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At a Glance

- This year's Climate Report focuses on the potential impacts of climate change on the agricultural sector and the resulting changes, which may, for example, be manifested in migration flows or security policy issues. It should be noted that climate change and its consequences are extremely complex issues, and it is not helpful to draw premature conclusions.

- Climate change and the agricultural sector are closely intertwined. The agricultural sector is a key economic sector worldwide, employing an estimated 866 million people. However, agriculture is also a major source of harmful greenhouse gas emissions and thus actively contributes to climate change.

- Climate change is very likely to exacerbate existing conflicts, as shortages of food and resources can lead to distribution conflicts, which in turn have a destabilising effect.

- Migration flows can be intensified by climate change and extreme weather events, as manifested in local migration. However, it is debatable whether there is a direct causal link, because migration can be attributed to a variety of reasons.

- The ability of agriculture to adapt to climate change must be strengthened. Climate Smart Agriculture (CSA) and agricultural technologies enhance adaptation while contributing to greater sustainability.

- International policymakers should focus more strongly on the agricultural sector, as this is a key area in the fight against climate change.

Table of Contents

Foreword 5

Gerhard Wahlers

1 How Climate Change is Impacting the Agricultural Sector, Migration, and Human Security in Sub-Saharan Africa 6

Anja Berretta

2 Climate Change and Agriculture – Correlations and Consequences for Migration and Security in Central America 17

Nicole Stopfer

3 Climate Change and Agriculture in Asia and the Pacific – Migration, Adaptation, and Innovation 25

Christian Hübner

4 Climate and Conflict – Opportunities for Environmental Peacebuilding 37

Tobias Zumbrägel

Conclusion 42

André Algermißen

The Authors 46

Gerhard Wahlers

Foreword

Dear Readers,

The agricultural sector is a vital economic sector worldwide, employing an estimated 866 million people. Against the backdrop of a growing global population and increasing demand for food, a productive agricultural sector is vital for combating hunger. However, agriculture also comes under fire because of its high greenhouse gas emissions and negative impact on biodiversity.

The role of agriculture as a contributor to climate change should not be ignored in the public discourse. But it is important to emphasise that it is farmers who are more directly affected by extreme weather events due to climate change, including droughts and floods which do not only threaten their economic survival, but also the food supply of entire regions and, in combination with other factors, may trigger migration.

This year's Climate Report focuses on the potential impact of climate change on the agricultural sector and the resulting changes, such as migration and security. Following on from 2007, 2011, 2014 and 2017, this is the fifth report in the series. The contributions from the Konrad-Adenauer-Stiftung's global climate and energy programmes describe the consequences of climate change in different regions of the world and highlight potential solutions. The articles underline the fact that climate change and its consequences are very complex, and premature conclusions tend to be unhelpful. Instead, it is important to differentiate and identify pragmatic, long-term ways and means of addressing these challenges. For the first time, the articles are supplemented by video interviews on our website, in which leading international experts give their views on these issues.

I hope you will find the articles a stimulating read.

Gerhard Wahlers

Gerhard Wahlers is Deputy Secretary General of the Konrad-Adenauer-Stiftung and Head of the European and International Cooperation Division

Anja Berretta

1 How Climate Change is Impacting the Agricultural Sector, Migration, and Human Security in Sub-Saharan Africa

In Sub-Saharan Africa, climate change and agriculture influence each other, and rapid population growth is increasing the pressure on dwindling resources. Sub-Saharan Africa (SSA) is particularly vulnerable to the impacts of climate change, as the region has minimal financial and technical resources to adapt to climate change, and thus poor resilience.[1,2,3] Rainfed agriculture dominates agricultural production in SSA, covering some 97 per cent of the total cultivated area.[4,5] This means agricultural production is particularly exposed to increasingly strong variations in seasonal rainfall.

At the same time, the agricultural sector in Sub-Saharan Africa is itself a major source of greenhouse gas emissions (GHG). However, Sub-Saharan Africa is only responsible for around 3.9 per cent of global GHG emissions[6] (excluding South Africa this figure would be 2.5 per cent). Globally, the main source of emissions is energy. In Africa, however, most emissions come from the Agriculture, Forestry and Other Land Use (AFOLU) sector. Globally, GHG emissions from this sector account for 14.8 per cent,[7] whereas in Sub-Saharan Africa agriculture, forestry and other land use account for 61 per cent of GHG emissions.[8] In addition, productivity in the agricultural sector is low and dominated by traditional farming practices,[9] but livestock emissions per capita/unit of product are higher globally.[10,11] On top of this, population growth makes it necessary to ramp up food production in order to guarantee food security. The growing African middle class also consumes more meat. Producing more food means that forests are cleared, more water is needed, and more pesticides that are banned in Europe are used. This pollutes the water, air and soil and reduces yields in the long run.

Agriculture is the largest economic sector in Sub-Saharan Africa, with some 65 per cent of the population working in farming, and 85 per cent of the population depend on it for their livelihoods.[12,13] This sector is a major contributor to the gross domestic product of the countries of the region,[14,15] in some cases as high as 40 to 60 per cent.[16] Agricultural production represents 55 per cent of the total exports of African countries.[17,18]

Forecasts for the Sub-Saharan region indicate a warming trend, especially in the subtropical interior, along with an increase in extreme weather events.[19] These include more frequent occurrences of extreme heat, increasing drought, and changes in rainfall patterns – with a particularly pronounced decline in Southern Africa and an increase in East Africa.[20] While rainfed agriculture is particularly vulnerable to these climatic changes, this practice accounts for 70 per cent of agricultural practice among communities in the region.[21]

Extreme weather events increase the risk for investing in the agricultural sector. This means there is less incentive to invest in the long term and could reduce the capital needed for innovations to increase productivity due to the uncertainty of projected returns. According to the Intergovernmental Panel on Climate Change (IPCC), it is very likely that the overall impact of climate change on yields of major cereals such as millet, maize and teff in the African region will be negative, though with strong regional differences.[22] At the same time, an additional 2.4 billion people are projected to be living in developing countries by 2050, mainly in Sub-Saharan Africa.[23] It is estimated that the demand for cere-

als in this region will nearly double to 317 million tonnes by 2050.[24]

Livestock are also vulnerable to drought, especially where they depend on local biomass production. There is a strong correlation between drought and livestock mortality.[25] The availability of land that is suitable for agriculture, the length of growing seasons, and potential yields are all expected to continue declining, especially on the margins of semi-arid and arid areas in SSA, which could negatively impact food security and exacerbate food shortages.

Achieving food security for a growing population in a sustainable manner that is in line with the Paris Agreement while securing the livelihoods of people who work in the sector represents a major challenge for Africa.

Vulnerability to extreme weather events depends on several factors: the extent to which the population is dependent on natural resources and the ecosystem; sensitivity of this ecosystem to climate change; and the extent to which people can adapt to the changes caused by climate change, i. e. potential for adaptation. In other words, the more people depend on climate-sensitive sectors and sources of livelihoods, the more vulnerable they are.

In future, we can assume that the high dependence of people in SSA on climate-sensitive agriculture, the increasing scarcity of the resources outlined above and the unequal access to these resources will lead to more violent competition for resources between different population groups in Africa.[26]

Today, we are already seeing an increase in conflicts between arable farmers and pastoralists in semi-arid areas of Sub-Saharan Africa due to competition for increasingly scarce resources such as grazing land and water. For example, as dry season grazing pastures decline, pastoralists are usually forced to move to arable areas, which often brings conflict with farming communities.[27] In some regions, including Nigeria and the Horn of Africa, these conflicts are turning increasingly violent.[28]

In regions characterised by weak state structures, low resilience, high rates of poverty, and poor socio-economic projections, the impact of climate change can be a push factor that exacerbates existing conflicts. Although there is no causal link between climate change and conflict, it can be assumed that occurrences such as changes in rainy seasons and increasing temperatures can accelerate conflicts in volatile situations.[29] If these lead to fewer employment opportunities in agriculture and are simultaneously linked to shortages of food and resources, this fuels competition for resources and endangers human security.[30]

However, the Lake Chad Basin provides an impressive example of how the increase in violent conflicts cannot be directly reduced to climate change. In the region around Lake Chad, increasingly extreme weather conditions have been a factor behind poor farmers and fishermen joining the Islamist terrorist organisation Boko Haram. The region bordering Nigeria, Niger, Chad, and Cameroon has been destabilised by a decade-long Islamist insurgency that has uprooted 2.5 million people in one of the world's poorest areas. At the same time, some 40 million people living in the Lake Chad Basin depend on the water from the lake for crop cultivation, livestock, fishing, and trade.

The rainfall in the area around the lake assured good conditions for agriculture in the past, but the amount and timing of the rainfall have become unpredictable, making it difficult for farmers to plan what to grow and when. The livelihoods of many farmers and fishermen have been destroyed. Some are now hoping to survive the food shortage in the shadow of the terrorist organisation.

Climate-Induced Migration?

Over the last few years, the question of whether and how climate change affects migration has been the subject of heated global debate, culminating (for the time being) in the adoption of the Global Compact for Migration in December 2018. In this legally non-binding document, UN member states recognise that extreme weather events affect migration and that people who have had to (temporarily) leave their homes due to such events are in need of protection.

It is undisputed that climate change affects agricultural production and thus also the livelihoods of the rural population in SSA, but there is no causal answer about the extent to which this directly leads to migration. We know that most migration in Africa occurs within a country's own borders, less frequently within a region, and even less frequently beyond the continent.[31] In this context, migration should be seen as an adaptation strategy to changing conditions. It can be assumed that migration will increase in the coming years if agriculture provides ever fewer opportunities for income and employment. Low productivity rates, low profit expectations, and public perceptions of agriculture as an old-fashioned profession have also made the sector unattractive, particularly with young people. This population group has an above-average rate of migration: it is estimated that more than 60 per cent of internal migrants in Sub-Saharan African countries are under 34 years of age.[32] A distinction should be drawn between short-term migration due to extreme weather events and long-term migration, which serves to secure livelihoods and contributes to the rapid urbanisation of Africa's cities.[33,34]

The IPPC predicts that extreme weather events such as floods, droughts and hurricanes will increase in the coming years. A study by the International Displacement Monitoring Centre (IDMC), in turn, shows that there is a high correlation between climate variables and international migration. Most migration takes place in high-risk environments, which are characterised by poor socio-economic prospects, low resilience and adaptive capacity, and high vulnerability to environmental events and conflicts. In this context, it is increasingly difficult to identify violent conflicts or natural disasters as the cause of migration. In the region around the Horn of Africa (Djibouti, Ethiopia, Eritrea, and Somalia), for example, periods of drought, lack of access to basic services and infrastructure, lack of economic prospects, and violent conflicts influence each other so that migration is often the only way for the vulnerable population to survive. This clearly shows that the connection between climate change and migration must always be examined in a socio-economic context. The decision to migrate cannot be narrowed down monocausal to climate change and its consequences.[35]

Potential Solutions

As the most important economic sector in Sub-Saharan Africa, agriculture can help to make the local population more resilient in the face of climate change, and it is also a prerequisite for guaranteeing food security for the growing population. Thirdly, there are numerous opportunities for reducing the proportion of global greenhouse gas emissions generated in the AFOLU sector.

Innovative methods to address these three challenges are called Climate Smart Agriculture (CSA). CSA increases agricultural productivity in a sustainable way, sustains incomes, and ensures food security. CSA methods can adapt to volatile climatic conditions, thus strengthening resilience in crop or livestock production and reducing GHG emissions from the production, processing, and marketing of food to the greatest possible extent.

CSA includes a number of methods and approaches that span the entire production cycle. These include climate-resilient seeds, agroforestry, improved pasture management, hydroponics, solar water pumps for irrigation, solar cold chain transfer, sustainable agriculture certificates, but also index-based insurance against crop failure among others.

CSA methods should be viewed in the context of specific countries and/or regions. For example, the cost of buying and maintaining solar-powered water pumps is too high for many smallholder farmers in East Africa. Other methods are only profitable if they are scaled up in larger agricultural production facilities. These methods are also of limited applicability to smallholder farmers in East and West Africa. If various feasibility aspects such as scalability, economic viability, and acquisition costs, but also the amount of GHG saved, are taken into account, then approaches such as smallholder agroforestry, the use of climate-resilient seeds and solar cold chain solutions are suitable for East Africa. These solutions are attractive because they are economically sustainable and, after receiving a small amount of initial support, farmers can apply the methods on their own.[36]

Climate-smart agriculture can build the resilience of the population, create economic opportunities, and reduce greenhouse gas emissions. However, the potential for CSA in Sub-Saharan Africa has not yet been fully exploited. Technology transfer and lack of funding are the main reasons for this. As in other sectors, there is a fundamental lack of private investment. In a global comparison, Sub-Saharan Africa receives the least money from the international climate fund. The scope for political action has also not yet been fully exhausted: targeted political initiatives could promote the spread of CSA and permanently improve the socio-economic conditions of the rural population.

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Smallholder Agroforestry

This method allows farmers to increase their income by planting trees on unused land. After a few years, this generates additional income from the timber. Planting trees absorbs greenhouse gas emissions and improves soil fertility. However, loan capital is often required in the early stages, and it can take some time before farmers see any profit. The potential of agroforestry to mitigate climate change is huge, which is why countries like Kenya have made agroforestry part of the national strategy for achieving its targets under the Paris Agreement.

Climate-Resilient Seeds

Using these seeds means they mature earlier, are more resistant to disease and pests, and increases yields in the value chains of corn, legumes, rice, and vegetables by 20 to 30 per cent. They have the potential to transform the food supply of the entire regions. Many new types of seed are currently being researched and marketed in East Africa, accompanied by strong knowledge transfer to smallholders, supported by both public and private initiatives. Supply and distribution chains are also expanding, which underlines the sustainability of this method, along with the affordable purchasing costs.

Solar Cold Chain Solutions

About 20 to 60 per cent of food in East Africa is wasted due to poor storage facilities, transport problems and lack of infrastructure. This particularly affects smallholders, who are unable to store and conserve their farm produce appropriately. The introduction of cold chain systems in East Africa is still in its infancy and is mainly driven by export-oriented sectors such as fruit and flowers. Conventional cold chain systems have limited reach because of the low rates of electrification in rural areas of Tanzania and Uganda, for example. This is part of the reason why solar-powered cold chain solutions are gaining ground. These systems are attracting broad support from development partners due to their huge potential. A particular focus here is on ensuring that smallholder farmers have access to cold chain technology, such as opportunities to rent cold storage rooms on a daily basis.

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Nicole Stopfer

2 Climate Change and Agriculture – Correlations and Consequences for Migration and Security in Central America

Climate change has adversely affected agricultural production in Latin America. Extreme weather events such as droughts and heat waves, along with heavy rain and floods, all have a direct impact on crop production and livestock farming. In the long term, this means declining yields, lower sales, and rising prices. While Latin American farmers are trying to adapt to new weather conditions, for the region's agricultural sector, climate change still poses a risk to livelihoods and food security. In parallel, agriculture in the region is one of the main producers of harmful greenhouse gases and is increasingly being highlighted as one of the causes of climate change. As a region, Latin America and the Caribbean are responsible for 17 per cent of all agricultural emissions, the second highest in the world. So the climate change debate is colliding with the livelihoods of Latin American farmers. In parallel, increasing migration and the associated security issues are leading to new areas of conflict.

The Climate Change/ Agriculture Nexus

The disproportionate effects of climate change on the agricultural sector and the resulting challenges for migration and security are particularly visible in the sub-region of Central America. The annual climate risk index published by the NGO Germanwatch highlights the region's vulnerability and how the Central American countries in the "Dry Corridor", which stretches from Southern Mexico to Panama,[37] are among the world's worst-affected countries by climate change. In addition, 40 per cent of the area's eleven million people live in rural areas, 60 per cent of them in poverty.

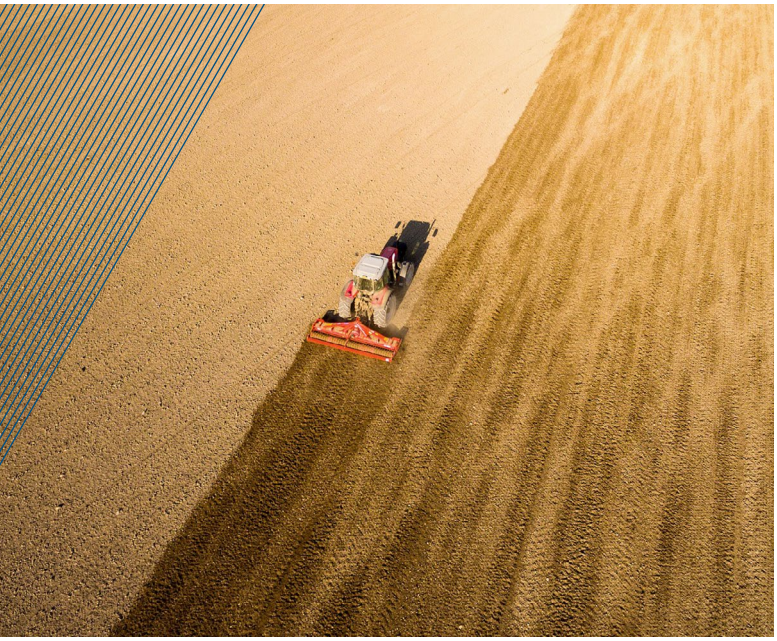
One of the effects of climate change in the region is a change in the usual rainy seasons and patterns, which traditionally determine the cultivation phases of local farmers. The changes mean that the expected rains are either arriving too late or not at all, resulting in prolonged periods of drought. In the Dry Corridor, these prolonged droughts are now causing losses of crops and income running to six figures.

In 2016 alone, up to 90 per cent of maize and 60 per cent of bean crops were lost in Nicaragua due to drought.[38] In El Salvador, the economic loss in the agricultural sector due to droughts between 2014 and 2019 was some 193 million US-Dollar.[39]

In addition to the shift in rainfall patterns, climate change is leading to an increase in the intensity of tropical storms, heavy rainfall, and flooding and will be observed more frequently in the coming decades in the region.

These extreme weather events affect farmers directly by degrading their productive land, and also indirectly by damaging the infrastructure. This makes it more challenging to use regional and national transport routes and result in supply bottlenecks. Essential services such as doctors' surgeries and schools can also become inaccessible for long periods, which adversely affects the lives of local people in both the short and long term.[40]

Figures recorded over recent years reveal that in 2018 more than two million people were experiencing food shortages due to loss of crops and income. In 2019, the number doubled and, on top of this, the coronavirus pandemic has led to more than seven million people being at direct risk of food insecurity since 2020.



Climate Migration as a Consequence?

For many decades, migration has played a central role in relations between the countries of Central and North America. Driven from their homes by precarious economic conditions, violence and political instability, huge numbers of migrants have flowed from Central America to the US over the years, often attracting media attention.

While climate change tends to be viewed as a catalyst that exacerbates existing shortages, combines different conflicts, and changes dynamics, violence and poverty are often cited as the main reasons for migration. Above all, gang violence and political unrest continue to determine migration flows to the US. Additional security conflicts subsequently arise from migration through Mexico and from illegal stays in Mexico and on the US border.

Even though smallholder farmers contribute around 60 per cent of total agricultural yields[41] and some two million families are engaged in subsistence agriculture as smallholders,[42] climate change has received little attention in the debate on the causes of migration and its management.

However, especially in the rural areas of Central America, the close links between climate change, poverty and migration are clear. In Nicaragua, around 50 per cent of all households in rural areas (1.2 million people) live below the poverty line of four US-Dollars per day.[43] For the whole of

Latin America and the Caribbean, over the last 20 years the proportion of the population living in extreme poverty in rural areas has been doubled compared to urban areas. Along with rising grain prices in the low-yield months, the main reason for this is the impact of climate change. Periods of drought or flooding quickly trigger increased rural-urban migration. Such sudden increases in the urban population lead to more problems with an already overburdened urban infrastructure. Cities such as San José in Costa Rica or Guatemala City in Guatemala are increasingly viewed as the best opportunity for finding alternative work opportunities. However, the cities' drinking water and sewage systems, waste disposal and transport infrastructure are under pressure from this increased migration. This directly impacts people's quality of life, fuels urban poverty rates, and can drive many people to migrate to other countries.

Climate change exacerbates the problems experienced by families, villages, and the urban and national infrastructure, and fuels trends that increase violence, poverty, and mass migration. It should be emphasised that the impact of climate change on migration processes is not linear and that there is no direct causal relationship. Rather, it is the interaction between many different individual, socio-economic and political factors, combined with the regional and temporal components of extreme weather influences, that are responsible for different forms of migration. The complexity of the interrelationships is also demonstrated by the fact that extreme weather events only lead to temporary migration. In this case, the main goal of farmers is to return home as soon as essentials such as drinking water and food have been restored.

Solutions and Opportunities

Against this backdrop, some countries in the Dry Corridor are attempting to invest in better agricultural management and new technology. However, with few exceptions, many projects and initiatives mainly take place at the local level and receive no national support. In Costa Rica, artificial irrigation systems have been built in some dry savanna areas. In Nicaragua, isolated sustainability projects, often initiated by NGOs, are gaining traction in smaller communities. For example, the construction of biogas plants aims to reduce the use of firewood and thus prevent deforestation. Their by-product, Biol, can also be used as an organic fertiliser to avoid harmful methane emissions.

Communities in Honduras and Guatemala are trying – occasionally with national support – to raise awareness of the complex problem and attract international aid by declaring states of emergency. In El Salvador and Guatemala, national agricultural aid packages worth several million dollars have been on offer over recent years,[44] with a view to providing farmers with seeds and fertilisers as a way of halting the increasing migration flows within and outside the countries' borders. However, so far these aid packages have only been short-term solutions. In the long run, they cannot solve the growing food shortage due to the increasingly evident consequences of climate change. International bodies such as the Food and Agriculture Organization of the United Nations (FAO) are also increasingly attempting to promote sustainable agricultural projects through funding models.[45]

The continuing flows of migrants and the many areas of potential conflict underline the lack of a long-term strategy for dealing with the changed climatic conditions to actually strengthen agriculture, especially in rural areas. Consistently linking prevention and adaptation strategies with climate protection requires state controls, communal structures, and competences.

However, the consequences of climate change also present new opportunities. Making the most of these in the long term requires farmers to be able to mitigate the risks of climate change. Adaptation to changing conditions can, therefore, only occur if the population is involved in the decision-making processes through training and education programmes, and if they are motivated to develop their own strategies and use their knowledge, some of which has been passed down over the centuries, to deal with climate change.

The similar climatic risks experienced across the region offer an opportunity to create regional synergies. Costa Rica seems keen to adopt a pioneering and leading role in this respect. For the World Day to Combat Desertification and Drought on 17 June 2021, the Costa Rican government invited all the countries in the Dry Corridor to join a virtual congress to analyse regional challenges relating to climate change, agriculture and migration and seek joint, innovative solutions. Such congresses show that there is political will and an awareness of the ongoing challenges. The narratives coincide with a harsher tone from the new US administration. During the first official visit of US Vice President Kamala Harris in June 2021, she made it clear that she would not accept illegal immigrants at the US border. It seems, therefore, that there is growing pressure on countries to find innovative ways of supporting their agriculture and halting migration flows.

Ultimately, if the region is to successfully adapt to climate change and ensure sustainable agriculture that guarantees food security and climate protection, this requires long-term political strategies and institutional structures, along with trade agreements that are economically fair. Climate change is weakening the region, both economically and politically. Support is required to ensure that Latin America's agricultural sector can make a sustainable contribution to climate protection and adapt to the changing climate conditions by diversifying its agriculture.

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Christian Hübner

3 Climate Change and Agriculture in Asia and the Pacific – Migration, Adaptation, and Innovation

Introduction

The impact of climate change on the agricultural economy in Asia and the Pacific are already clearly visible and pose a threat to food security in the region, including in the form of foreseeable income losses. However, the consequences are manifested very differently on the ground, depending on geographical and social conditions.

Over recent years, the growth of the agricultural sector in Asia has largely been driven by increasing demand for food rather than the challenges of climate change. Production capacities have been ramped up thanks to new agricultural technologies and cultivation methods and the use of genetically modified crops. Although rice is still the main agricultural product, fishing, livestock farming, and fruit and vegetables are now forming a larger part of the population's diet. The chronic food shortages among the region's poor and the associated health risks, especially for babies and young children, have been significantly reduced.

Nevertheless, the Asia and Pacific region is still characterised by pronounced social and agricultural heterogeneity. Even today, there are countries in the region where food is scarce and malnutrition widespread. There is a clear disparity between countries in the region, with South Asia lagging behind East and Southeast Asia. In many Asian countries, large swathes of the population still work in agriculture. Today, it seems likely that these regions and population groups will be some of the worst affected by climate change.

In this context, it is clear that the availability of both traditional and more modern agricultural knowledge and the capacity for technological innovation will be the key to how the Asia and Pacific region copes with the impact of climate change on agriculture.

Impacts, Adaptation Attempts, and Climate Migration

The direct consequences of climate change on agriculture in the Asia and Pacific region are now the subject of increasing scrutiny and growing political concern, as demand for food is set to soar in view of the region's anticipated population growth. In general, rising temperatures in the region have a negative impact on food cultivation. Rice cultivation is particularly affected by shorter growing seasons. However, the effect of climate change plays out differently around the region. In North-Eastern Kazakhstan in Central Asia, longer growing seasons and milder winters are expected to lead to higher cereal yields, while in Western Turkmenistan and Uzbekistan, more frequent droughts are a threat to cotton growers.

The effects are particularly dramatic on the fertile Indo-Gangetic Plain, which encompasses parts of Pakistan, Northern India, some of Nepal, and the whole of Bangladesh. Here, widespread food crop losses can be expected due to rising temperatures, with wheat being particularly affected. In East Asia, on the other hand, climate change could open up new rice-growing areas with conditions that would allow for higher overall yields. Rising sea levels are increasingly restricting rice cultivation, which mainly takes place near the coast. This has serious consequences for the local people. Increasingly frequent extreme weather events such as droughts and cyclones, especially in the island states of Southeast Asia, can quickly destroy food-growing areas. So far, little research has been conducted in Asia and the Pacific on the effects of additional CO_2 fertilisation on food production due to the increased concentration of CO_2 in the atmosphere. Increasing attention is being paid to CO_2 emissions from agriculture itself and the resulting interactions with climate change.

The varying effects of climate change on agriculture create complex interactions that can also serve as a driver of local migration. The nexus of climate change, migration, and agriculture is articulated on two levels.

Firstly, the effects of climate change may slowly manifest themselves in agriculture, for example, as water becomes increasingly scarce or agricultural land decreases, people are gradually forced to move away. This development is frequently observed in the main rice-growing areas near the coast. In Vietnam, the Mekong River flows into the China Sea via a wide and winding river system, forming the Mekong Delta. The region is densely populated and a major rice-growing area for the entire region. Fruit and seafood are also harvested here. It is already evident that sea levels are rising in the region, reducing the amount of land available for cultivation. The salinisation of freshwater resources is also seriously exacerbating the situation. On top of this, new animal diseases and infectious diseases are emerging that can spread to humans. Forecasters predict that this could impair Vietnam's economic growth. Against this backdrop, migration from the Mekong Delta is already increasing, often to large urban centres such as Ho Chi Minh City. Local authorities are trying to adapt

to this development with several measures, such as encouraging the cultivation of more resilient types of cereals and fruit. In general, monoculture should be reduced. One approach is to use rice-growing areas for the cultivation of shrimp. However, shrimp need large amounts of fresh water and the addition of antibiotics to prevent disease. Both have negative side effects. The increased use of freshwater leads to soil subsidence, which increases the impact of the rising sea levels caused by climate change. The large-scale use of antibiotics brings significant health risks in form of antibiotic resistance. A similar development can be observed in the densely populated Ganges Delta, a river system that flows into the sea via India and Bangladesh.

Secondly, migration can occur due to sudden extreme weather events. In 2019, for example, Cyclone Bulbul hit the Bay of Bengal and destroyed agricultural land. In 2017, torrential rains hit various districts of Nepal, wiping out farms and irrigation systems. South Asian countries have different extreme weather events to contend with, such as river water eroding the banks in Bangladesh; annual floods and droughts in India and Pakistan; melting glaciers in Nepal; as well as droughts and torrential rains in Sri Lanka. These are all factors that can drive migration decisions. Most dramatically, the region's working population is highly dependent on agriculture and fishing: 65 per cent in Nepal, 41 per cent in India, 38 per cent in Bangladesh, and 24 per cent in Sri Lanka.[46] There are currently 18 million climate migrants in South Asia. This figure is projected to increase to 37.4 million by 2030 and 63 million by 2050.[47] Even in the best-case scenario of a temperature increase of 1.5 to 2 degrees Celsius, the figure will be 22.5 million and 44.5 million respectively.[48]

In the mountain regions of South Asia, climate change is also becoming apparent. Nepal, a country with a variety of climate conditions and a high degree of plant and animal diversity, is particularly affected. More extreme precipitation in summer and increasing drought in winter pose a serious challenge. The agricultural sector is trying to cope with this development by introducing new plant species, new technologies, improved agricultural management systems, and by varying cultivation cycles for cereals. Water-intensive rice cultivation, for example, is to be replaced in certain areas by millet plants that require less water. Crop diversification by cultivating beans and maize together is another method to cope with more unpredictable weather. To counteract soil erosion, coffee, lemons, grasses, and cardamom plants are to be integrated into terraced field cultivation. This is a fresh challenge for the local farmers, who have been farming in mountainous areas under extreme conditions for hundreds of years. However, cultural knowledge of traditional agriculture and modern climate research provide a good basis for tackling this. The greatest danger for countries in mountainous areas is posed by floods resulting from the annual monsoon rains, which may not only be a threat to agriculture but also to life. The recent flood disasters in India, Pakistan and Bangladesh are of particular concern. An essential element of adaptation is, therefore, the establishment of early warning and protection mechanisms for disaster prevention.

Innovation and Knowledge

Many countries in the region, such as China, Japan, Australia, New Zealand, and South Korea have extensive capacity to develop technical solutions in the agricultural sector, including precision agriculture. Precision agriculture is a farming management method based on observing and measuring variability in the field to optimise yields and maximise cost-savings. It makes use of agricultural technology such as artificial intelligence, the Internet of Things, drones, and satellites. Farmers use these technologies to transmit agricultural data in real time and optimise the use of resources without human intervention. In Malaysia, for example, farmers use drones to irrigate fields and transmit up-to-date data to agricultural equipment for the purposes of irrigation, fertiliser application and pest control. In addition, aerial monitoring and sensors connected via the Internet of Things provide farmers with data to forecast future crop yields and monitor harvest figures. In China, more than 80 per cent of rice grown in the Heilongjiang province is irrigated by drones. In this way, agricultural technology and precision farming are already permeating Asian agriculture.

Precision agriculture can, therefore, help smallholder farmers to practice more resilient field management regarding climate change by ensuring that the cultivated land is in the best possible condition at all times – even when faced with weather fluctuations. The soil becomes less susceptible to crop failure from slow-onset disasters that can lead to permanent migration, although it is still vulnerable to sudden-onset events. As the use of agricultural technology is still new in developing countries in Asia, the upfront costs for smallholder farmers are high. They may not have the skills and knowledge to use the technology. This is only possible if data and technology work together seamlessly, which requires prior training. More development and support is therefore needed before the technology is accessible to the most vulnerable smallholder farmers.

Climate-smart agriculture (CSA) is a concept for integrating adaptation and prevention strategies into traditional agricultural management. It has three main objectives: sustainably increasing agricultural productivity and incomes (food security); adapting and building resilience to climate change (adaptation); and reducing emissions. It also involves two key principles: improving resource use efficiency in the agricultural system to increase net incomes; and increasing the resilience of the agricultural system to reduce vulnerability and improve adaptive capacity. Ecosystem services such as soil management, agro-biodiversity and landscape management are more important for climate-smart agriculture than other farming methods as mentioned above. This type of agriculture is more suitable for smallholders in developing countries, as it can be considered an optimisation of proven farming methods and the technology does not require much training. In this context, efficiency-boosting technology such as drip irrigation is used to increase yields while saving resources. In addition, on-farm storage facilities are established to prevent post-harvest losses due to climate shocks. Technology for disseminating weather information is also used so that farmers can change their irrigation and pest management strategies according to the weather forecast, which improves their ability to adapt.

In India, climate-smart agriculture is applied in various locations, with each area differing from the other depending on the environmental conditions. In terms of soil management, trees and hedges are planted to combat wind-induced soil erosion in semi-arid areas, whereas farmers in humid and coastal areas employ contour ploughing and plant terraced hedgerows. In the mountains, the cultivated area is increased by terracing. For water management, the tried-and-tested methods of water storage are still the most useful and effective for saving water. This practice is also widespread in Bangladesh. This shows how easy it is for smallholder farmers in developing countries to adopt climate-smart agriculture.

Urban Farming

Urban farming is also known as vertical farming. It is a method of cultivating food in urban areas and conurbations through indoor farming in multi-storey buildings. The main feature of such a farming method is the absence of soil. Instead, hydroponics and aeroponics are used to grow vegetables, fruit, and herbs in multi-storey greenhouse complexes stacked on top of each other. These greenhouses also use LED lights in combination with natural sunlight. Japan, China, South Korea, Singapore, and the US are the pioneers in the use of this technique.

Vertical farming has many advantages considering the challenges posed by climate change. For example, it requires significantly less land and water. The controlled environment also reduces the need for pest control so the use of chemicals and pesticides can be minimised, making vertical farming compatible with organic farming. Another advantage of the controlled environment is that the plants are largely protected from climate shocks. Salinisation, droughts, floods, hurricanes, and irregular rainfall are no longer issues, making it possible to guarantee consistent production all year round.

However, this method has the same disadvantages and obstacles as precision agriculture. First and foremost, the skills required will exclude many farm workers because vertical farming uses sophisticated technology – even more complex than in precision agriculture. This, in combination with the location factor, means that only a small proportion of farmers have the capital required to move into this kind of farming. And, despite the higher efficiency, production is still very much limited to a small space, so overall production will be lower than in conventional farming. High energy consumption due to the method's reliance on artificial lighting and automation also makes urban farming vulnerable to power outages.

Conclusion

The agricultural sector in the Asia and Pacific region is directly affected by climate change which could limit its ability to provide enough food. Along with food shortages, this could have serious consequences for the people of the region in the form of lost employment opportunities. It particularly affects workers on small farms, which make up the bulk of Asian agriculture. This could accelerate migration to the urban centres still further. However, politicians have recognised this problem and most countries in the region are taking steps to adapt. For smallholdings, knowledge transfer is of vital importance – including traditional, lost knowledge and newer expertise. Digital transformation has also brought new technology in the form of precision agriculture, which helps farmers to be more efficient. Promising new opportunities are also opening up thanks to innovative approaches such as vertical farming, which grows crops in a totally controlled environment in urban spaces.

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Tobias Zumbrägel

4 Climate and Conflict – Opportunities for Environmental Peacebuilding

Climate change is one of the grand challenges of the 21st century. The current Covid-19 pandemic, which was most likely caused by a zoonosis, has revealed the close and fragile connection between humans and nature. Under the term "climate wars", it was long assumed that security risks and climate change directly influenced each other. However, recent studies indicate that it is unlikely that climate change will be a key factor in triggering wars between countries. The risk of such conflicts seems to be mainly due to other contextual conditions. These findings argue that there is an indirect link between climate change as a conflict driver and crisis multiplier.

A striking example is the Syrian civil war, which has already lasted for more than ten years and impacted European foreign and security policy, not least by causing a huge wave of refugees. Early on, some commentators identified climate change as the driving force behind the civil war, but more recent research points to a complex web of causes in which increasing environmental stress (e. g., due to a long period of drought) is just one component. In addition to the pervasive repression exerted by the Assad regime, other factors such as the liberalisation of the agricultural economy and the reduction of subsidies, corruption, lack of channels for political participation, and mismanagement also played a significant role.

At the same time, the discussion about the triggers for the Syrian civil war reveals that it is still difficult to determine the effects of global climatic events in specific (regional) contexts. It also remains unclear which strategies and solutions need to be developed to reduce or prevent the impact of climate and environmental stress on the dynamics of conflict.[49]

Environmental Stress as a Threat Multiplier

A glance at the Mediterranean region reveals numerous connected factors that demonstrate the growing threat posed by climate and environmental stress but also highlight how potential solutions to these problems have to be sought jointly and in a multilateral fashion. It is possible to identify a variety of threat scenarios.

Firstly, the geographical area comprising the countries bordering the Mediterranean is affected by long-term climate change. This applies above all to the heavily populated coastal regions, which are threatened by rising sea levels. Regional climate and temperature fluctuations are to be expected, as well as persistent rainfall or severe storms. For

example, forecasts show that the average temperature in North Africa and the Middle East could rise from the current 43 degrees Celsius to 46 degrees Celsius by mid-century and to almost 50 degrees Celsius by the end of the century. In urban centres, the temperature rise could be even more drastic. In parallel, heat waves are becoming more frequent, affecting mortality rates. Prolonged droughts are exacerbating the already acute water shortage in the region. Extreme hydrological events, such as heavy rainfall, flash floods, along with natural hazards like earthquakes and landslides, are also becoming more frequent and intense. Secondly, anthropogenic influences (such as pollution) are intensifying climate change and environmental stress. The Mediterranean Sea, which is not only vital for the livelihood of coastal communities through fishing, agriculture, and tourism, is polluted by plastic waste and industrial waste. There is a lack of recycling facilities, regulations, and monitoring bodies to both the north and south of the Mediterranean. There is also a shortage of reprocessing plants for polluted freshwater. Along with a lack of political will and specific action plans, structural problems also play a role here. The violent conflict in Gaza has destroyed its water and energy supply infrastructure. In contrast to its neighbouring state of Israel, the potential to repair these major public utilities is often limited.

Competition for Resources

Linked to these climate- and environment-related stress factors are questions of resource access and distribution, which fuel intra- and inter-state conflicts. This becomes evident once again when it comes to access to an essential resource – water. Most of the countries share common groundwater reservoirs, rivers, or lakes. Only a few countries, including Syria, Jordan, Israel, and Lebanon, have agreements that contractually regulate the distribution of this resource. International "water wars" may seem unlikely as things stand, but ongoing or re-emerging conflicts between the parties involved regularly lead to inter-state agreements either stalling or being terminated. The future water shortage will exacerbate competition for resources between countries or between different ethnic groups within countries and, in addition, evoke conflicts over food shortages, especially between countries that are dominated by agriculture.

Future energy security is also closely interwoven with the issue of dwindling water resources, as water is not only used in the process of generating energy but is also produced in energy-intensive processes such as desalination. To guarantee energy security and public goods, promote industrialisation and modernisation, and become independent of energy imports, many countries are focusing on the use of technologies such as nuclear power in addition to the ongoing development of conventional, non-sustainable resources such as coal, oil and gas. Many of these measures are not only environmentally dubious but may also raise new security issues. For example, the nuclear

aspirations of Egypt, Israel or Turkey should be discussed from the perspective of a regional Mediterranean security architecture. Beyond this, the newly discovered gas fields in the Eastern Mediterranean already point to future potential for conflict between the various countries that lay claim to these resources.

Interactions between climate change and security risks also have a political dimension, which is reflected in a deliberate instrumentalisation on the part of political elites and increased activism on the streets. This is particularly evident in the Arab countries bordering the Mediterranean Sea, which are often beset by conflict, autocratic governance and weak political institutions, social injustice, corruption, and huge numbers of displaced people and refugees.

Many Arab nations have deliberately politicised the consequences of climate change. In the past, social minorities have often been cut off from access to public goods – particularly the water supply – while certain elite players such as large agri-businesses in Egypt, Lebanon, and Syria have profited from these resources. In recent years, some states have begun to bolster their green image, as evidenced by the announcements of major initiatives by Morocco's King Mohammad VI. (such as the Moroccan Solar Plan and the Green Moroccan Plan) or more recently by Crown Prince Mohammad Bin Salman in Saudi Arabia (the Saudi and Middle East Green Initiatives). Heads of state love to boast about these visions to their domestic audience and in the international arena.

A Powder Keg of Social Unrest

The consequences of climate change and government mismanagement are also a powder keg for social unrest. In Morocco, Tunisia, and Lebanon, issues surrounding environmental pollution and access to, and distribution of, resources have been a major driver of public protest and resistance movements over recent years. Reduced subsidies because of distribution conflicts have promoted social exclusion and distrust of authorities and politicians, often leading to a loss of trust in the respective governments. At the same time, increased environmental awareness may encourage activists to challenge their ruling regimes. Here we can mention the Gezi protests in Turkey in 2013, where the Turkish government proved powerless to deal with such bottom-up processes (similar examples can be found in Egypt and Iran). All forms of environmental activism were suppressed, certain non-governmental organisations were banned, and many activists were imprisoned.[50]

The links between the dynamics of conflict and climate and environmental stress form a complex web rooted in environmental, socio-economic, and political issues. A comprehensive approach that balances these aspects is a prerequisite for climate-sensitive conflict transformation. At the same time, it is not enough to view the climate crisis solely as a threat multiplier. Rather, it also offers opportunities for environmental peacebuilding.

Environmental Peacebuilding

In this context, effective, long-term environmental peacebuilding must not be based on merely tackling the short-term symptoms with a narrow focus on the environmental risks. Instead, a detailed analysis should be carried out while intensifying preventative action. First of all, this should include improving systems for equitable access and the collective distribution of resources. At the same time, the complex interdependencies between local socio-economic and political conditions must be considered, since environment-related conflicts and crises often arise in the context of weak statehood and poor governance. This assessment of systems should be given greater prominence in existing cooperation formats. Representative examples are the environmental and climate protection measures adopted by the Union for the Mediterranean, the Barcelona Convention with its Mediterranean Action Plan, and the proposals for the Green Deal, which is to encompass the whole Mediterranean region.[51]

Furthermore, local initiatives for transnational cooperation on the environment and resources must be strengthened. One example is the EcoPeace organisation's Green Blue Deal, which promotes energy security and peaceful regional water distribution and use between Israel, Palestine, and Jordan. Similar mechanisms should be developed and implemented in other regions relating to many other issues (e. g., sandstorms, desertification) or agreements on transnational environmental disasters (e. g., nuclear or oil spills). They could not only prevent transboundary environmental conflicts, but also initiate multilateral cooperation between individual states. In addition, at the national level a climate-sensitive dialogue should be promoted that involves civil society and socially disadvantaged population groups in the decision-making processes. This should be accompanied by widespread educational programmes and campaigns to raise public awareness of the dangers of climate change and environmental stress. Environmental peacebuilding should open up new channels for political participation but should also be closely linked to the protection of human rights. Together, they could serve to counteract environmental migration.

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André Algermißen

Conclusion

This year's Climate Report looks at the potential impact of extreme weather events and climate change on the agricultural sector from the perspective of different world regions, focusing on developing regions. The authors also analyse the extent to which climate change influences migration and the security issues that arise from this. Five key points can be derived from their contributions:

1. **Climate Change and Agriculture are Closely Linked**
   Agriculture is one of the main causes of harmful greenhouse gas emissions (mainly nitrous oxide and methane), for example from livestock farming, and thus actively contributes to climate change. On the other hand, farmers are affected by climate change and extreme weather events such as drought and heavy rainfall and are facing major losses. In 2016, for example, a drought in Nicaragua led to the failure of some 90 per cent of the maize harvest, threatening the livelihoods of countless families. At the same time, climate change is a threat to food supplies and increases the risk of famine in fragile states.

2. **Climate Change is Likely to Exacerbate Existing Conflicts**
   In regions with difficult socio-economic conditions, such as the Horn of Africa, changes to the rainy seasons and temperature shifts can exacerbate conflict. Shortages lead to competition for food and resources and have a destabilising effect. In future, water shortages will be particularly likely to intensify conflict. However, the frequent suggestion that there is a direct causal link between climate change and violent conflict is an over-simplification of complex interrelationships. As a rule, conflicts do not have a monocausal explanation but result from an interplay between factors such as lack of statehood, ethnic and religious conflicts, and economic problems.

3. Climate Change and Extreme Weather Events Can Fuel Migration

Climate change contributes to shortages of water and agricultural land, both of which fuel local migration. In Vietnam, for example, people are moving to urban centres like Ho Chi Minh City because rising sea levels (combined with other factors) are resulting in a loss of agricultural land. Periods of drought or flooding can also trigger a rural exodus. However, it is difficult to prove a direct causal link between climate change and migration in specific cases because of other key influences, such as violent conflict, political instability, and precarious economic conditions. Consequently, migration should always be considered in its context and not explained using a blanket term like climate change.

4. Climate Smart Agriculture (CSA) and Agricultural Technologies are Vital Tools for Ensuring Agriculture Adapts to Climate Change

Climate Smart Agriculture (CSA), which integrates adaptation and prevention strategies into traditional land management, is an important instrument for increasing the adaptive capacity of the agricultural sector and achieving greater sustainability. This term covers a wide range of practices, such as climate-resistant seeds, improved pasture management, and agroforestry systems, which help to increase productivity and income. At the same time, technologies such as drones and satellites offer great potential: for example, more than 80 per cent of rice grown in the Chinese province of Heilongjiang is irrigated by drones.

5. The Agricultural Sector Must Be Given Greater Consideration in International Climate Policy.

International climate policy must pay more attention to the agricultural sector. It is not only the mainstay of many countries' economies, but also a vital tool in the fight against climate change. The agricultural sector can make a major contribution to reducing greenhouse gas emissions. Adapting to climate change is essential for the food supply. One-sided perspectives that see farmers primarily as emitters are not helpful here. Instead, there is a need for long-term political strategies that promote sustainable and resilient agriculture. Emerging and developing countries must be supported in this transformation process so that, for example, technological innovations can be applied across the board. European initiatives from business and society are of particular importance. The Konrad-Adenauer-Stiftung promotes exchange and networking between relevant stakeholders, such as the One World – No Hunger initiative, along with various projects as part of its climate and energy programmes. German development cooperation has been committed to climate policy in the agriculture and food sector for many years: between 2014 and 2018, the Federal Ministry for Economic Cooperation and Development (BMZ) supported some 190 projects to the tune of 1.3 billion Euro. Adaptation measures in African agriculture are a particular focus.[52] This commitment must be continued and extended to affected countries in other regions of the world.

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52 German Federal Ministry for Economic Cooperation and Development. 2021. *Climate Change and Rural Development: Climate Policy Engagement in the Agriculture and Food Sectors*. file:///C:/Users/gillm/Downloads/BMZ-rural-development-en.pdf (accessed 22.7.2021).

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