

*Exploring Kenya's vulnerability to
future transnational climate risks*
SENSES Case Study in Kenya

Report from the 2nd Workshop held on 14th October
2019, SEI Africa Center, ICRAF Campus, Nairobi

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Introduction

That climate change is likely to negatively impact Kenya's future development and achievement of the goals of *Kenya Vision 2030*¹ is evident with the recent publication of Kenya's National Climate Change Action Plan 2018-2022 (NCCAP)². The report states that climate change has increased the frequency and magnitude of extreme weather events in Kenya. This has led to loss of lives, diminished livelihoods, reduced crop and livestock production, and damaged infrastructure, among other adverse impacts. Kenya's economy is very dependent on climate-sensitive sectors such as agriculture, water, energy, tourism, wildlife, and health, and there is a worry that increased intensity and magnitude of weather-related disasters might aggravate conflicts, mostly over natural resources, and contribute to security threats.

However, Kenya does not need to only adapt to those challenges emerging from within the country's borders: In an increasingly globalized world, no country is fully insulated from the impacts of climate change outside its borders. Hitherto very little attention has been paid to this aspect of climate change in most countries, and Kenya is no exception. Looking at the Kenyan policy context (National Climate Change Action Plan 2018-2022: NCCAP), Kenya Vision 2030, etc.), it is evident that Kenyan adaptation architecture is designed primarily considering impacts of climate change within Kenya's borders, while in addition to these risks, Kenya will also be exposed to impacts of climate change in other countries.

Transnational climate impacts (TCI) reach across borders, affecting one country – and requiring adaptation there – as a result of climate change or climate-induced extreme events in another country. In other words, transnational impacts of climate change are those that occur in one place as a consequence of climate impacts somewhere else. TCIs are transmitted across borders along four risk pathways: the biophysical pathway, the finance pathway, the people pathways and the trade pathway³.

In the lack of any references to cross-border climate risks in the Kenyan adaptation architecture, it is necessary to identify future TCI risks and update the Kenyan adaptation strategies accordingly. The SENSES⁴ case study in Kenya aims at exploring future cross-border climate risks transmitted to Kenya through the four TCI pathways and develop adaptation options and proactive action items in respond to transnational climate impacts.

¹ <http://vision2030.go.ke>

² Government of Kenya (2018). *National Climate Change Action Plan (Kenya): 2018-2022*. Nairobi: Ministry of Environment and Forestry.

³ Hedlund, J., Fick, S., Carlsen, H., Benzie M. (2018), "Quantifying Transnational Climate Impact Exposure: new perspectives on the global distribution of climate risk", *Global Environmental Change* 52, 75-85.

SENSES; Climate Change Scenario Services

In times of high volatility and complexity, climate change scenarios can be a helpful means to investigate potential futures and understanding risks and opportunities. The SENSES⁵ (Climate Change Scenario Services: Mapping the future) project aims to develop tools and approaches to make climate change scenarios more accessible and comprehensible to a wide range of stakeholder groups. The overarching goal of the SENSES project is to develop a tailor-made, user-determined Climate Change Scenario Toolkit (the “SENSES” Toolkit) connecting the wide array of scenarios developed by the climate change research community to selected user and stakeholder groups.

The SENSES project is being led by world-class research institutions; the Potsdam Institute for Climate Impacts Research (PIK), the International Institute for Applied Systems Analysis (IIASA), Wageningen University, the Potsdam University of Applied Sciences and the Stockholm Environment Institute (SEI).

The SENSES project includes two case studies, one in Kenya and one in the Netherlands. These two case studies aim to explore how user-driven regional scenarios can be connected to the global scenario literature and develop effective approaches and best practice guidelines for the co-production of socioeconomic scenario on local and regional levels. However, in addition to this overall goal, each case study aims at delivering real value to the national and local stakeholders involved. The case study on Kenya is led by SEI Africa Center located in Nairobi and strong connections and collaborations with local and national stakeholders and policy makers.

SENSES case study in Kenya

The SENSES case study in Kenya is called “*Exploring Kenya’s vulnerability to future transnational climate impacts using futures scenarios*”. In this case study, we focus on identifying future transnational climate risks, i.e. climate risks originating outside Kenya. Those risks are classified according to four risk pathways (trade, bio-physical, finance, people). The identified risks are then embedded in a set of futures scenarios including both climate projections and socioeconomic developments.

The socioeconomic scenarios for Kenya are linked to the shared socio-economic pathways (SSPs), the global set of scenarios currently used by the climate change research community.⁶ The set of future scenarios for Kenya will be used as a backbone for assessing further transnational climate risks and opportunities along the four pathways mentioned above.

¹<http://vision2030.go.ke>

²Government of Kenya (2018). *National Climate Change Action Plan (Kenya): 2018-2022*. Nairobi: Ministry of Environment and Forestry.

³ Hedlund, J., Fick, S., Carlsen, H., Benzie M. (2018), “Quantifying Transnational Climate Impact Exposure: new perspectives on the global distribution of climate risk”, *Global Environmental Change* 52, 75-85.

⁵ www.senses-project.org. SENSES is funded by JPI Climate which is an initiative of EU member states and associated members to align national programs.

⁶ O’Neill et al. (2017), “The roads ahead”, *Glob. Env. Change* 42, 169-180.

The SENSES case study in Kenya builds upon the national futures projections and adaptation plans and adds value by 1) linking national impacts and scenarios to the global shared socio-economic pathways and 2) exploring transnational climate impacts to the Kenya climate risk profile and 3) co-producing adaptation options in response to those risks and contributing to the current adaptation architecture in Kenya.

The overall process of the Kenya case study consists of six steps:

- *Scoping*; with a set of semi-structure interviews with experts and stakeholders, users' needs and knowledge gaps will be identified.
- *Drafting future scenarios for Kenya*; in the first stakeholder workshop, the skeleton of a set of scenarios for Kenya will be co-produced through a participatory process with selected stakeholders.
- *Scenario building*; the co-produced scenarios will be enriched by adding climate change impacts for Kenya as well as relevant impacts from outside of Kenya.
- *Combining scenarios with TCIs*; in the second stakeholder workshop, the Kenya scenarios and the TCI pathways will be used as the framework to identify future TCI risks as well as options for adaptation. This workshop will also initiate the development of adaptation pathways in response to both national and transnational climate impacts.
- *Communication and outreach*; the results, including the set of scenarios and future TCI risks and opportunities will be communicated with Kenyans stakeholders, policy makers and practitioners. We are currently investigating plans to organize an event around the publication of the case study report.

In the SENSES case study in Kenya, we use co-production techniques and participatory processes to build socioeconomic future scenarios and use them to co-create knowledge about adaptation options together with local stakeholders. For this purpose, two workshops were initially foreseen in this case study; the first focused on building the scenarios and the second aimed at using the scenario framework to identify TCI risks and opportunities and assess the Kenyan adaptation architecture considering cross-border climate risks.

This report is focused on presenting the process and results of the second SENSES workshop in Kenya, held on 14th October 2019 at SEI Africa. The workshop was a follow up to the first SENSES workshop, held on 10th January 2019, and aimed at identifying future transnational climate risks in Kenya and co-producing adaptation options to address these risks. In the following sections, we first present a brief overview of the scope, objective and results of the first SENSES workshop and the overall back-office processes done by the SENSES team between the two workshops. Finally, we proceed to the second SENSES workshop and explain the overall process, content presented in different sections and results and outcomes.

First workshop: Developing the skeleton of socioeconomic scenarios for Kenya

The first workshop in the case study was held on Thursday 10 January 2019 at the SEI Africa Centre and brought together stakeholders and representatives from the National and County Governments, NGOs, private sector, universities and international organizations working in the climate change adaptation space.

The main objective of the first workshop was to create a skeleton for future scenarios as tools to explore the future TCIs in Kenya. The skeleton of the socioeconomic scenarios for Kenya were constructed through combined top-down and bottom-up co-production process, where the bottom-up element consisted of identifying the most important drivers for understanding Kenya's vulnerability to future transboundary climate risks and the top-down element consisted of the using the global Shared Socioeconomic Pathways (SSPs) as common boundary conditions to explore alternative states (conditions) for the identified drivers. The aim was to link national impacts and scenarios to the global socio-economic scenarios.

The process started with the identification of key drivers for understanding Kenya's vulnerability to future transnational climate risks. The drivers were generated in respond to the question "What are the most important drivers for understanding Kenya's vulnerability to future transnational climate risks?". After the idea generation, the identified drivers were clustered and prioritized into seven key cluster of drivers.

Table 1. Key clusters of drivers

No	Prioritized Clusters	Drivers
1	Import of food	1. Food security - Storage - Process – value addition - Value chain
		2. Food security - Innovations and technologies
		3. Irrigation technologies available related to import of food
		4. Adaptation of sustainable consumption and production practices - Best agriculture
		5. Trade cross-border vulnerability assessment
2	Regional collaboration on TCI	1. Improve regional coordination - East Africa
		2. Regulatory frameworks - inter-regions
		3. Sugar from Brazil domestic production versus import -> creates dependency
3		1. Governance

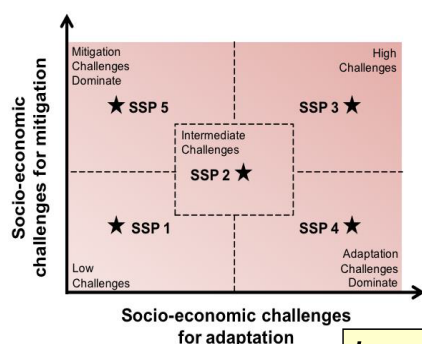
	Policy implementation	- Due care - Inclusion - Stewardship
		2. Improve policy implementation
		3. Devolution - Affects governance agreements and implementation
		4. Implementation of relevant regional policies and strategies
4	Knowledge management systems	1. Access, use and effects of climate information and advisories - (services)
		2. Creation of knowledge management platforms - Fragmented knowledge
		3. Develop data bases and baseline surveys
		4. Awareness creation of climate risks
		5. Information sharing - (Local and Global)
5	Rapid population growth	1. Rapid population growth - Competing for same resources, pollution and waste disposal
6	Technology transfer	1. Technologies to reduce vulnerability to TCIs
		2. Innovation for enhanced and sustainable production of food
		3. Research and technological transfer - Mechanization OMO
7	Shared natural resources	1. Transnational water availability and management
		2. Water and wastewater management practices - Improving
		3. Investment in water sector - And interdependencies to other countries
		4. Sharing natural resources - Desertification of livelihoods - +Uganda +Ethiopia
		5. Resource – use conflicts

In the next step, four SSPs were introduced. The SSPs are the current generation of socioeconomic scenarios in climate community research which offer a systematic exploration of possible socioeconomic futures in terms of widely different predispositions to mitigate and adapt to climate change. Socioeconomic challenges to mitigate vary, e.g., with the resource and carbon intensity of consumption. Socioeconomic challenges to adapt vary, e.g., with the level of education, health care, poverty and inequality in societies around the world. The following figure shows the SSPs narratives and place them

on two axes representing challenges to adaptation and mitigation (the SSP2 is the business as usual scenarios and has been excluded in this study).

This world places increasing faith in competitive markets, innovation and participatory societies to produce rapid technological progress and development

A resurgent nationalism, concerns about competitiveness and security, and regional conflicts push countries to increasingly focus on national and regional security issues, including energy and food security.



The world shifts gradually, but pervasively, toward a more sustainable path, emphasizing more inclusive development that respects perceived environmental boundaries.

Increasing disparities in education, economic opportunity and political power lead to growing inequalities across and within countries. A gap widens between a well educated international society supporting a high-tech global economy, and fragmented lower-income, poorly educated societies that work in regional low-tech economies.

Figure 1. Shared Socioeconomic Pathways (SSPs)

The SSPs were introduced into the process as the top-down element to be used as ‘boundary conditions’ (context scenarios) for the future development of the prioritized drivers. Hence, after introducing the SSPs, the stakeholders were asked to assign alternative states (conditions) to each driver given that the world at large is described as in the alternative SSPs. The core question for this exercise was: “How might this cluster (of drivers) play out in the 2050s perspective given each context scenario?”.

The combination of drivers and their assigned states given the alternative SSPs constructed the skeleton for the alternative extended SSPs for Kenya (table 2).

Table 2. Alternative states for the seven prioritised (clusters of) driver for each SSPs

Clusters of drivers	SSP1	SSP3	SSP4	SSP5
Shared natural resources	Collaborative management of shared natural resources Improved resource efficiency Shared equitable economic benefits from the shared resources	- Isolated planning for the use of shared natural resources (leading to degradation of resources) - Increased investments in national / local governmental institutions	- Some countries use the shared natural resources more than other shareholders - High disparities in level of development btw Kenya and western countries	- Increased use and harvest of natural resources - Collaboration and shared approaches in managing shared natural resources
Technology transfer	Increased use of green tech and renewables Full food security Improved human settlement Increased life expectancy	- Greater investments in research and knowledge creation in local and national institutions - Protection to access of locally developed technologies and innovations - High costs of access to knowledge	- Increased capacity gap btw high- and low-income people - Only wealthy people and countries have access to technology - Poor people and communities are not able/ cannot afford to have access technologies	- Advanced exploration and exploitation of fossil fuel resources - Low adoption of clean green technologies
Knowledge management systems	Increased research on sustainability and resource management Enhanced governance Robust information systems Better decision making based on knowledge	- Poor knowledge sharing practices internationally and externally - Increased knowledge gaps due to poor and low sharing of knowledge	Poor do not have access to and cannot contribute in knowledge	- Increased research on fossil fuel-based development and infrastructures (roads, ports, etc.) - Better national planning + projections of fossil fuel resources for economic growth
Policy implementation	Effective implementation of sustainability policies Vision 2030 will be attained	Poor attention to regional and global policies and increased attention to national and local policies	Disparities in policy implementation between countries Vision 2030 won't be attained	Strong policies on economic development but weak in sustainability
Import of food	Slightly down	Down for trans-continental, And up for neighbouring states	Continues (Elite benefits from imports, masses do not)	First: (Strong) increase Later: stabilising
Regional collaboration	Improves (and keep growing)	Start: positive, collaboration Long run: rivalry up, collaboration down	Elite collaborates Blocs try to unite	Increases
Rapid population growth	Slowly comes down	Continues high	Continues high	Maintain high growth



ESSP1:
Kenya in a sustainable world



ESSP3:
Kenya and regional rivalry



ESSP4:
Kenya struggling inequality



ESSP5:
Kenya and fossil-fuelled

Second workshop: Identifying TCI risks for Kenya and co-producing adaptation options

The second workshop was held on October 14, 2019 at the SEI Africa Centre. The overarching aim of this interactive and participatory workshop was to use the scenario framework we developed in the first workshop to explore adaptation solutions to climate risks originating outside Kenya. The workshop used scenarios and integrated climate impact data to assess the current adaptation architecture in Kenya and explore adaptation solutions and strategies in response to both national and transnational climate risks (the focus). The aim of the workshop was to 1) present the results from the 1st workshop and back office work on building four socioeconomic scenarios for Kenya, 2) identify new transnational climate risks (and opportunities) for Kenya, 3) identify adaptation options including institutional considerations and recommendation.

The workshop brought together a total of 25 participants drawn from national government (4), county government (1), universities (4), the private sector (1), Intergovernmental (1) and NGO's (10) with a gender distribution of 15 males and 10 females. A participation list can be found in annex 2.

Exploring Kenya's vulnerability to future transnational climate risks

Henrik Carlsen, Senior research fellow SEI started the workshop by an introductory presentation on the case study and its aim and objectives. He highlighted the overall objective for the Kenyan case study which is to design and execute a process in order to better understand how the global development influences what climate risks Kenya might face in the future.

Henrik further noted that climate change is likely to negatively impact Kenya's future development and achievement of the goals of Kenya Vision 2030 and the Big Four Agenda: food security, affordable housing, manufacturing and affordable health care for all. Kenya's economy is very dependent on climate-sensitive sectors such as agriculture, water, energy, tourism, wildlife, and health. He emphasized that key impacts of climate change originated inside the borders of Kenya include floods, droughts, sea level rise, rising sea temperatures. However, in an increasingly globalized world, countries are not independent non-interacting entities anymore.

The presenter also stressed that Kenya, like all other countries, is a node in a network of countries which are interconnected with each other and interacting through several flows, like trade and finance. In this sense, climate impacts are not only limited to impacts of climate change within the country, but also include impacts from climate change in other countries, crossing the borders and migrating to other countries through global flows.

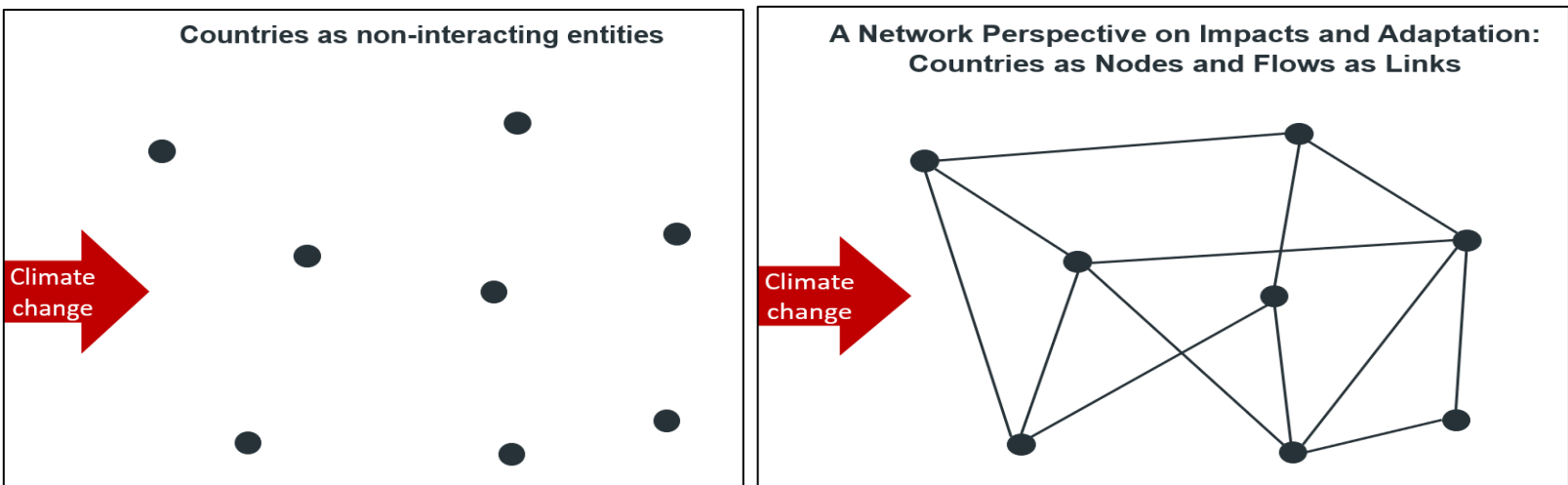


Figure 2. A systematic perspective on climate impacts and adaptation

Taking a systematic perspective on climate impact and adaptation, we need to study the impacts on any nodes (country) given the inter-linkages with other nodes. In other words, when identifying climate impacts in a certain country, it is necessary to take into account both impacts of climate change within the country (aka national climate impacts) and impacts of climate change originated outside the country (transnational climate impacts, TCI). The adaptation architecture of any given country has to be prepared to respond to both of kinds of climate impact.

Scenario analysis; Introducing four socioeconomic scenarios for Kenya

The second session of the workshop was focused on presenting the socioeconomic scenarios for Kenya and explaining how a scenario set linked to global socioeconomic scenarios is a reliable and legitimate framework for identifying future transboundary climate risks. The presentation, given by Henrik Carlsen, the workshop's lead facilitator, first highlighted the definition and use of socio-economic scenarios as tools to describe plausible futures of a certain region, sector or society.

The presentation addressed the necessity of linking local/regional scenarios with global socioeconomic scenarios when investigating global flows of climate impact. Taking a cross-border perspective for regional level analysis of future climate impact, it is immediately realized that local and national scenarios need to be linked to global scenarios in order to provide a coherent baseline for analyzing climate risks that transmit across space.



Figure 3. The necessity of linking scenarios cross scale when looking into global flows

The figure above (figure 3) illustrates why it is necessary to link scenarios across scale when investigating transboundary climate impacts. The yellow arrows resemble flows of climate impact originated in one country, moving across borders and being transmitted to another country (Kenya in this case). The global flows of impact make any given country linked to other countries. Hence, in an inter-connected world, it is always necessary to consider the global context and to link local and global scenarios when studying future impacts originating outside of a country and transmitted through global flows.

Following the presentation, and as a reminder from the first workshop, the Shared Socioeconomic Pathways (SSPs) were again introduced as the global scenarios to which the national scenarios for Kenya need to be linked in order to analyze the TCI risks for Kenya. After this introduction, the process and results of the first workshop including the drivers and the skeletons for socioeconomic scenarios for Kenya were reviewed and the back-office process for developing scenario narratives was briefly mentioned.

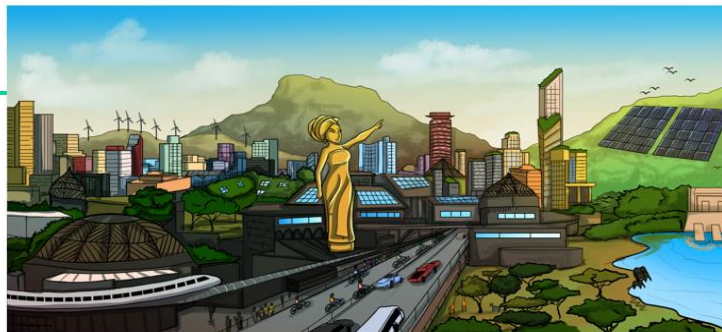
The main aim of this session of the workshop was to present the so-called extended SSPs for Kenya (ESSPs); the socioeconomic scenarios for Kenya built by extending and linking the global and the local development. For each ESSP, the presentation highlighted a brief scenario narrative and relevant quantifications for GDP and population and tested the Kenya vision 2030 against the scenario and assessed whether the targets of the vision will be achieved or not in a world described in each alternative scenario. The next section presents the four future scenarios for Kenya.

SUSTAINABILITY

Regional collaborations towards sustainable development improves within the east African community.

Kenya and neighbors collectively develop a regional governing body for managing the Lake Victoria

Conflicts over access to and use of water from the Mara River between upstream users in Kenya and downstream users in Tanzania come to an end.

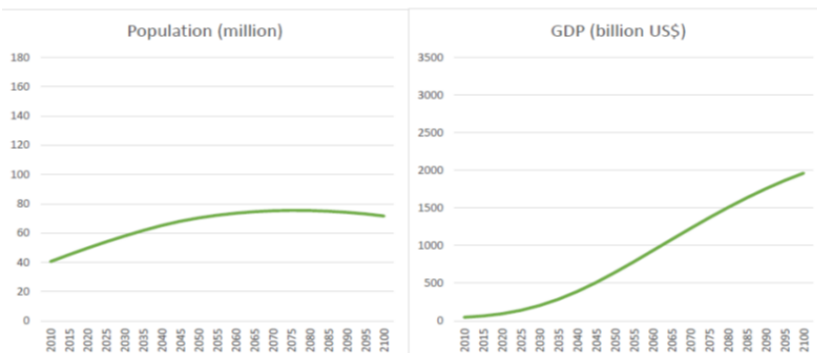


Kenya and Tanzania agree on controlling tourist activities in the Mara-Serengeti region to preserve wildlife.

A growing number of research and policy institutions in Kenya work on climate change impacts, adaptation and sustainability.

Clean energy is accessible for a larger share of Kenyan population. Technology transfer to Kenya is specifically focused on smart agriculture solutions.

Food imports to Kenya slightly go down. As a result of development in agricultural technologies, local agricultural production increases.



Kenya Vision 2030 in 'Sustainability'



Social Pillar

Social targets are attained: As a democratic political system, the Kenyan government aims to decentralize power and empower the decentralized strategic frameworks and local policy processes.



Political Pillar

Political targets are attained: Investments in health and education, and environmental solutions and technologies increase. Kenya moves in a pathway toward equality, equity and social cohesion between all diverse socioeconomic groups.



Economic Pillar

Economic targets are justified: Kenya focuses on sustainable development instead of economic growth. Environmental technologies for agricultural production are implemented. Trade based businesses are encouraged to follow sustainable trade networks.

FOSSIL-FUELLED DEVELOPMENT

Kenya implements strong and effective policy processes focused on economic growth and increasing competitiveness in the global market.

Environmental policies, climate change adaptation and sustainable development issues are not a priority for Kenya

Kenya increases economic collaborations with countries in the east African community; business partnership; compete in the global market.



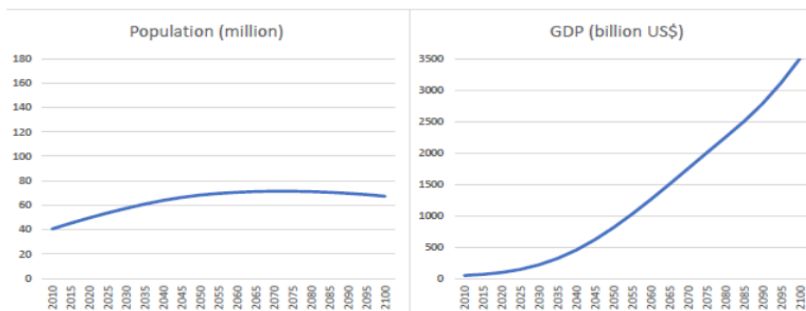
Tourism in the Mara-Serengeti region, shared between Kenya and Tanzania, becomes a fast-growing industry for both countries.

The historic dispute between Kenya and her neighbours over the cause of a drop in the water level is settled

Carbon-intense technologies are extensively developed and used.

The share of renewable energy sources in Kenya's energy mix is low.

Food imports to Kenya increases as the global market works better



Kenya Vision 2030 in 'Fossil-fueled development'



Social Pillar

Social targets are attained: investments in health and education, and adaptation solutions and technologies increase.



Political Pillar

Political targets are attained: as a democratic political system, integrated in the global and regional collaborations, Kenyan government becomes an influential actor in global and regional decision processes.



Economic Pillar

Economic targets are attained: Kenya puts faith on economic growth. Manufacturing targets are achieved and contribute in huge increases of GDP. Kenya is integrated in the global market and trade networks resulting in a competitive and growing economy.

REGIONAL RIVALRY

Growing nationalist values and intense competition over scarce resources intensify rivalry.

Kenya increasingly uses its share of common natural resources as much as possible.

Increasing competition over the use of shared resources intensifies the historical conflicts in the region, and results in serious degradation.

The water level of the Lake Victoria continues to drop dramatically. Serious dispute over the cause of the drop.



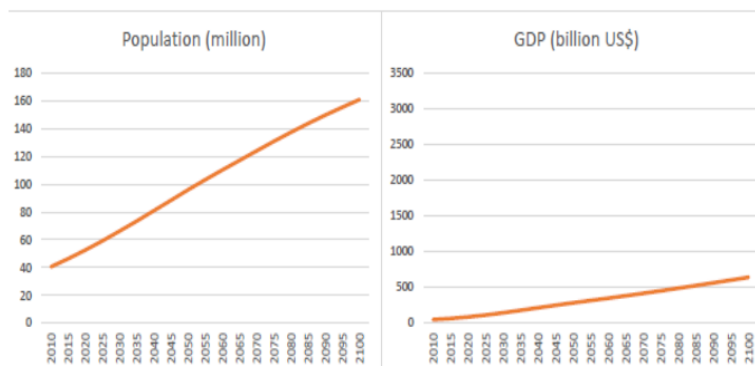
Tensions over demarcating Lake Victoria and establishing on which side of the border the island of Migingo lies.

However, Kenya cooperates with neighbouring countries around the common interests and aim to compete against other regional blocs.

Challenges for evidence-based policy processes in Kenya.

Trans-continental food imports go down and replaced with increasing imports from neighbouring countries.

Kenya aims at reducing import dependency by encouraging local production which results in excessive land use and water resources degradation



Kenya Vision 2030 in 'Regional Rivalry'



Social Pillar

Social targets are not attained: Kenya faces increasing struggles to maintain minimum living standards for the poor, and as a result, investments in education and healthcare dramatically decline. As nationalist values are being propagated by the government, the public experience a sense of social cohesion around nationalist ideas.



Political Pillar

Political targets are not attained: the international and regional conflicts and the resurgent focus on security leads the Kenyan government to increasing nationalism and authoritarian values and sabotage democratic goals and processes.



Economic Pillar

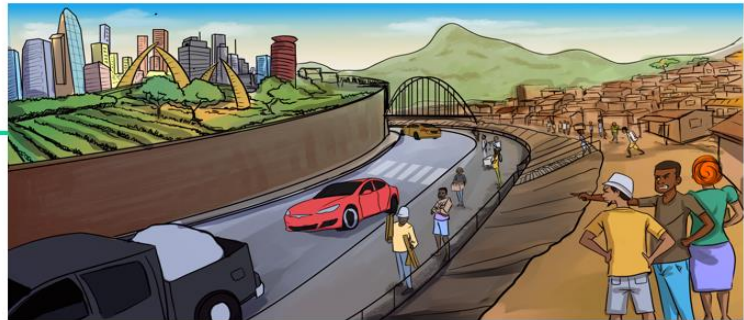
Economic targets are not attained: trade relations between Kenya and her neighbours become dysfunctional resulting in an increase in agricultural production regardless of the resource degradation. Tourism and other cross border service-based businesses are going to bankruptcy because of the conflictual and hostile situation.

INEQUALITY

Kenya – like most low-income countries – is struggling to provide the minimum life capacity for the poor majority of the population.

The agricultural technologies are undeveloped, resulting in vulnerabilities to the long periods of drought.

The conflicts regarding use of water from the Mara River increase between upstream users in Kenya and downstream users in Tanzania.

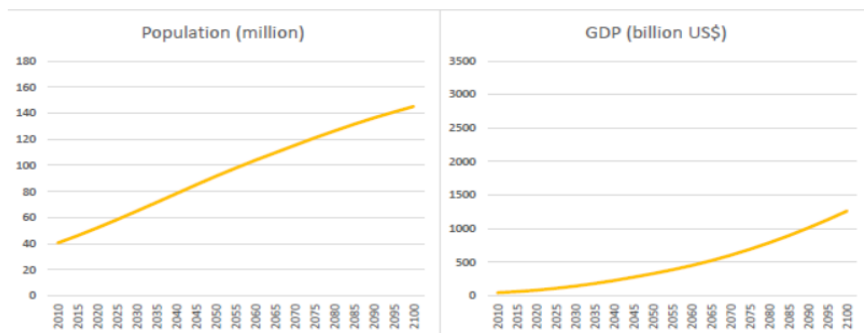


While Kenya as a leading country in the region aims at facilitating regional collaborations, some of the neighbouring countries exit the collaborative and focus on creating military coalitions and political power blocs. Tensions between the countries sharing Lake Victoria intensify.

The energy mix in Kenya maintains fossil fuel-based and highly carbon-intense.

Imported foods to Kenya are distributed and consumed unequally.

While higher-income communities and urban areas benefit from basic and luxury food imports, masses cannot afford to consume the imported food and face food security issues



Kenya Vision 2030 in 'Inequality'



Social Pillar

Social targets are not attained: inequality between socioeconomic classes increases in Kenya with a rich and privileged minority and poor and disadvantaged majority. Lack of social cohesion between different socioeconomic groups deepen further heightening class divisions and social unrests.



Political Pillar

Political targets are not attained: attempts to develop a decentralized policy framework failed because of huge gaps and disparities between a small number of developed urban areas and poor suburbs and rural regions. Perhaps political participation is extremely low and civil society has no representation in the Kenyan power structure.



Economic Pillar

Economic targets are not attained: Kenya faces low economic growth and a deepened income gap between the poor and a rich minority. Agricultural systems are focused in rural areas and operate significantly inefficient due to the lack of technology. Manufacturing targets are not achieved to the huge technological gap between Kenya and the global north.

Impact Scenario of crop production under climate change

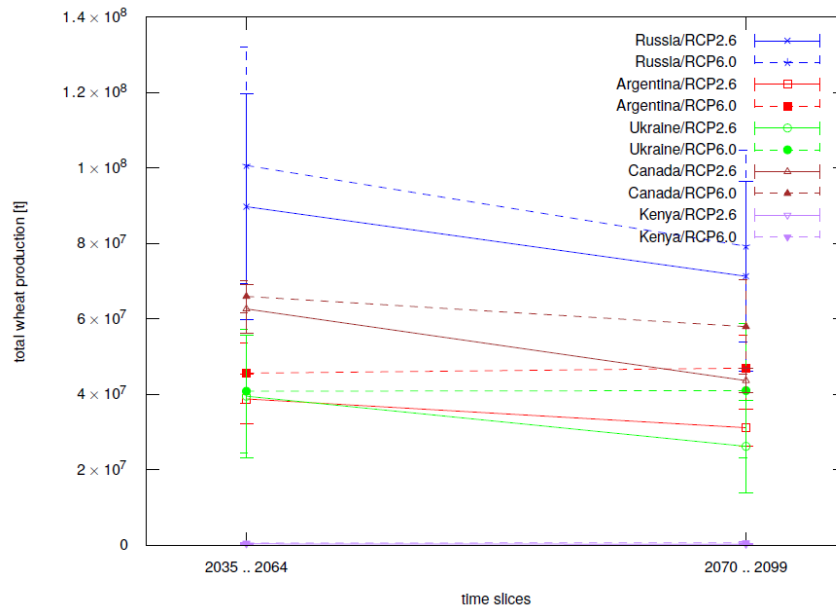
In the third session of the workshop, a presentation on “Impact Scenario of crop production under climate change” was given by Jan Volkholz, an impact model expert from PIK. This presentation aimed to show the impact of climate change outside Kenya on the country’s food security given the four socioeconomic scenarios crafted together with stakeholders. Among different aspects of food security, we looked into the imports of essential crops into Kenya.

Kenya depends substantially on imports of the main crops, including wheat, corn and rice. In 2017, wheat (29%), corn (27%) and rice (19%) were the main crops imported to Kenya. Of the total imported wheat, 30 % came from Russia, 19% from Argentina, 12% from Ukraine, 9% from Canada. 45% of the imported corn came from Mexico, 19% from South Africa, 11% from Uganda, 9% from Zambia, and of the total rice imported to the country, 67% came from Pakistan and 25% from Thailand.

Given the current situation of crops imports to Kenya, the ISIMIP⁷ database was used to run a set of impact models to develop future projections of crop production in the main countries from which Kenya imports essential crops (wheat, corn and rice). The crop models were run for two future time slices (2035-2064 and 2070-2099) under two climate projection, one representing a low-end (RCP 2.6) and one representing a high-end climate scenario (RCP 6.0). The plots below show the annual crop production projections for wheat, rice and corn in the top countries from which Kenya imports these essential crops.

⁷ The ISIMIP (Inter-Sectoral Impact Model Intercomparison Project, (www.isimip.org) collects cross-sectorally consistent climate-impacts simulations by providing common climate scenarios (daily, gridded data), common data sets describing socio-economic conditions (population, GDP, land use etc.) and strives to disseminate data and knowledge widely with low barriers to access.

Wheat projection (annual production)

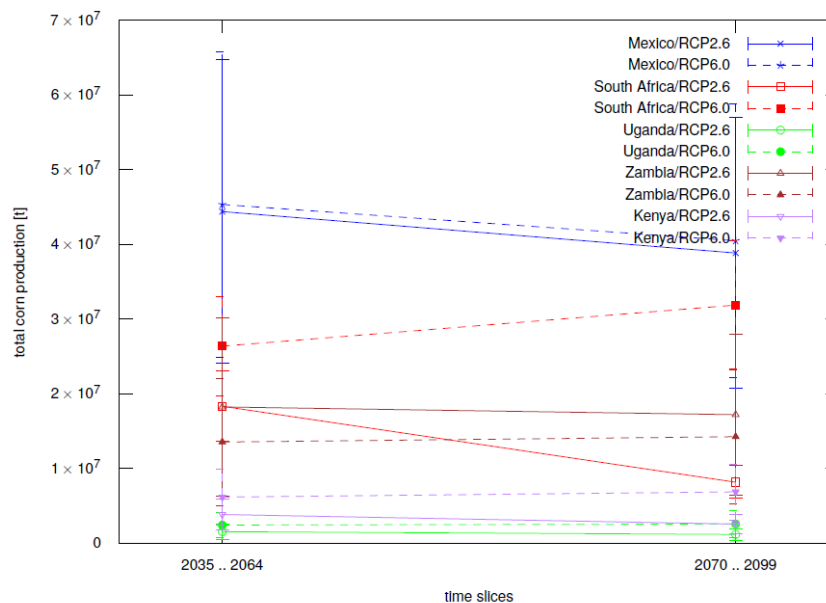


data points: mean of 3 crop models (GEPIC, LPJmL, PEPIC) driven by 4 climate models (GFDL-ESM2M, HadGEM2-ES, IPSL-CM5A-LR, MIROC5)

error bars: standard deviation across all climate model / crop model projections

Figure 4. Projection of future wheat production in exporting countries to Kenya

Corn projection (annual production)

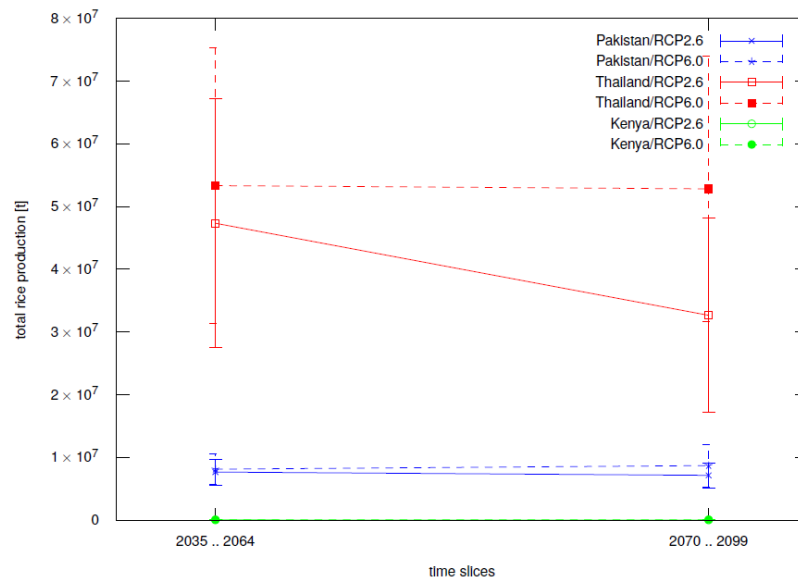


data points: mean of 3 crop models (GEPIC, LPJmL, PEPIC) driven by 4 climate models (GFDL-ESM2M, HadGEM2-ES, IPSL-CM5A-LR, MIROC5)

error bars: standard deviation across all climate model / crop model projections

Figure 5. Projection of future corn production in exporting countries to Kenya

Rice projection (annual production)



data points: mean of 3 crop models (GEPIC, LPJmL, PEPIC) driven by 4 climate models (GFDL-ESM2M, HadGEM2-ES, IPSL-CM5A-LR, MIROC5)

error bars: standard deviation across all climate model/crop model projections

Figure 6. Projection of future rice production in exporting countries to Kenya

Agriculture is arguably the sector most affected by climate change, but assessments differ and thus are difficult to compare. Models differ substantially in the processes they simulate, i.e. CO₂ fertilization, nitrogen stress, etc. Crop production depends on two major variables: yields (t/ha) and area used for a specific crop, which both are very difficult to project. In this case study, we used the land use and crop yield scenarios provided by ISIMIP. Due to the inherent difficulty, the results should not be compared to current productions, but we rather should look at trends.

Looking at the results of modeling, it can be seen that production decreases are expected for severe global warming in many parts of the world. Models also found increases in production, in particular for mid to high latitude regions at moderate global warming. However, the results of modeling and projections must be interpreted in connection with future socioeconomic drivers and states.

To create a holistic way of understanding the quantitative data, we attempted to incorporate future population as a socioeconomic driver in the interpretation of rice production increase in Pakistan as an example. Projections of future population in 2035-2070 show that Pakistan's population is going to increase significantly. In 2015, the country's population was 190 million and this number is going to reach to 242 million in 2030 and 230 million in 2070. Hence, although total rice production in Pakistan is going to increase slightly in 2035-2070 in comparison to current numbers, the country's population is going to grow as well. In this sense, while the current amount of rice production per capita in Pakistan is about

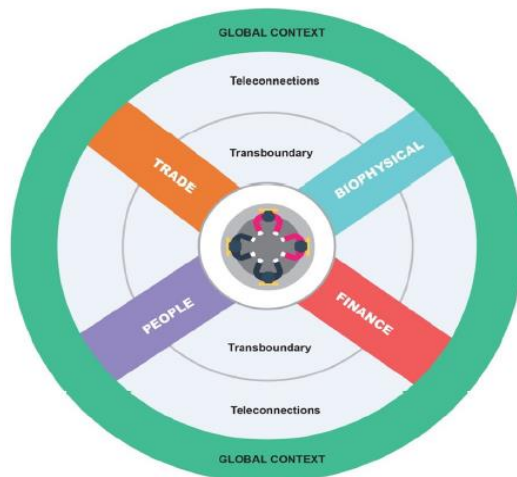
39.4 Kg, this number is going to decrease to 22.9 Kg in 2030 and 14.8 Kg in 2070 given a moderate global warming (RCP 2.6).

The significant decrease in rice production per capita in Pakistan implies that the country will probably have to decrease rice exports to other countries (including Kenya). Here, despite the probable benefits of global warming for rice production in Pakistan, the impact of climate change in Pakistan will negatively affect Kenya in the shape of rice deficit. Dealing with this climate impact which was originated as a result of climate change in Pakistan, Kenya will experience difficulties in finding alternative sources, countries or markets to provide the demanded amount of rice for its own growing population.

Identifying TCI risks and co-producing adaptation options (Group work)

After introducing the socioeconomic scenarios for Kenya, the last session of the workshop was an interactive and participatory process aimed at identifying future TCI risks and adaptation options given the world described in each plausible scenario. This session was designed to be held in two facilitated working groups. Each group was given detailed instructions and facilitation during the group work session.

To start the session, the TCI framework and four pathways (Trade, Finance, Biophysical, and People) were reviewed in a short presentation by the lead facilitator. TCI risks are transmitted through four pathways:

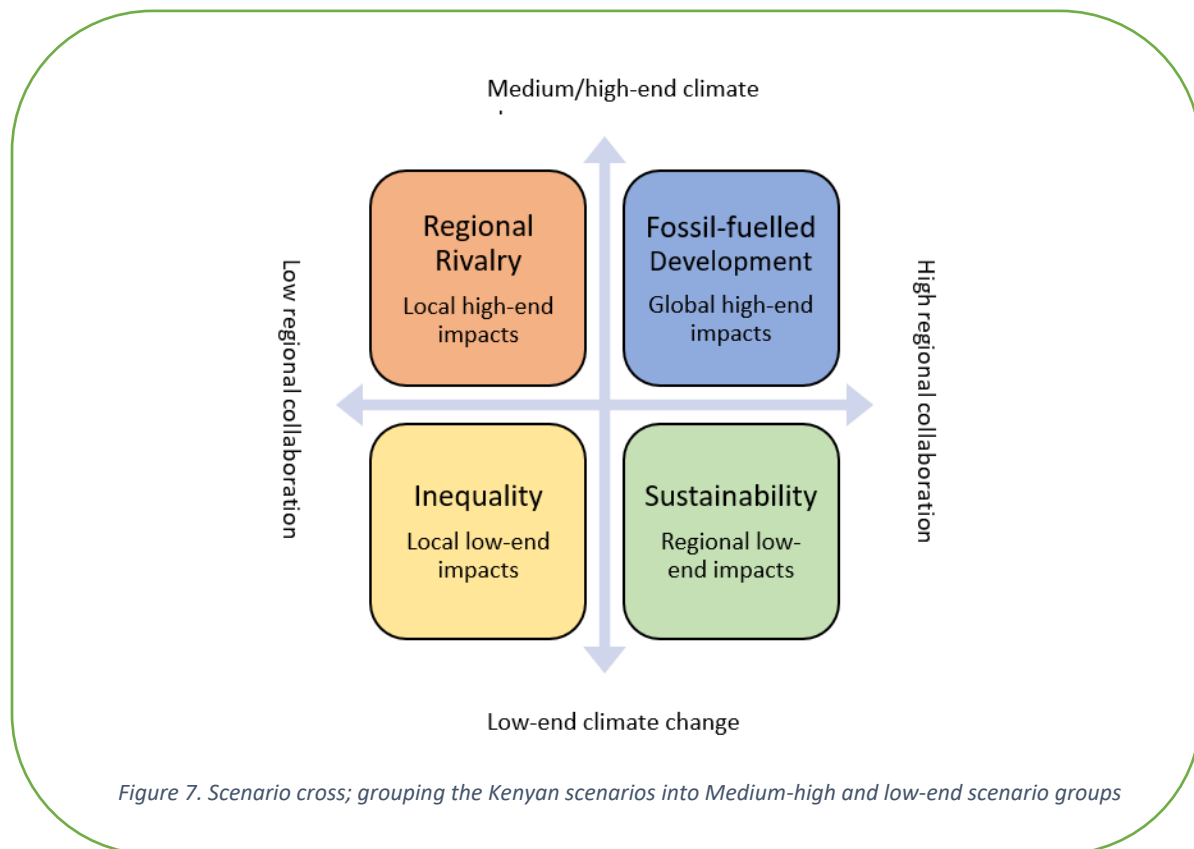


- The biophysical pathway encompasses transboundary ecosystems, such as river basins, oceans and the atmosphere.
- The finance pathway represents capital flows and climate impacts on assets held overseas.
- The people pathway involves the movement of people between countries, e.g. tourism and migration.
- The trade pathway transmits climate risks across international supply chains.

After introducing TCI pathways and making examples of risks relevant to each pathway, the group work protocol was presented, including the core question and justification, group division, and task at hand for each group.

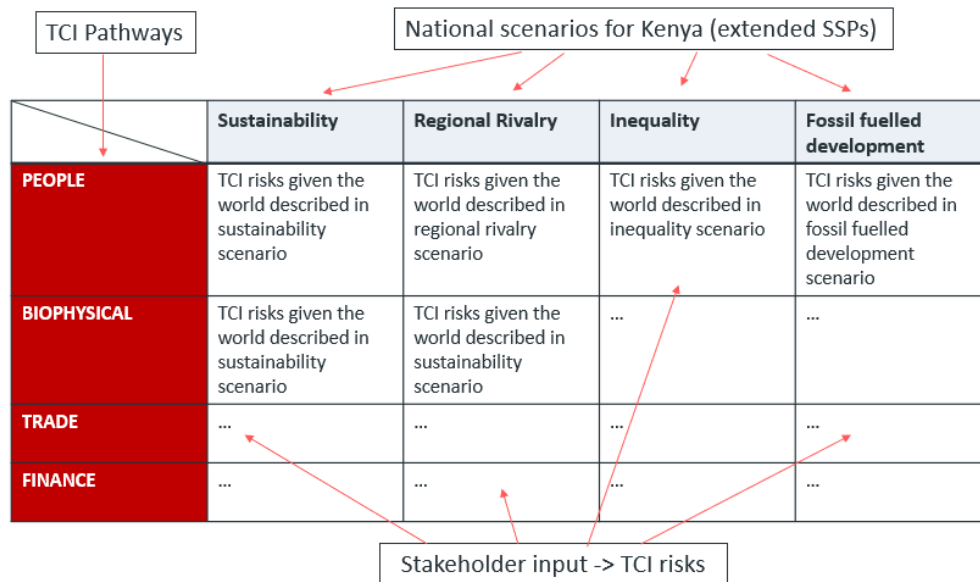
The participants were divided in two groups. Each group was invited to work across four TCI pathways and two socioeconomic scenarios with associated climate change. Group 1 worked with the Sustainability and Inequality scenarios and group 2 worked with the Regional rivalry and Fossil-fueled development scenarios.

To select two scenarios for each group to work with, we locate the Kenyan scenarios on a so-called scenario cross. A scenario cross shows two main drivers and their associated states as polarities, hence a two-by-two matrix is produced. Situating the Kenyan scenarios on a scenario cross is an appropriate approach to add the climate change dimension, hence one axis is climate change with polarities 'Medium/high-end' and 'Low-end'. The second axis should represent the socio-economic dimension and reflect the focus of the case study, i.e. challenges to Kenya with regards to transnational climate impacts. For this dimension we defined low and high regional collaboration as polarities.

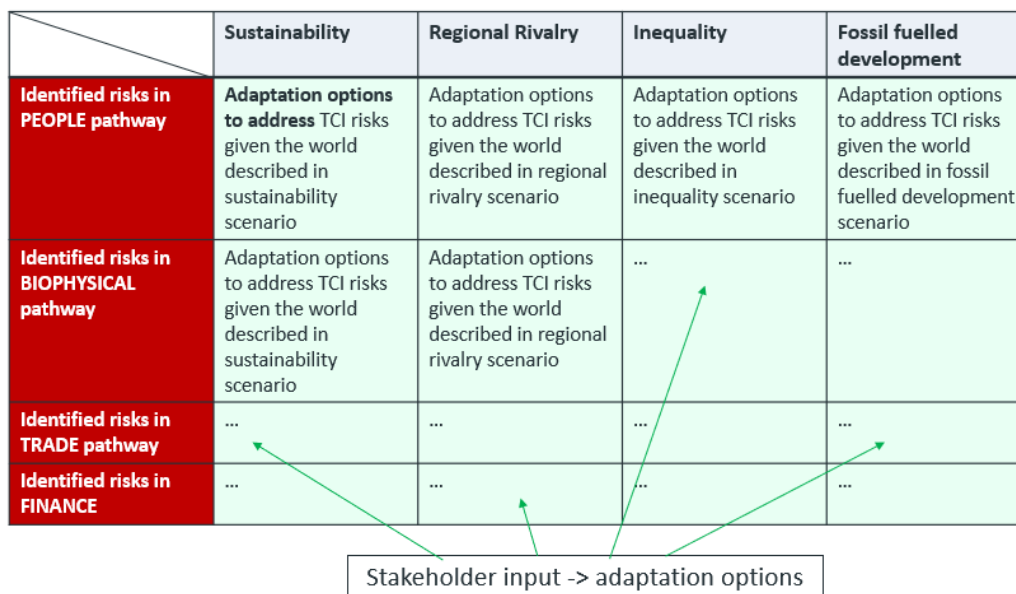


Accordingly, we grouped medium-high end scenarios i.e. Regional rivalry and Fossil-fueled development together and low-end scenarios i.e. Sustainability and Inequality together and gave each group of scenarios to one of the working groups to work with.

The overarching question of the group work session was: “Is the current adaptation architecture in Kenya prepared to adapt to the TCI risks?”. To answer this question, the participants were asked to identify future TCI risks (and opportunities) for Kenya through the four TCI pathways given the alternative socioeconomic scenarios for Kenya as well as the global scenarios. Then, the group were asked to discuss whether there are adaptation options and action items in the current adaptation architecture to mitigate and/or prepare for these TCI risks.



Discussions showed that the current adaptation architecture in Kenya is not prepared to address and adapt to future TCI risks. After the discussion, the participants were invited to generate adaptation options for Kenya to address a specific TCI risk or TCI risks in general given the context as described in the scenarios. On an overarching level, the participants were asked to produce adaptation options which strive for reaching the Kenya Vision 2030 targets.



Given the socioeconomic scenarios for Kenya in 2040-2060, stakeholders identified TCI risks and opportunities for Kenya in the same time horizon in the future. However, the process of generating adaptation options was focused on the present time and short-term future from now towards 2040. In other words, identifying future TCI risks, the stakeholders were asked to generate actionable and

implementable adaptation options and items in the present and near future well before the time when the identified TCI risks are anticipated to hit the country.

The identified TCI risks and opportunities and adaptation options to address such risks given each socioeconomic scenario for Kenya are shown below:

Sustainability; TCI risks and adaptation options

TCI pathways	TCI risks	Adaptation options
People	Health people	-
	Enhanced livelihoods	- Climate proof infrastructure - Development of solar mini grids - Rainwater harvesting (in-situ) - Revival of national soil and water conservation efforts
	Sustainable food production	- Adoption of indigenous crops
	Social stability	-
	Affordable products (use of locally available materials)	- Use technology in production - Youth attractive technologies
	Improved nutrition	- Adoption of indigenous crops
	Voluntary migration	-
	Reduced cross border conflicts	-
Biophysical	Cleaner environment and sustainable use of resources	- Adoption of green energy sources - Enforce and synthesis on R3 (Reduce, reuse and recycle)
	Increased flooding	- Water catchment rehabilitation
	Increased access to clean water	-
	Increased tree cover (carbon sinks)	-
	Well maintained biodiversity	-
	Reduced cross border conflicts	- Regional summits on TC1 and regional climate change impacts
	Enhanced tourism	-
	Proper transboundary mgt of resources	-
Trade	Low demand for local produce	-
	Better/better regional integration	- Promote regional common market
	Better adaptation options due to technology increase	- Cross border climate resilient food value chain - Capacity building and adoption of biotechnologies
	Increased business for entrepreneurs	-

	Moving away from fossil fuel development	-
	Production of technological equipment locally	-
	Attain a better energy mix	- Adoption of green energy sources
	Improved transport network	-
	Policy coherence between countries (Implementation of policies)	- Multi-level governance of common resources
Finance	Sustainable energy from renewable sources	- Adoption of green energy sources
	Incentive FDI	-
	Climate finance still flows into Kenya	- Advocate for financing towards sustainable livelihood practices
	Increased climate resilient	- Welfare schemes for vulnerable groups
	Production of technological equipment locally	-

Fossil-Fueled Development: TCI risks and adaptation options

TCI pathways	TCI risks	Adaptation options
People	Economic Migration to booming economy (strain on resources)	- Effective taxation managed immigration
	Displacement in neighboring countries from ff extraction conflict	- Promote alternative energy
	Regional integration bad for Kenyan national identity	- Support improved governance in neighbors
	Unsustainable tourism in neighboring countries (Parts share ecosystem)	- Raising Awareness of ecotourism/ promotion of eco-tourism - Co sharing tours across boarder - Bring something to the table
	Neighbors use up water resources first	-
	Fisheries collapse, biodiversity decreases, pollution increases	-
	Regional loss of water resources- impacts on industrial processes	- Management and conservation of shared resources - Transboundary agreement on sustainable management of shared water resources - Participatory community management of water/forest resources

	Unsustainable tourism in neighboring countries (Parts share ecosystem)	<ul style="list-style-type: none"> - Raising Awareness of ecotourism/ promotion of eco-tourism - Co sharing tours across boarder - Bring something to the table
Trade	Expanded middle class, higher consumption	- Improved public transport infrastructure and infrastructure incentives
	Local waste mgt	<ul style="list-style-type: none"> - Promote alternative energy - Research and innovation in various sectors. - Standards to ban dirty technologies
	Increased production+ emissions in supplier countries	-
	Regulations banning imports of fossil fuel derived/produced products	- Promote alternative energy
	Dumping of dirty technologies (but research could mitigate)	-
	Exporting TCI (coal demand leads overexploitation In South Africa + Environment degradation)	-
Finance	No more development aid	- Increase Finance from other sources
	Global push towards divesting from fossil fuels	<ul style="list-style-type: none"> - Promote alternative energy - Develop collaborations to implement NDC

Regional Rivalry; TCI risks and adaptation options

TCI pathway	TCI risks	Adaptation options
People	External population growth makes it harder for Kenya to access resources	- Reduce loses and waste increase efficiency, circular economy
	Reduced tourism due to regional conflict	<ul style="list-style-type: none"> - Encourage more domestic tourism which is sustainable - Promote Kenya as welcoming and desirable tourist destination
	Return of Kenyan diaspora from region	<ul style="list-style-type: none"> - Develop reintegration options for returning diaspora - Increase consular protection/ maintain good diplomatic ties - Create more opportunities to work in Kenya - Improve Kenya's international reputation and profile
	Kenya Somalia territorial disputes (juba land and sea)	-

Biophysical	Border conflict over scarce resources	<ul style="list-style-type: none"> - Transboundary agreement, co- management, participatory - Promote alternative energy to fuelwood/fossil fuel
	Water use, food production in neighbors import affected	<ul style="list-style-type: none"> - Water efficiency, climate smart technology produced locally
	Neighbors use up water resources- loss of industries(fishing)	<ul style="list-style-type: none"> - Transboundary agreement, co- management, participatory - Water efficiency, climate smart technology produced locally
	Kenya Somalia territorial disputes (juba land and sea)	-
Trade	Lack of access to knowledge about alternative crops	<ul style="list-style-type: none"> - Transboundary agreement, co- management, participatory
	Water use, food production in neighbors import affected	<ul style="list-style-type: none"> - Transboundary agreement, co- management, participatory - Efficient industry
	Neighbors use up water resources- loss of industries(fishing)	<ul style="list-style-type: none"> - Invest in research and development, build international resource networks, connect with farmers, digital infrastructure/ICT - Promote use of indigenous crops/reintroduce them where necessary
	Increased black market for food and commodities	<ul style="list-style-type: none"> - Reduce trade barriers and promote peace in the region - Encourage govt to implement EAC Protocol on cross border trade
	Trade barriers to import and export	<ul style="list-style-type: none"> - Establish more innovation hubs - Protect local IPR, strengthen local research capacity, funding - Build skills and capacity to commercialize solutions with real world value
	Protected technologies not shared by richer regions	<ul style="list-style-type: none"> - Set standards for acceptable imported technology - Set manufacturers disposal requirements, recycle waste to sell or use
	Dumping of obsolete technologies	-
Finance	Reduced FDI from neighbors due to conflict	<ul style="list-style-type: none"> - Reduce trade barriers and promote peace in the region - Improve relations with neighbors
	Reduced ODA due to Kenya's Governance	<ul style="list-style-type: none"> - Good governance and transparency

Inequality; TCI risks and adaptation options

TCI pathways	TCI risks	Adaptation options
People	Climate induced economic migration/ Forced migration	- Transboundary policies/Transnational policy framework - Cross boarder legal programs
	Opportunity for Green economy and circular economy	Education
	Environmental exploitation due to lack of alternatives	- Capacity building in natural resource management
	Seasonal cross boarder migration of livestock	- Transboundary policies/Transnational policy framework - Cross boarder legal programs
	Livelihood disruptions	- Community owned vulnerability and capacity assessment
	Social disorganizations and unrest	- Community involvement/ Innovative community incentives
	Disease patterns	-
	Poor sanitation and hygiene	-
	Food insecurity and malnutrition	- Farmer managed natural resource regeneration - Downscaling CSA frameworks to sub national level
	Destruction of infrastructure due to sea level rise at the coast	- Climate proof infrastructure
	Opportunity to invest in climate resilient infrastructure	- Climate proof infrastructure
Biophysical	Seasonal migration of wildlife	- Diversify tourism (growing domestic and regional tourism) - Multi-level/ transboundary governance of shared resources
	Emerging invasive species	- Useful use of invasive species for income (i.e. mathenge for briquets)
	Environmental degradation	- Use of non-wood products to promote tree conservation - Promotion of alternative sources of energy (green energy)
	Loss of biodiversity due to bioengineering	-

	Unequal use of shared resources	- Multi-level/ transboundary governance of shared resources
	Implementation of policies	- Policy implementation/ Nation policies to be downscaled to counties
Trade	Trade of livestock	-
	Trade imbalance (low balance of trade terms)	- Enabling environment for private sector participation (incentives).
	Low foreign exchange (low - production of cash crops)	- Diversify cash crops and advocate for value addition
	Increased carbon footprints in trade	- Tax exemption higher tier cookstoves
Finance	Low foreign exchange (low production of cash crops)	-
	Climate financing (carbon trading)	- Climate insurance (crops and livestock) - Use of global climate funds for adaptation technologies
	Decreased tourism at the coast/ a shift in the tourism interests	-

Closing Session

The second workshop for SENSES case study in Kenya was arranged as a one-day workshop. The program for the workshop was profound and included extensive new information about transnational climate impacts as a framework, linking future scenarios for Kenya to the global socioeconomic pathways, and impact scenarios for crop production under different degrees of climate change.

We received feedback from stakeholders that the information presented during the workshop was relevant to the Kenyan national adaptation landscape and added value through introducing the concept of transnational climate impacts and presenting the future socioeconomic scenarios for Kenya. The co-production process in the second workshop for identifying future TCI risks and adaptation options was recognized to be useful and beneficial for informing the current adaptation architecture in Kenya.

The stakeholders collectively agreed that the present status of the Kenyan adaptation architecture, stakeholders had consensus that the Kenyan national adaptation architecture is designed only to adapt to climate impacts within Kenya's borders, while Kenya will also be exposed to impacts of climate change in other countries. They noted that stakeholder engagement and co-production processes for identifying future TCI risks and adaptation options to address TCI risks can help refine, update and improve national adaptation policies and plans.

The global scenarios (SSPs) were proved to be relevant to local/national adaptation attempts and studies, especially when considering the cross-border climate impacts and risks. Therefore, extending global scenarios to a specific national/local context was proved to be a proper systematic approach to develop a national socioeconomic scenario set.

Considering the workshop's process and results, and taking stakeholders' feedback into account, we concluded that the combination of top-down and bottom-up approach is useful and transparent method to link scenarios across scales, and participatory approaches and co-production processes increase transparency, and buy-in.

We tested a scenario-based analysis framework to identify future TCI risks and adaptation options in Kenya. Results show that assessing globalized climate risks and designing adaptation options can be significantly facilitated through a scenario-based analysis framework.

Results also show that taking a Transnational Climate Impacts perspective, Kenya will be exposed to more TCI risks in future alternatives depicted by regional rivalry and/or inequality, while in a sustainable future, Kenya will benefit from transboundary opportunities. Most adaptation options for adapting to future TCI risks in Kenya require regional collaboration, shared management and transboundary governance of natural resources, and sustainable development of the EAC.

Annexes

Annex 1. Full workshop program

Time	Activity
8:30-9:30	Coffee and sandwiches
9:30-9:45	Welcome Welcome to SEI and the 2 nd SENSES workshop
9:45-10:00	Introduction to SENSES and the case study in Kenya Introduction to SENSES project and the case study in Kenya Introduction Transnational Climate Impacts (TCIs) Introduction to the Shared Socioeconomic Pathways (SSPs) Overview of workshop 2 and its key objectives: <ul style="list-style-type: none"> • Presenting the extended SSPs for Kenya • Identifying TCI risks given each scenario • Co-producing adaptation solutions
10:00-11:30	Four futures scenarios for Kenya Introducing the extended SSPs for Kenya; national scenarios linked to global Shared Socioeconomic Pathways Open Discussion Comments and feedback in plenary discussion
11:30-12:00	Coffee and sandwiches
12:00-14:00	Identifying Transnational Climate Impacts and risks Introduction to the TCI conceptual framework and pathways Identifying TCI risks given the alternative scenarios for Kenya
14:00-15:00	Lunch
15:00-18:00	Co-producing adaptation options Facilitated group work session <i>The overarching question of this session:</i> <ul style="list-style-type: none"> • Is the current adaptation architecture in Kenya prepared to adapt to the TCI risks? • What are the adaptation options given the alternative scenarios for Kenya?
18:00+	Closing; Cocktails and mingle Thank you for your participation! Next steps

Annex 2. List of Participants

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