Project Brief: Climate Resilient Economic Development (CRED)
MANAGING ECONOMIC RISKS OF CLIMATE CHANGE

Developing Macroeconomic Models for Climate-Sensitive Development Plans and Economic Development Strategies

Climate change is increasingly impacting on people's lives, disrupting national economies and local livelihoods alike. The costs of climate change on people and the economy are clear. The toll on human life and on the economic system is irrefutable. The question arises how states will respond: with business as usual or by investing in adaptation, and in the innovation that comes with it to unlock new opportunities and spur change. Climate adaptation can no longer be confined to single sectors (like agriculture) but needs to be mainstreamed into economic decision making. Only such a whole-economy approach to climate adaptation will allow countries to adequately understand and react to the increasing risks which climate change poses for their future national development and social welfare. We need a systematic assessment of climate risks for all economic sectors. This is the cornerstone for efficient planning of adaptation and climate-resilient economic development.

To enable climate-resilient economic development, it is essential that countries strengthen their ability to understand, plan for and continuously manage climate risk for their key economic processes. Macroeconomic modelling can make a major contribution to actionable, evidence-based policy-making for enhancing economic resilience.

However, in many countries, capacities for the assessment of country-specific climate change impacts on economic development via quantitative modelling are insufficient. Policy-makers need reliable economic model for anticipated climate impacts and adaptation

Beneficiary:	Economics/planning ministries in the three partner countries: Kazakhstan, Vietnam, Georgia
Funder:	German Federal Ministry of the Environment, Nature Conservation and Nuclear Safety
Duration:	01.01.2019 – 31.12.2022

options. These are necessary to decide upon effective direct economic-policy and fiscal-policy instruments that lead to resilient economic development by improving adaptation capacities and reducing the vulnerability of the economy and population.

CRED Programme: Added Value for Pilot Countries and National Partners

The CRED programme supports the partner countries in developing climate-sensitive development plans and economic development strategies. Setting this framework for climate-resilient economic development will help mitigate the economic and social risks due to climate change. This will also contribute to accomplishing national adaptation goals in national climate strategies and adaptation plans (NAPs) and Nationally Determined Contributions (NDCs) while maintaining sectoral competitiveness.

The lead executing agencies, the political partners of the CRED programme, are the Ministry of National Economy (MNE) in Kazakhstan, the Ministry of Planning and Investment (MPI) in Vietnam and the Ministry of Economy and Sustainable Development (MoESD) in Georgia. Further implementing partners are the Economic Research Institute (ERI) in Kazakhstan and the Central Institute for Economic Management (CIEM) in Vietnam.

The CRED programme supports its partners in developing climate-sensitive development plans and economic development strategies, by:

(1) Developing methods and tools for modelling the economic impacts of climate change and adaptation options;
(2) Supporting the lead executing agencies and implementing partners to become independent users of macro-economic models (capacity building through training and coaching);
(3) Supporting the lead executing agencies and relevant stakeholder in integrating the results in policy-making processes and adaptation planning

The programme creates synergies by achieving the same objective across the three countries but considering different starting positions, existing tools and requirements that result in individual measures for capacity building and policy advice.

Programme Objectives

The programmes targeted outcome is to provide methods and instruments to analyse and plan climate-resilient economic development. This also supports the implementation of the adaptation components of the Nationally Determined Contributions (NDCs). The outcome is tied to three different outputs, which are capacity building, policy advice and the dissemination of the programme results, illustrated in the figure below.
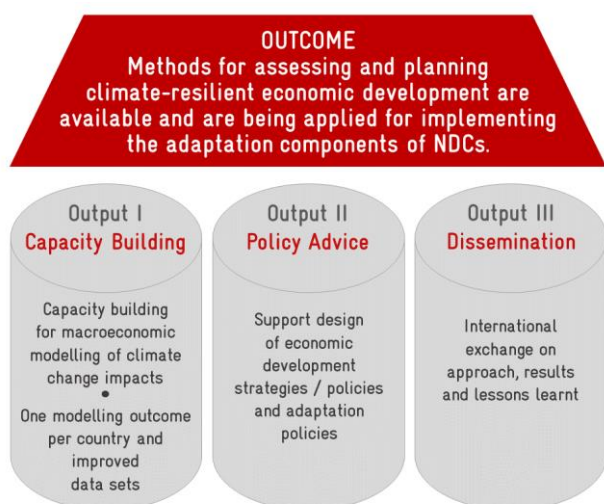

Fig. 1 Outcome and Outputs of the CRED programme

Macroeconomic Modelling of Climate Impacts

CRED supports macroeconomic modelling of anticipated climate risks. Specifically, it allows partner countries to assess how different economic sectors (and relevant sub-sectors) and their productivity (gross value added) are impacted by future climate change scenarios including extreme weather events and damages caused by slow-onset events (e.g. sea-level rise). Based on this impact assessment CRED enables partner countries to mitigate these impacts and identify adaptation measures that make economic sense, in terms of reducing the damage to GDP, raise labor productivity and be in line with development objectives. The CRED programme, jointly with its partners, therefore developed country-specific economic models (Table 1). CRED supports two different kinds of economic models responding to the specific demands from partner governments – E3 Model and Dynamic General Equilibrium Model.

Country	Kazakhstan	Georgia	Vietnam
Political Partner	Ministry of National Economy (MNE)	Ministry of Economy and Sustainable Development (MoESD)	Ministry of Planning and Investment (MPI)
Implementation Partner	Institute of Economic Research (ERI)	MoESD Sustainable Development Division	Central Institute for Economic Management (CIEM)
Model	E3 Model (e3.kz model)	E3 Model (e3.ge model)	Dynamic General Equilibrium Model (DGE-CRED Model)
Software	Excel, EViews	Excel, EViews	Dynare, Matlab or Octave
Consultancy	GWS	GWS	IWH

Table 1: Overview of the macroeconomic models

E3 Model: e3.kz model in Kazakhstan & e3.ge model in Georgia

The E3 models used in Kazakstan and Georgia contain three interlinked model parts, the (1) economy model, the (2) energy module and the (3) emission module (compare fig. 3). The central part of the economic model are the input-output tables and national accounts (macroeconomic data) depicting the key and supporting industries, their interlinkages as well as the domestic and foreign drivers for economic growth. Employment and income trends are part of the model to monitor the impacts on jobs and wealth. Energy balances, which include energy supply, transformation and demand for various fossil fuels and renewable energy sources, are at the center of the energy module. Energy demand is determined by the economic activity but also influenced by energy costs and prices which, in turn, affects energy supply provided either domestically or imported. The emissions module contains the energy-related countries CO_2 emissions caused by the combustion of fossil fuels.

Modeling future impacts of climate change on the national economy needs a link between climate projections and sectoral economic damages. Official and comprehensive data sets do yet not exist, so that economic damages must be derived from single past climate events in the countries and serve as a benchmark. In contrast, physical climate indicators such as temperature and precipitation are available as time series. The identified country specific climate hazards (drought, heatwave, flooding etc.), are then projected with regionalized/ down-scaled climate models and scenarios by experts from the University of the Balearic Islands (UIB) associated with CORDEX (Coordinated Regional Climate Downscaling Experiment). The evolution of the number of days or events per year for each climate hazard is used to estimate the future economic damages based on the benchmark assuming that a doubling of climate hazards also doubles the damage.

These sector-specific damages cause chain reactions in the E3 models which allow to analyze the ffects of climate change on core economic variables such as GDP, employment, or changes of production in certain economic sectors. Also, various adaptation measures (their costs and benefits based on national or international evidence) are introduced in the E3 models to identify adaptation options with high effectiveness and positive effects on the economy and the environment under different climate scenarios.

The E3 models are implemented in Microsoft Excel using Visual Basic for applications. Econometric estimations are done with EViews and linked to Excel.

The E3 models are developed by the Institute of Economic Structures Research (GWS) in close cooperation with the national partners.
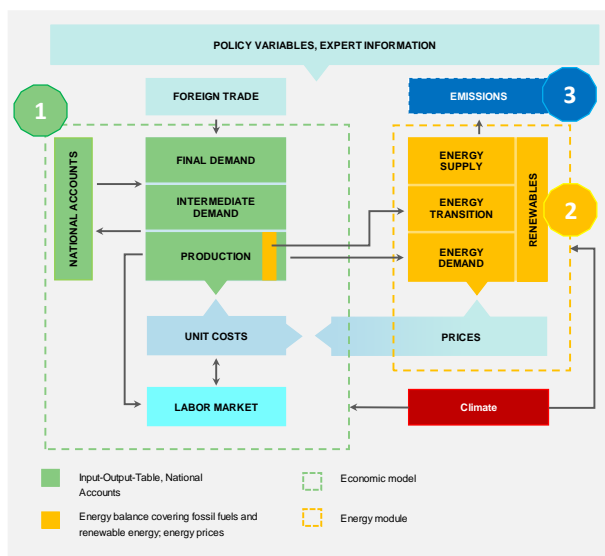

Fig.2 Illustration of the Dynamic Input-Output Model (E3.kz model in Kazakhstan & E3.ge model in Georgia)

Dynamic General Equilibrium Model (DGE-CRED Model in Vietnam)

In Vietnam, the CRED programme jointly with national partners from the Ministry for Planning and Investment (MPI) develops a Dynamic General Equilibrium model (DGE-CRED model) to capture the risks of climate change for the national economy. The DGE-CRED model developed in Vietnam builds on the analytical advantages of DGE-models, an approach already used in similar form in Vietnam to inform economic policy-making. Dynamic general equilibrium models with optimising agents are a standard tool to assess the impact of different policy measures. The DGE-CRED model allows integrating climate change effects into the relevant productivity equations. The model also allows differentiating between different regions and economic activities to account for different regional climate developments (the basic model structure is depicted in figure 4). Besides climate hazard and sector-specific damage functions, the model covers adaptation measures that reduce expected damages. The model can be used to assess future impacts of climate change on the economy of Vietnam and identify effective adaptation options. The CRED-DGE model is implemented in the environment Dynare and can be run using Matlab or Octave. Responsible for the development of the model is the Halle Institute for Economic Research (IWH). The code and a more detailed description are published on Github (see here).

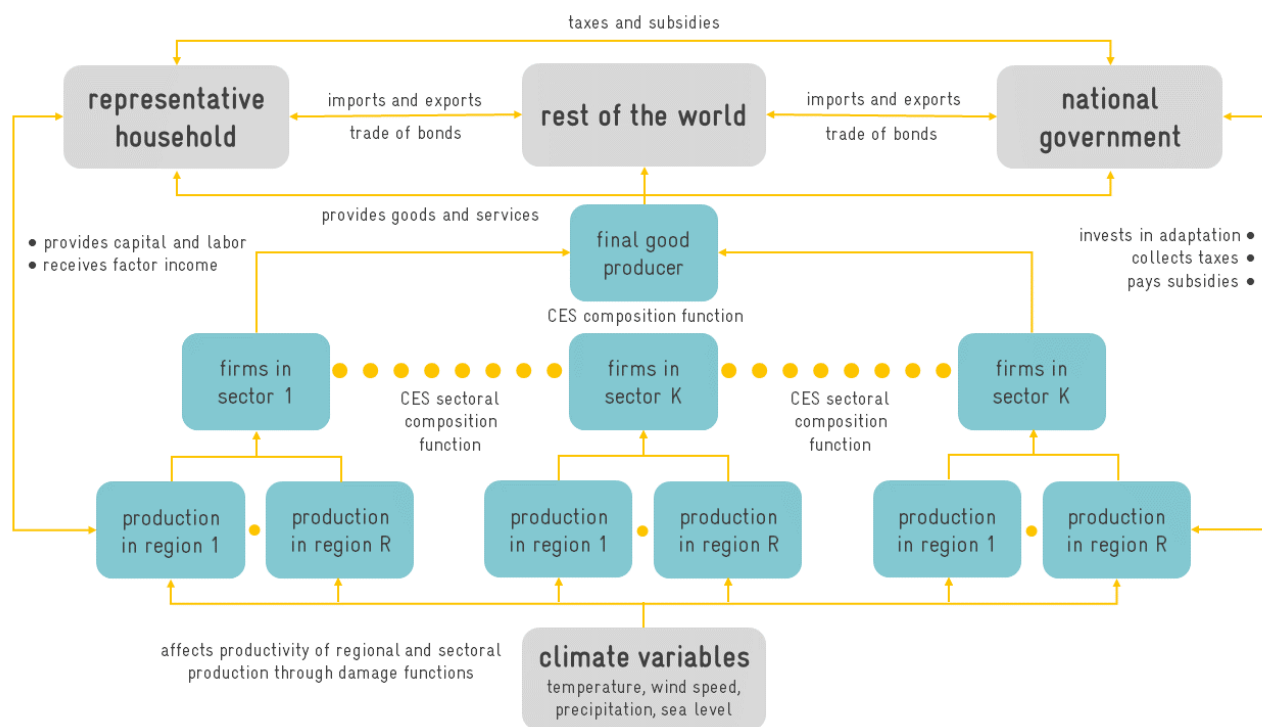*Fig.3 Illustration of the DGE-CRED Model in Vietnam*

CRED Model Building Training and Policy Advice

The primary focus of the CRED programme is to develop a model for climate-resilient economic development. It is the basis for policy-makers to design successful economic policies and adaptation strategies. By that, the CRED programme combines capacity building in macroeconomic modelling with advisory services in the use of these modelling results for evidence-based climate-resilient economic policies and strategies.

(1) Model Building Training

With the help of GWS and IWH the CRED programme conducted targeted trainings in each country. The first training was to establish the economic models, the second training was dedicated to the application of the models for analyzing the economic effects of climate change and adaptation to it. Both trainings differentiated some sessions for model builders only and others for model users. So called model users are experts that will be able to use the developed models for policy advice activities, without necessarily being skilled in the programming and re-coding of the economic model. This will further support the use and relevance of the developed model. In the trainings the participants learned about the model's mechanism and inner workings to properly

interpret the climate change and adaptation scenario results. The model extension and application is continued to be practiced through coaching in 2021 of adaptation scenarios in selected sectors.

Due to COVID-19, the model building trainings and coaching are done remotely. For this purpose, the CRED program established digital exchange rooms based on Microsoft Teams. The training participants from ministries, research institutes, universities and think thanks use this platform to exchange data, discuss open questions and contribute their knowledge. This supports the use of CRED's macroeconomic models and knowledge management within the participating institutions in the long term. Finally, the economic models supported by CRED are transferred to the partner institutions that will act as future owner and independent users of the models.

(2) Policy Advice Support

The CRED programme supports the translation of the modelling results in economic development strategies and adaptation policies. Therefore, the CRED programme prepares a general policy advice framework (defining the policy advice activities in all three countries), country-specific policy briefs (applying the general framework to the specific circumstances of the partner countries using the results from the CRED modelling activities) as well as country-specific recommendations on concrete options for adaptations policies. Furthermore, the programme organizes national workshops to discuss economic assessments of adaptation strategies and supports reviewing and

contributing to adaptation policies, strategy papers, briefing documents or presentations. The policy advice handbook will summarize the gained experiences from the policy advice support processes for national political decision-makers and their staff. The policy advice work is supported by the International Institute for Sustainable Development (IISD).

Technical capacities in modelling the macroeconomic impacts of climate risks and climate change adaptation measures combined with effective policy advice support can pave the path to climate-resilient economic development in the three partner countries.

Linking Adaptation and Mitigation

Adaptation, mitigation and sustainable development are inextricably connected, with potential for synergies and trade-offs. Considering the long-term development of nations, they need to simultaneously develop low-carbon economies while also adapting to increasing climate risks. That is why the CRED programme contributes to the development of Long Term Strategies (LTS) taking a more holistic approach by linking adaptation and mitigation. The CRED programme promotes the exploration of this nexus (e.g. see here).

To practically link adaptation and mitigationthe CRED programme works in Kazakhstan jointly with the BMU IKI programme "Support of Green Economy in Kazakhstan and Central Asia for a Low Carbon Economic Development (GE Kazakhstan)" on linking the modelling teams for mitigation and adaptation in the elaboration of Low-Emission Development Strategy (LEDS) and integrating adaptation in the LEDS narrative, the key policy document for NDC implementation.

Benefits of linking adaptation and mitigation

Better climate action to reduce risks of maladaptation, ineffective mitigation measures and stranded assets

Better understanding of the controversial causal relationship between ambitious international climate policy and it's impact

Tool for consensus building in a "win-lose" country and understanding needs for new business models

In Vietnam, the CRED programme cooperates with the GIZ programme "Macroeconomic Reform - Green Growth" that supports the Vietnamese government in implementing measures for sustainable growth according to the National Green Growth Strategy (VGGS). CRED supports the modelling of climate change risks and adaptation effects on the currently developed next phase of the VGGS and by that fosters the alignment between mitigation and adaptation strategies in Vietnam.