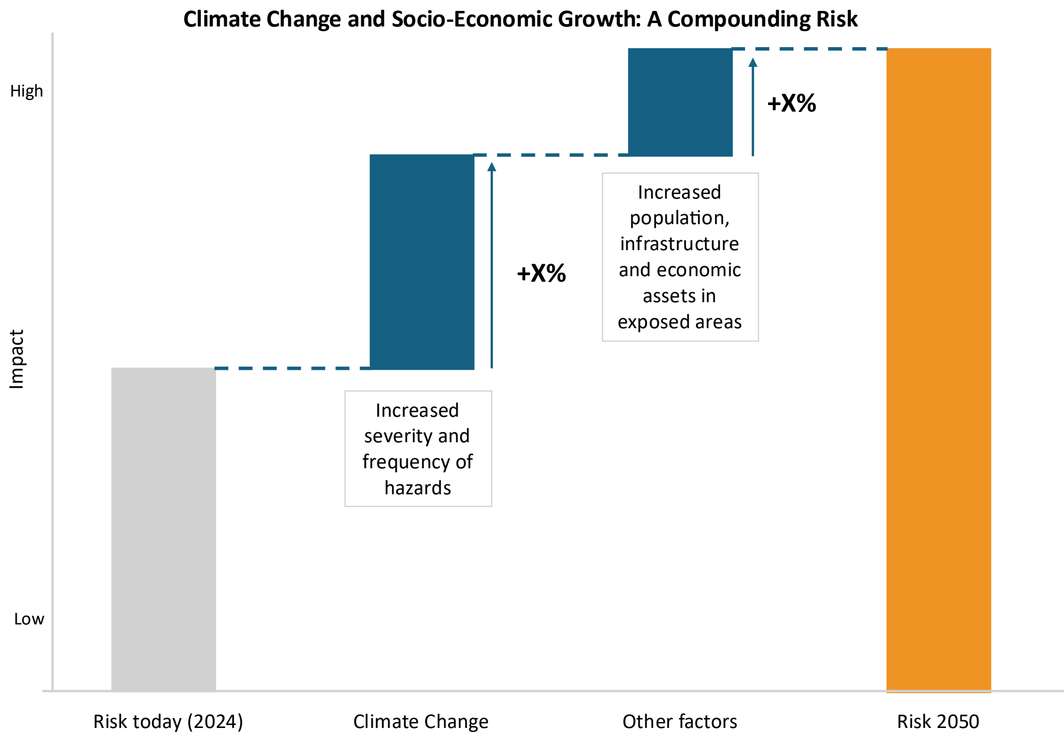

For example, flood damages are projected by the CLIMADA Model to rise from about USD 122,14 million per year now to well over USD 791.36 million per year by 2050 (RCP 8.5), a 6.5-fold increase. Flood risks are worsening as urban expansion encroaches on poorly drained floodplains, especially around the Bangkok Metropolitan Area and near industrial parks. This increases the vulnerability of Thailand's rapidly diversifying economy, which is now driven by strong manufacturing and tourism sectors, in addition to its traditional agricultural focus.

The interaction of socio-economic growth and climate change leads to a compounding of risk in Thailand. Even if climate hazards remained constant, the increasing concentration of people and economic value in vulnerable areas would raise climate-related losses.

Macroeconomic Implications for Thailand

Looking at the economy, *climate change will perhaps be the biggest challenge for Thailand's economic growth trajectory* over the coming decades. The integrated DGE-CRED macroeconomic model assessed how recurring disasters (floods, droughts, and heatwaves) could compound over time:

- Under a high emission scenario, *the cumulative impact of these climate hazards could reduce Thailand's GDP by up to 2% by 2050*, compared to a hypothetical baseline scenario without climate shocks. These impacts are not one-off events; *repeated shocks have long-lasting effects* that can depress investment and productivity, creating a

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persistent gap in the economy's output. Although GDP changes may seem modest, the model reveals a more significant concern: the projected *decline in household consumption could reach about 12% by 2050 under high-emissions (RCP8.5) climate scenarios*, indicating a substantial decrease in individuals' economic resources and quality of life.

- This projection of growing losses underscores that without adaptation, climate change could erode decades of development gains as well as fiscal stability. However, the modeling also delivers a hopeful message: investing in adaptation can significantly offset these impacts, projecting scenarios where effective adaptation measures can half the economic losses. The study highlights timely adaptation efforts as crucial to prevent climate shocks from disrupting Thailand's economic development.

In summary, the ERA project's risk assessment paints a stark picture of escalating climate risk to Thailand's economy and society. Yet it also demonstrates that early and sustained adaptation efforts could significantly reduce these risks.

Projected Compounding Risk and Potential Impact of Adaptation

To manage these escalating risks, Thailand has a wide range of adaptation options. Adaptation strategies are crucial for **addressing the pressing climate challenges** Thailand faces, including the severe impacts of floods, droughts, and heatwaves. They help in **reducing potential damage** from extreme weather events and are designed to **lower the intensity or frequency of these effects**, decrease the vulnerability of assets, or reduce the number of affected assets and populations.

As can be seen from the above, the impact of climate risk in Thailand would be exacerbated by the socio-economic growth expected up to 2050. Therefore, adaptation efforts and strategies must be implemented to mitigate the potential impact of climate risks and minimise their effects.

The following table summarizes the compounding effects of climate risks and socio-economic drivers up to 2050 and potential impacts of selected adaptation efforts. The cost-benefit analysis of implementing these measures was calculated according to the potential averted damage.

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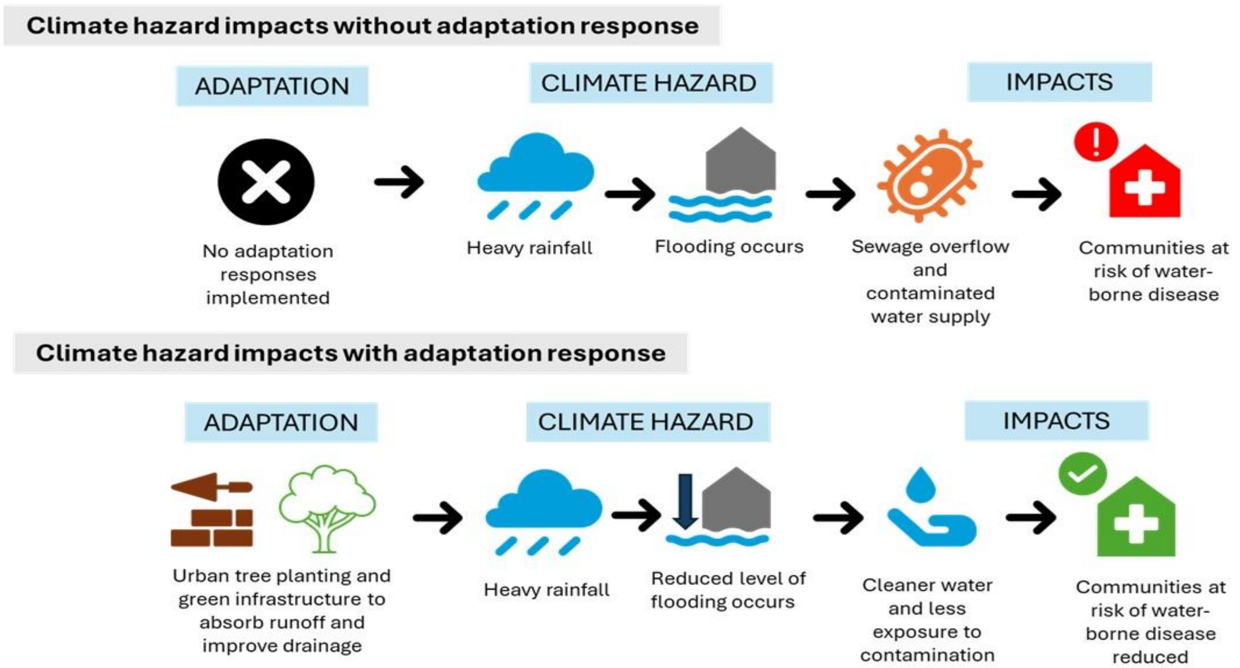
Impact Category		Compounding Risks	Current Impact (projected in 2024)	Projected Impact without Adaptation (in 2050, RCP 8.5 + Growth)	Potential Impact of Adaptation Efforts
Floods	Economic Damages	Climate Risks + Economic Growth	Up to USD 122.14 million in annual losses	Up to USD 791.36 million in annual losses	Wetland restoration and rehabilitation, followed by training on agricultural adaptation topics, are the most cost-effective strategies for mitigating future flood damage. However, scaling up these options is rather limited, and dredging canals will likely achieve the greatest reduction in risk.
	Health Risk (Diarrhea Patients)	Flood Intensity + Informal Settlements Growth	15,050 people affected per year	18,990 people affected per year	**Every USD 1,000 invested** in expanding Green Spaces could **reduce the number of diarrhea cases caused by flooding by almost 11 cases.** This makes Green Spaces the **most cost-effective** strategy for reducing flood-related health impacts that has been evaluated, and they also offer **great scalability**.
Droughts	Economic Damages	Variable Rainfall + Heavy Dependence on Water-Intensive Agriculture and Wet Markets	Up to USD 354.22 million in annual losses	Up to USD 763.65 million in annual losses	1 USD invested in Soil, Water & Pest (SWP) management and Climate Smart Agriculture offers adaptation benefits worth 1.4 USD and 1 USD respectively.
Heatwaves	Education Disruptions (Students Affected)	Rising Heat Intensity + Rapid Urban Growth and Aging Population	490,090 students impacted	1,077,490 students at risk	The benefit/cost-ratio of investing 1 USD in Green Spaces is greater than 1 for students, meaning that for every dollar invested, more than one student is protected from the impacts of heatwaves. For Buddhist monks the ratio is 0.3. Overall, the two measures assessed (Green Spaces and Roofs) do not sufficiently address total heatwave risk, highlighting the need for complementary interventions.
	Health and Well-Being Disruptions (Buddhist Monks Affected)		14,780 Buddhist monks impacted	33,680 Buddhist monks at risk	



Inter-Linkages between Climate Hazards, Vulnerable Assets, Adaptation Responses, and the Emergent Benefits

Adaptation Measures for Flood, Drought and Heatwave Risks and their Cost-Benefit Assessments

The ERA analysis applied a systematic framework to identify and evaluate the most effective adaptation measures across sectors. Starting from an extensive list of 82 potential adaptation interventions (37 for floods, 25 for droughts, and 20 for heatwaves), the project narrowed it to 24 high-priority measures: 15 focused on flood risk, 7 for droughts and 2 on heatwave risk, deemed most relevant and feasible for Thailand.

These measures span a spectrum of approaches, including **"Grey" infrastructure** (i.e. engineered structures), **Nature-based Solutions** (NbS) that leverage existing ecosystems, **Hybrid measures** that combine green and grey techniques, **Systemic measures** (policies, capacity-building, and community programs) and **Risk financing instruments** (like insurance and microinsurance).

The following table provides a summary of the cost-benefit estimates for selected measures that address floods, droughts and heatwaves, which often overlap, through a cost-benefit analysis using the CLIMADA model to simulate the Annual Average Impact up to 2050.

Each measure's cost has been estimated based on Thai data or localized international benchmarks, representing the investment (including maintenance) needed from now to 2050 to implement at scale.

Adaptation Measures Category	Flood Management Measures	Drought Management Measures	Heatwave Management Measures	Key Cost-Benefit Insights
Systemic Measures Policies, capacity-building, and community programs	**Early Warning System (EWS)** ▪ Monitoring and forecasting systems ▪ Advanced warning communications ▪ **Cost: USD 12.7 Million** **Improved Solid Waste Management (SWM)** ▪ Addresses blockages in drainage systems by removing waste and invasive species ▪ **Cost: USD 4.7 Million** **Flood Index Insurance (Index Insurance)** • Financial protection for farmers, for example through Thailand's National Rice Insurance scheme • **Cost: USD 92.3 Million** **Training in Agricultural Topics for Adaptation** • Capacity-building initiatives to help farmers and communities cope better with the impacts of flooding • **Cost: USD 1.6 Million** **Agricultural Zoning** • Optimizing land use and preventing unsustainable farming practices in flood-prone areas • **Cost: USD 13.5 Million** **Water Tolerant Crops** • Crops that can thrive in soggy conditions • **Cost: USD 13.5 Million**	**Management of Protected Environmental Areas (MPA)** ▪ Management of protected areas and preserving ecosystems ▪ **Cost: USD 13.2 Million**	*No specific heatwave measures identified*	▪ EWS has a 1:10 cost-benefit ratio as an adaptation measure ▪ SWM is highly cost-effective for reducing flood-related health impacts ▪ Flood Index Insurance safeguards rice farmers, facilitates recovery and complements other adaptation approaches ▪ MPA is one of the most cost-effective strategies for mitigating future drought damage for farmers

Nature-based Solutions Leveraging existing eco-systems	**Green Spaces (GS)** • Expanding green areas in cities, primarily through tree planting • **Cost: USD 32.3 Million** **Wetland Restoration and Rehabilitation (WR)** • Preserving and enhancing essential ecosystem services that help regulate water supply and improve resilience to climate change • **Cost: USD 3 Million**	**Wetland Restoration and Rehabilitation (WR)** • Preserving and enhancing essential ecosystem services that help regulate water supply and improve resilience to climate change • **Cost: USD 3 Million** **Soil, Water, and Pest Management (SWP)** • Approaches to improve soil quality, enhance water retention, and manage pests in a way that reduces environmental impact • **Cost: USD 6.6 Million** **Legume Seed Production and Propagation** • Producing, propagating, and distributing peanut and mung bean seeds, which are more drought-tolerant and require less water • **Cost: USD 3.7 Million**	**Green Spaces (GS)** • Expanding green areas in cities, primarily through tree planting to lower ambient temperatures and mitigate the urban heat island effect • **Cost: USD 32.3 Million** **Green Roofs (GR)** • Growing vegetation on flat rooftops to reduce greenhouse gas emissions and mitigate the urban heat island effect countering heatwaves • **Cost: 1.5 Million USD**	• Green spaces are amongst the most cost-effective strategies for reducing flood (and heatwave) related health impacts, mitigating future economic damages • WR is a cost-effective strategy for mitigating future flood damage but it has limited scalability • Green roofs have a lower cost-benefit ratio than expanding green spaces
Hybrid Measures Combining green and grey techniques	**Detention Swales along Roads (DSR)** • Shallow, vegetated channels designed to slow down and capture stormwater runoff, allowing it to infiltrate the soil • **Cost: USD 5 Million** **Retention Reservoirs (RR)** • Artificial lakes to reduce peak water flows and lower flood risk during heavy rainfall events • **Cost: USD 5 Million** **Retention Furrows (RF)** • Vegetated depressions designed to capture runoff from impervious surfaces • **Cost: USD 30.6 Million**	**Climate-Smart Agriculture (CSA)** • Making farming systems more resilient to water shortages and high temperatures • Water-saving irrigation systems, introducing heat-tolerant and water-efficient crop varieties, intercropping, etc. • **Cost: USD 12.9 Million**	*No specific heatwave measures identified*	• DSR and RR offer high cost-efficiency in mitigating future flood damage for Buddhist monks and students • Retention Furrows tend to have lower cost-benefit ratios • CSA emerges as one of the most cost-effective strategies for mitigating future drought damage for economic assets

Grey Infrastructure Engineered solutions	**Dredging of Canals (DC)** • Removing sedimentation in open drainage canals or pipes • **Cost: USD 50.8 Million** **Improved Drainage System** • Manage excess stormwater by quickly channeling it away from vulnerable regions • **Cost: USD 21.9 Million** **Sandbags** • Temporary barriers to prevent or redirect floodwaters • **Cost: USD 13.6 Million** **Floodwall** • Physical barriers that prevent floodwaters from inundating vulnerable zones • **Cost: USD 382.4 Million**	**Improvement of Water Storage Systems (WSS)** • Setting up new rainwater storage tanks and maintaining existing ones to ensure a steady water supply during dry seasons • **Cost: USD 21.4 Million** **Improvement of Water Distribution Facilities (WDF)** • Rehabilitating existing water distribution systems, such as water channels • **Cost: USD 105 Million**	*No specific heatwave measures identified*	• DC can contribute to the largest reduction in risks for economic assets against floods • Cost-benefit assessments of improved drainage systems, sandbags and flood barriers are not explicitly estimated • WSS and WDF are among the most cost-effective strategies for mitigating future drought-related damage to economic assets

Key Policy Recommendations

Building climate resilience in Thailand is **not the mandate of a single ministry or sector** – it requires integrated, all-of-government action. Floods, droughts and heatwaves affect agriculture, water, housing, health, education, transport, finance and more, so effective adaptation demands that these domains work in concert. ERA's conclusions consistently emphasize cross-sectoral coordination as the linchpin for success.

Based on the insights generated through the ERA project, the following policy recommendations aim to support managing and financing of climate risk adaptation in Thailand by addressing both short-term priorities (actions that can be initiated immediately for quick benefits) and long-term strategies (systemic changes and investments for sustained resilience). They are tailored to national policymakers, local implementers, and supporting partners (donors and development agencies), and are organized into cross-cutting initiatives and sector-specific actions.

Thailand faces escalating climate risks from floods, droughts, and heatwaves that threaten agricultural productivity, energy security, and socio-economic stability. The ERA project highlights the importance of integrating data-driven climate modelling (through the RISK WISE tool) with targeted adaptation investments. The following five recommendations present a unified policy agenda to strengthen national resilience, reduce economic losses, and safeguard livelihoods:

1. **Establish a National Multi-Hazard Climate Resilience Framework:** Develop and operationalize a comprehensive, multi-sector policy targeting priority hazards – floods, droughts, and heatwaves – across high-risk regions and with differentiated adaptation approaches for each sector, e.g. agriculture, energy, and tourism. This framework should integrate climate modelling, adaptation costing, and sectoral action plans to halve projected GDP losses through timely, evidence-based interventions that prioritize resources toward high-risk areas and vulnerable sectors.
2. **Scale Up Investment in Integrated Adaptation Infrastructure:** Increase funding for a blended portfolio of nature-based solutions (NbS), grey, green, and blue infrastructure to bolster national resilience. Grey infrastructure should prioritize high-value economic assets in flood prone areas, while NbS and climate-smart practices can target non-economic assets and environmental conservation, especially in rural regions.
3. **Institutionalize Climate Data Integration and Decision Support:** Mainstream the RISK WISE tool and related analytics across ministries and subnational authorities to integrate climate data into policy, planning, budgeting, and public investment decisions. Strengthen local capacity to interpret and apply risk data in sector-specific adaptation planning through training programs, ensuring that risk information informs fiscal and regulatory frameworks and translates into actionable, region-specific adaptation plans.
4. **Prioritize Early and Targeted Adaptation Investments:** Implement phased adaptation programs in high-exposure sectors – particularly energy and agriculture – to minimize future economic shocks. Evidence from ERA modelling shows that early measures can reduce projected climate-induced losses by up to 50%, while enhancing long-term economic stability and risk financing readiness.
5. **Advance Localized, Community-Based Resilience Measures**: Promote targeted flood management in key river basins (Chao Phraya, Mekong, Mun), drought-resilient agricultural practices in agriculture-dependent regions, such as the Isan area, and urban green infrastructure in heat-prone, high-density urban areas, like Bangkok. Empower local governments and communities to co-design and implement these measures, combining physical defenses with early warning systems and social preparedness.

In conclusion, Thailand faces escalating climate risks from floods, droughts, and heatwaves, severely impacting the agricultural sector and socio-economic stability. The Enhancing Risk Assessments (ERA) project uses advanced modeling and the RISK WISE tool to provide crucial, data-driven insights that inform effective adaptation and risk financing strategies. The report's findings underscore the necessity of a comprehensive, integrated strategy. By blending nature-based solutions, grey infrastructure, and systemic measures strategically, and prioritizing early and targeted investments, Thailand can reduce vulnerabilities significantly, enhance resilience, and secure sustainable growth for its communities and economy. The RISK WISE tool translates these insights into actionable steps for stakeholders, facilitating informed decision-making for a climate-adaptive future that aligns with Thailand's unique geographic and economic landscape.

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Registered Offices

Bonn and Eschborn

Friedrich-Ebert-Allee 32 + 36
53113 Bonn, Deutschland
T +49 228 44 60-0 | **F** +49 228 44 60-17 66

Dag-Hammarskjöld-Weg 1 – 5
65760 Eschborn, Deutschland
T +49 61 96 79-0 | **F** +49 61 96 79-11 15

CONTACT

Nihar Jangle (GIZ) - ERA Project Director

Email: nihar.jangle@giz.de

Julian Tost (GIZ Thailand) - Project Director Thailand

Email: julian.tost@giz.de

For more information, please refer to the final report for Thailand.

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