23 Impacts of Climate Change on Water and Food Security in River Basins

The Need for Climate-Smart Agriculture

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23.1 INTRODUCTION

> Human-induced climate change is already affecting many weather and climate extremes in every region across the globe. Evidence of observed changes in extremes such as heatwaves, heavy precipitation, droughts, and tropical cyclones, and, in particular, their attribution to human influence, has strengthened.
>
> (IPCC, 2021a)

This was only the latest in a long series of warnings by climate scientists over the last few decades. Unprecedented changes over many hundreds to even thousands of years have occurred "across the whole climate system, as well as various aspects of climate change".

While the impacts of climate change will be felt globally, developing countries, particularly those in Asia and Africa, are the most likely to be the hardest hit. This is particularly so because these agrarian economies are dependent on climate variables for food production and for the livelihood of local communities. As the climate changes and the world warms, global agricultural production will be impacted, in some cases positively, but for the agricultural economies of Asia and Africa, these impacts will most likely be negative. Decreased water availability due to variability in temperature and precipitation will impact agricultural processes leading to loss of livelihoods, food and water scarcity, and declining economies.

The aim of the chapter is to highlight the impacts of climate change on water availability and food security in river basins in Asia and Africa. It will then go on to consider the implications of climate-smart agriculture (CSA) for water availability and food security in river basins in light of climate change. Case studies from Asia and Africa, showing successful CSA activities in river basins will be presented as evidence base for CSA, to highlight its innovative and comprehensive model.

23.2 CLIMATE CHANGE IN RIVER BASINS

> Continued global warming is projected to further intensify the global water cycle, including its variability, global monsoon precipitation and the severity of wet and dry events.
>
> (IPCC, 2021a)

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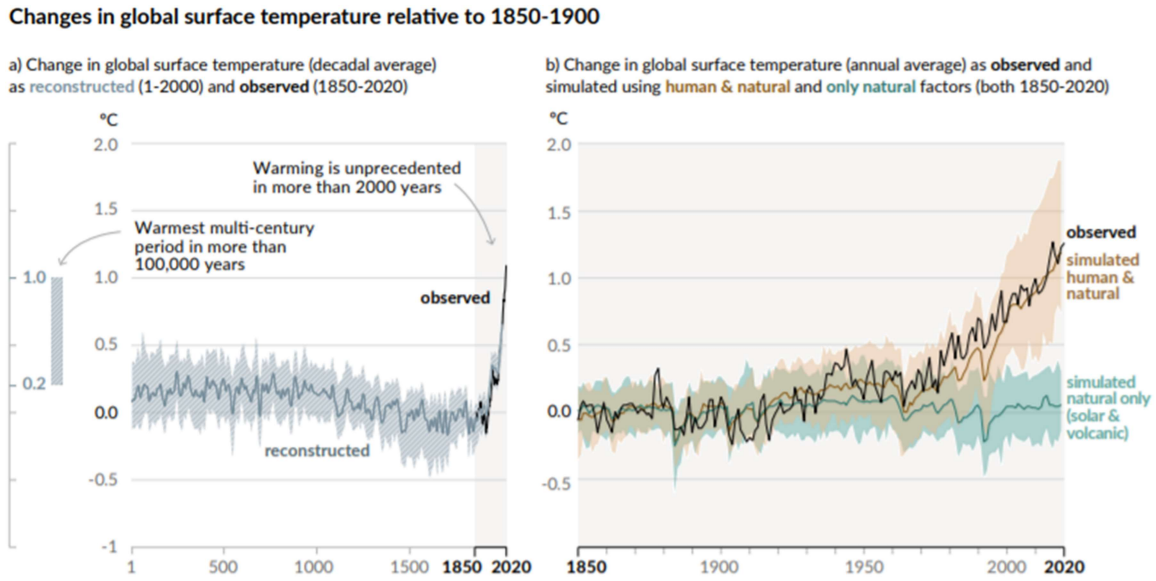


FIGURE 23.1 Human influence has warmed the climate at a rate that is unprecedented in at least the last 2000 years.

Source: IPCC, 2021a.

Human-induced climate change had already reached approximately 1°C above pre-industrial levels by 2017 (IPCC, 2018). At the current rate of increase, warming levels are likely to reach 1.5°C between 2035 and 2050. The decade ending in 2015 was 0.87°C higher than the average when compared to 1850–1900 (IPCC, 2018). Global surface temperature was 1.1°C higher in the decade between 2011 and 2020 than between 1850 and 1900 (IPCC, 2018).

Past and ongoing greenhouse gas (GHG) emissions are resulting in the increase of current global warming at 0.2°C per decade.

> Global surface temperature will continue to increase until at least the mid-century under all emissions scenarios considered. Global warming of 1.5°C and 2°C will be exceeded during the 21st century unless deep reductions in carbon dioxide (CO_2) and other greenhouse gas emissions occur in the coming decades

says the IPCC's Sixth Assessment Report (IPCC, 2021a). In the coming decades, we are likely to observe increased changes in climate across the globe. The whole climate system will change with further global warming, followed by increases in the frequency of hot extremes, the intensity of precipitation and cyclones, as well as melting sea ice, permafrost, and snow cover.

Every additional 0.5°C of warming will raise the intensity and frequency of hot extremes such as heatwaves and heavy rainfall (IPCC, 2021a). Meteorological and hydrological droughts will increase in some regions for every additional 0.5°C global rise in temperature (IPCC, 2021b). In other areas, extreme rainfall will intensify by 7% for each additional 1°C of warming (IPCC, 2021a).

Reaching temperatures of 1.5°C or above will result in varying spatial and temporal impacts (Ebi et al., 2016). However, an increase in average temperatures by 1.5°C or 2°C will mean all regions of the world will experience high temperatures, changes in wet and dry seasons, variability in winds and precipitation, sea-level rise, and melting glaciers and ice sheets, as well as rises in the occurrences and intensity of extreme weather events. Agricultural and ecological droughts[1] will become common in many regions as the global hydrological cycle is impacted by a warming world (IPCC, 2014, 2021b).

Even 1.5°C of global warming will induce unprecedented surges in the occurrences of extreme events (IPCC, 2021b). These effects are already being felt. The number of weather-related disasters has already increased five-fold, with more than 11,000 occurring between 1970 and 2019 (WMO,



FIGURE 23.2 End hunger, achieve food security and improved nutrition and promote sustainable agriculture.

Source: UN SDG 2.

2020). Almost all global glaciers have been retreating synchronously since the 1950s – unprecedented in the last 2,000 years (IPCC, 2021b).

Many Asian and African countries are already experiencing increases in hot extremes, heavy precipitation, and agricultural and ecological drought. As Asian glaciers melt and recede, river basins being fed by them are going to be impacted. For example, in South Asia, glacial melt from the Himalayas will result in the dual issues of increased flooding initially, followed by water scarcity due to the reduction of snow melt into river basins and watersheds of the Indus, Ganges, and Brahmaputra, as glaciers shrink and some even disappear.

Low-lying and crowded coastal cities in many South and Southeast Asian countries are under intense stress, and this situation is likely to worsen, with hundreds of millions of people who live there particularly vulnerable (World Bank, 2013). Sea-level rise could cause massive flooding and inundation of many coastal and deltaic regions. Sea-level rise projections show that over one million people living in coastal regions of South and Southeast Asia will be at risk from flooding (IPCC, 2014). Some countries are (and will continue to be) impacted by scarcity of water, as well as intense cyclones and flood events, with inconsistencies in the monsoon season and heat extremes (World Bank, 2013).

West Asia has experienced rising temperature trends in the last few decades, in addition to a downward trend in precipitation and an increase in extreme weather events (IPCC, 2014). Rising temperatures, low rainfall, and drought will continue to impact river basins and watersheds across the Middle East and West Asia.

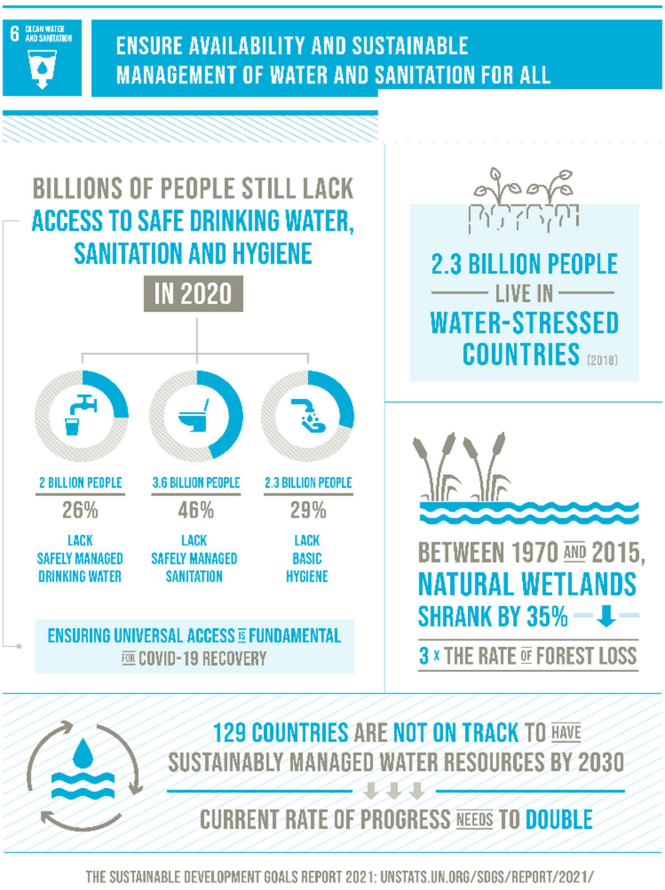


FIGURE 23.3 Ensure availability and sustainable management of water and sanitation for all.

Source: UN SDG 6.

This has already come to pass in Iraq and Syria. Record low rainfall has decreased river flow into the Euphrates and Tigris (OCHA, 23 August 2021). More than 12 million people are losing access to agricultural and drinking water in addition to electricity due to the resultant water crisis. Drought conditions have arisen because of unseasonably low levels of precipitation across the eastern Mediterranean Basin, since the autumn of 2020 (OCHA, 2021a). Syria is facing the worst drought in seven decades. Iraq is also suffering through drought due to an unusually dry winter, its second driest in 40 years (OCHA, 23 August 2021).

In India, news media[2] reported excessive rains over the coastal city of Odisha, India, impacting almost two million people and compelling the Indian Meteorological Department to issue a red alert. The town of Puri experienced 341 mm of rainfall, the first in September in 87 years, while Bhubaneswar recorded 194 mm in 24 hours, beating a 63-year record – both due to a depression in the Bay of Bengal. People in low-lying areas had to be evacuated, houses were damaged, and other infrastructure impacted. The rains have led to the Jalka River in Balasore reaching overflowing levels. The affected districts are in and around river basins of six rivers, and floods could severely damage their agriculture-based economy.

In Africa, since 1901, large areas have already warmed by more than 1°C, experiencing more heatwaves and hot days (IPCC, 2014). The year 2019 was one of the three warmest years since records began, and this warming trend is expected to continue (WMO, 2020). Large areas of Africa will exceed 2°C of warming above pre-industrial levels by the end of this century (IPCC, 2014). Rising temperatures are likely to lead to increases in the frequency and intensity of extreme weather conditions across the continent, especially in and around its river basins.

For example, Sudan was hit with heavy rains and flash flooding in August 2021, following on from 2020, when a wetter rainy season than usual meant that the Nile River and some of its tributaries reached their highest levels in a century (OCHA, 2 September 2021).

River floods in southern Somalia in 2020 also indicate the impacts of extreme events, as the Juba and Shabelle rivers' water levels rose due to heavy rains in the Ethiopian highlands (FAOSWALIM and UNHCR). This continued in 2021, when Juba River broke its banks in Doolow, reaching 4.7 m and flooding three villages (OCHA, 2021c).

As these very recent examples indicate, there is no doubt that continued changes in climate across the world's river basins will aggravate prevailing livelihoods, food security, and water scarcity problems – in particular, across the Asian and African river basins.

23.3 WATER AVAILABILITY AND FOOD SECURITY IN RIVER BASINS

World hunger and lack of safe drinking water are experienced by billions of people in almost all regions. Globally, 2.37 billion people lack food or do not have access to a healthy diet (UN SDG, 2021), while 2.3 billion people live in water-stressed countries and 2 billion people (26%) lack access to safe drinking water (UN, 2021). As the global population rises, this situation will only worsen.

Rising temperatures will be accompanied by immense changes in Earth's water cycle – already wet areas will become much wetter and arid areas will experience more drought (IPCC, 2021a).

Dramatic changes in the flows of global rivers have already resulted in the loss of endemic biodiversity and have had negative impacts on ecosystems and human well-being (Palmer et al., 2008), including those in Asia and Africa. Changes in the hydrological cycle will result in higher levels of evapotranspiration in tropical regions, while some areas around the equator will face higher rainfall – droughts will become worse and will last longer in the first case, flooding will occur in the second (IPCC, 2021a). Almost every river basin population will experience changes in river discharge, and many will experience water stress (Palmer et al., 2008) and resultant food insecurity. Already, one-fifth of global river basins are undergoing swift increases or decreases in surface water area (UN SDG, 2021). River basins that drain into lakes are also not free of problems. Globally, lake water quality has declined and out of 2,300 large lakes assessed by the UN in 2019, almost one-fourth recorded high to extreme turbidity[3]. Natural wetlands in all regions are also deteriorating, with more than 80% estimated to have been lost since pre-industrial times (UN SDG, 2021). Additionally, marine and coastal wetlands shrank by almost 35% – three times the rate of forest loss.

Riverine and river basin populations in Asia and Africa are already experiencing severe food security and water scarcity concerns due to rising populations, compounded by the impacts of climate change. Asia has 57 transboundary river basins accounting for 39% of its surface area (Moynihan et al., 2013). Africa has 59 transboundary river basins making up 62% of its land.

23.3.1 Water Scarcity

A vast majority of the populations of these two continents rely on these river basins for food, livelihood, agricultural and drinking water, and electricity. They are likely to be affected by variability in the water cycle. Already, many communities face extensive water shortages, where people must travel for miles to get potable water in some areas. The 4.5 billion people who live in Asia use around 65% of the global water supply (Satoh et al., 2017). Out of this, 30% of the population is already experiencing water scarcity.

Western and Southern Asia and Northern Africa have levels of water stress[4] at more than 60%, 77%, and 108%, respectively (UN SDG, 2021). Water stress levels in Southeast Asia and sub-Saharan Africa increased from 2017 to 2018 (UN, 2021), and in Eastern Asia, they were 45.6% (UN

SDG, 2021). In sub-Saharan Africa alone, 76% of the population lacks access to safe drinking water (UN, 2018), and half of the global population without access to basic drinking water services (387 million) lives there (UN SDG Report, 2021).

It is estimated that by 2050, 20% of the land area in the Asia-Pacific region, home to 1.2 to 2 billion people, will experience severe water stress (Satoh et al., 2017). Compared to 2010, the demand for water in Asia will increase by 30 to 40% for agriculture, industry, and household use by 2050, by which time its water demand is projected to be larger than all the other continents of the world put together (Satoh et al., 2017).

In South Asia, changes in the monsoon rains will affect crop productivity, livelihoods, and the health of millions of people. As mentioned earlier, floods and then water scarcity will become prevalent as Himalayan glaciers – which have been retreating since the 1990s – melt (IPCC, 2021). Ice volume in Asia is likely to decrease by approximately 36% under the 1.5°C scenario, affecting future water availability in the Indus basin, which is highly dependent on meltwater (Kraaijenbrink et al., 2017) for domestic and agricultural use.

Downstream irrigation and potable water unavailability will become prevalent in the major global climate change hotspots of the Indus, Brahmaputra, and Ganges basins, to say nothing of the floods and landslides that will subsequently occur. Lack of water available for agriculture will mean low crop production and crop availability, together with scarcity of water for drinking and other domestic uses.

According to projections, a global temperature rise of 1.5°C in the river basins could result in a temperature increase of 1.4–2.6°C, while in the 2.0°C scenario, the increase could lead to 2.0–3.4°C (Lutz et al., 2019). This means that the resultant likely increase in monsoon precipitation would lead to more severe and frequent floods in this region, as well as landslides, GLOFs,[5] and sedimentation (Lutz et al., 2019). However, this does not necessarily mean that there will be a direct increase in water availability of the Indus, Brahmaputra, and Ganges basins. In some regions, like the Ganges basin, periods of water excess may be followed by more periods of water shortage (Lutz et al., 2019). Any changes in the length of wet and dry periods could result in increasing crop water demand, adding further stress to water resources and declining food availability.

In East, South, and Southeast Asia, as well as in the Sahel, precipitation due to monsoons is likely to increase by the end of the century, but overall, the monsoon season will have a lot of regional variability (IPCC, 2021a). As the world continues to warm, each degree rise will intensify the frequency and severity of rainfall, flooding, and drought. Sub-Saharan Africa, a region already beleaguered by food and water insecurity, will experience more severe droughts, with added water scarcity in many locations. As soil moisture decreases due to low rainfall in southern Africa, the productivity of agricultural land will be impacted due to agricultural and ecological drought (IPCC, 2021a).

Added to the variability in temperature and precipitation are the effects of sea-level rise. This will inundate low-lying areas in rice-growing regions, such as those in the Mekong River Delta and Bangladesh (IPCC, 2014), as well as the Indus basin.

23.3.2 Food Insecurity

Water stress is not just an issue for human well-being. While accessibility to and availability of safe drinking water is essential, there is another important aspect. Water is intrinsically linked to agriculture. As more and more areas face declining water resources, crop productivity will be impacted, amplifying food insecurity and lack of nutrition. Rapidly growing urban areas will place more pressure on water resources, and this will only be compounded by climate change.

As of 2020, hunger impacts 21% of the population in Africa, with the highest levels in sub-Saharan Africa at almost 67% (UN SDG, 2021). In Asia, it affects 9% of the population. More than half of the global undernourished population is in Asia, and one-third is in Africa, where the number of undernourished people has increased by 45.6% since 2012 (WMO, 2020).

Agriculture is the dominant source of income in Asia. With 58% of the population living in rural areas, 81% rely on agriculture for their livelihoods (IPCC, 2014), a majority in riverine areas and river basins. In Southeast Asia alone, one hundred million smallholder farmers rely on river basins for food and water (SEI Asia). Adverse climate impacts on rice production and other food crops will increase food insecurity for these populations.

Africa is more vulnerable to climate change than probably any other region. Agriculture is the mainstay of its national and regional economies, as well as the livelihoods of most of its households (WMO, 2020). A vast majority of its population are small-scale farmers, who depend on seasonal rainfall for agricultural production, while many others obtain their livelihoods in river basins and watersheds. It is therefore at considerable risk of reduced agricultural productivity due to heat and drought stress, pest, and disease damage, to say nothing of flood impacts (WMO, 2020). This, coupled with a rising population, means that the African continent is most vulnerable to food insecurity and erosion of livelihoods, especially among rural communities.

As Asian and African river basins are impacted by climate change, whether through glacial melt or sea intrusion – among a host of other drivers – crop productivity will most certainly be impacted. Production of rice and wheat in Asia and sorghum, millet, wheat, and maize in Africa is likely to decline. Grazing land for livestock will also experience a reduction.

For example, food availability deteriorated across Ethiopia, Somalia, Kenya, and Uganda due to poor rainfall between March and May 2019 (WMO, 2020). The number of people suffering from food insecurity in Somalia and Kenya increased from 1.6 to 2.1 million and from 0.7 to 3.1 million respectively, from late 2018 to late 2019. Conversely, heavy rainfall from October to December 2019 caused widespread river floods, which again resulted in crop losses and livestock deaths in central and southern Somalia, south-eastern Ethiopia, northern and eastern Kenya, and South Sudan (WMO, 2020). Indeed, this heavy rainfall created conditions that prompted a favorable environment for the most severe locust outbreak the region had seen in decades. In 2020, flooding in the Juba and Shabelle rivers in southern Somalia washed away livestock, inundated agricultural land, and displaced people (FAO SWALIM and UNHCR, 2020). Around 650,000 people were displaced across the country, suffering from food supply shortages, malnutrition in children, starvation, as well as increases in prices of basic food items such as milk and vegetables (FAO SWALIM and UNHCR, 2020). In 2021, in parts of the Somalian region of Shabelle, flooding of the river affected almost 25,000 people in 15 villages in Jowhar, displaced people in eight villages, and inundated farms (OCHA, 9 May 2021). Many states in Sudan were impacted by heavy rains and floods due to the rising levels of the Nile in 2021; around 12,700 homes were damaged and 4,800 were destroyed, displacing people, and increasing the need for food assistance (OCHA, 2 September 2021).

The water crisis and drought currently threatening 12 million people in Syria and Iraq might result in a total collapse of food production and water availability for Syrians and Iraqis. The level of the Euphrates River fell from 500 cubic meters per second in January to 214 cubic meters per second in June 2020 (OCHA, 27 June 2021), resulting in large swathes of agricultural land in and around the river basin in Syria experiencing severe drought conditions. This meant the inability to grow crops in addition to a lack of drinking water for at least five million people.

In Iraq, seven million people were affected because thousands of kilometers of farmland, together with fisheries and drinking water resources, have severely declined (OCHA, Iraq 2021) due to the reduction of flow in the Euphrates River (OCHA, 27 June 2021). In the Nineveh governate, wheat production is expected to reduce by 70% and by half in the Kurdish region (OCHA, Iraq 2021). People have been compelled to spend exorbitant amounts of money to buy drinking water.

In addition to crops and livestock, Asian communities also rely on fisheries and aquaculture. In fact, Asia is a leader in both global capture fisheries and aquaculture (FAO, 2010). Fish production is a vital source of livelihood, with almost 86% of global fishers and fish farmers in 2008 being in Asia (IPCC, 2014). Fisheries also provide food security in the Asian Arctic (Zeller et al., 2011).

Inland fisheries – an important source of livelihood and food security – are immensely threatened by overfishing, habitat loss, pollution, and dam construction (IPCC, 2014). Added to these, climate change will impact flow regimes and increase water temperatures, both of which will affect the reproduction of many fish species. Sea-level rise will adversely affect fisheries and aquaculture in river basins (IPCC, 2014). Marine fisheries will also go through changes due to the redistribution of species, as well as a general decrease in productivity, specifically in the tropics, as coral reefs, sea grasses, and mangroves decline.

Many urban areas with rapidly rising populations will also experience water shortages and rising food prices. Three years of very low rainfall and overuse of water in Cape Town, South Africa that resulted in a severe water crisis made headlines in 2018. Dams dried up and the government had to take extreme measures to manage water scarcity at the municipal level. The water crisis in Cape Town was felt the most by its poor residents, many of whom share communal taps. While the situation has become somewhat better there, the urban poor still face the same water availability issues (Parks et al., 2019).

Considering the climate change-related issues that will impact Asian and African river basins, it is crucial that sustainable agriculture and water management strategies be put in place that can increase crop productivity and water resources, while also ensuring the implementation of climate change adaptation and mitigation strategies.

23.4 CLIMATE-SMART AGRICULTURE

The challenge of providing food to rising populations as the climate crisis progresses is, and will continue to be, felt most acutely in Asia and Africa, including in the agriculture-dependent river basins of the two continents. Feeding the world is only going to become more difficult particularly due to agriculture's vulnerability to climate change. On the flip side, agricultural production also contributes 15–25% of GHG emissions to the global total (Vermeulen et al., 2012), and deforestation to make room for agricultural land further adds to the climate crisis.

BOX 1

CASE STUDY: IMPLEMENTING SUSTAINABLE AGRICULTURE AND LIVELIHOODS IN EGYPT

In Egypt, water, and agriculture both are likely to be adversely impacted due to climate change, increasing the vulnerability of poor rural populations. Projections indicate that sea level rise will reduce the area under cultivation in the Nile Delta reducing crop production. Rising temperatures will decrease water availability for human and agriculture use. As crop water requirements increase, water use efficiency will decrease. From 2012 to 2040 projections show reductions in the yields of wheat (down 11 to 12 percent), rice (down 26 to 47 percent) and maize (down 40 to 47 percent). A project by IFAD aims to reduce pressure on land and water resources by enabling smallholder farmers to improve profitability, diversify their livelihoods and increase their incomes. It helps to increase agricultural productivity by improving irrigation systems by piloting soil-less hydroponic agriculture. Alternative crop varieties, cropping patterns and livestock are also being tried. Loans were disbursed to farmers to modernize irrigation systems (from tradition to drip irrigation), livestock production, agricultural processing, and non-agricultural activities. Early warning systems were also established in five regions to provide weather related information. Recycling and reuse of water training has also been provided. Solar powered pumping systems have replaced diesel as the energy source and biogas units are promoted as energy sources for domestic use contributing to climate mitigation.

Source: FAO, 2021

CSA is an integrative approach that can help to effectively manage croplands, fisheries, livestock, and ecosystems, as well as mitigate the interlinked issues of climate change, food security, and water scarcity (CGIAR, CCAFS) in these regions. According to the Research Programme on Climate Change, Agriculture and Food Security, CSA has three objectives:

A. Sustainably increasing agricultural productivity to support equitable increases in farm incomes, food security, and development
B. Adapting and building resilience of agricultural and food security systems to climate change at multiple levels
C. Reducing greenhouse gas emissions from agriculture (including crops, livestock, and fisheries)

Climate-smart agriculture was first defined by the Food and Agricultural Organization of the United Nations in a background document for the 2010 Hague Conference on Food Security, Agriculture and Climate Change (FAO, 2013). This is a three-pronged approach that facilitates increasing crop productivity and enhances resilience and adaptation to climate change while implementing mitigation strategies to reduce emissions. It adopts a landscape methodology to transform and re-orient agricultural development for current and future food security, with climate change at its center (FAO, 2013 and Lipper et al., 2014).

BOX 2

CASE STUDY: SCALING UP CLIMATE SMART CROP SYSTEMS IN SRI LANKA

A recent project in Sri Lanka is supporting the transition to more productive and resilient smallholder farming, as well as reducing GHG emissions in rice production. A combination of heavy rains, soil tillage, and poor nutrient cycling in the uplands, results in soil erosion, loss of soil fertility and loss of productivity. In addition, siltation of water reservoirs leads to difficulties for the irrigation system and reduced water productivity in the lowlands.

The project is providing training to farmers to optimize water use, labour, and machinery. Furthermore, the project also builds an evidence base for CSA through the assessment of future climate change impacts on rice, maize, green gram, onion, chilli, and potato, thus helping to identify vulnerabilities of farmers to climate change impacts. The evidence base also assists policy makers to make informed decisions regarding effective adaptations strategies. Studies also provide opportunities for future climate smart activities that could help to increase resilience of the local population.

Farmers cut back rice irrigation requirements by 10 to 20 percent by adopting new water management practices. Training in alternating wetting and drying techniques helped farmers increase land under irrigation by 15 percent during the dry season. The whole community had the highest water capacity ever recorded during the dry season, due to implementing various new water management practices. Precise application of fertilizer reduced its application by 27 percent. The activities together provided benefits towards increasing water availability and increasing adaptive capacity.

Source: FAO, 2021

While it aims to increase productivity, CSA also recognizes the necessity to reduce short-term climate risks to agriculture and increase the resilience of farmers to shocks and long-term stresses, to achieve sustainable food security objectives (CGIAR, CCAFS), particularly in developing countries. At the same time, it seeks to maintain healthy and resilient ecosystems that provide crucial services for human well-being. Finally, it provides mitigation opportunities through several integrated strategies (CGIAR, CCAFS). Participatory approaches, involving marginalized groups and

women, are used to manage trade-offs and to identify synergies between different context-specific options without resorting to a "one size fits all" methodology. Diverse ground realities, differences in landscapes and ecosystems, varying institutional arrangements, and political aspects are crucial components of its implementation strategies (CGIAR, CCAFS).

BOX 3

CASE STUDY: PUNJAB IRRIGATED AGRICULTURE PRODUCTIVITY IMPROVEMENT PROGRAMME, PAKISTAN

The main objective of this project is to improve water use in irrigated agriculture in the Punjab, around the Indus River and its tributaries. It contributes to increased agricultural production and livelihoods, as well as positive environmental outcomes by improving physical delivery and irrigation practices, as well as crop diversification and effective application of inputs that translate into greater agricultural output per unit of water used. By 2019, high efficiency irrigation systems had been installed covering 23,500 hectares and a further 3,677 were in progress. The project improved 11,916 water courses and 621 ponds were constructed. Water management improved in 5.7 million acres of farmland. The project estimates that 500,000 farm households are directly benefiting from the project and 15,000 full time jobs were created. All of this contributes to increased food security and improved water management.

Source: WORLD BANK, 2020

CSA's use of a systems approach based on finding synergies, managing trade-offs, and undertaking cost–benefit analyses between productivity, landscapes, ecosystems, and value chains (CGIAR, CCAFS) can provide resource-poor farmers with a framework to achieve sustainable increases in crop productivity in the face of undeniable climate variability. Incorporating value chains also ensures efficient food supply management and a decrease in food waste. Such a framework can help to secure local livelihoods and contribute to global food security. It can thus support national economies, decrease poverty, and assist developing countries in Asia and Africa to enhance the resilience of agricultural systems and farmers, meet adaptation targets, and devise mitigation strategies to decrease the contribution of agriculture to global emissions.

At the global level, CSA can also help to achieve the 17 Sustainable Development Goals that are part of the 2030 Sustainable Development Agenda (FAO, 2019) by helping countries to advance their climate, food security, and income objectives, as well as bringing about positive environmental and social changes.

CSA approaches are widely being applied worldwide, based on its five crucial action points (Box 3). Out of 189 countries that had submitted Intended Nationally Determined Contributions (INDCs) for the Paris Agreement in 2016, 32 had referenced CSA (FAO, 2017). A further 50 prioritized activities based on the synergies between adaptation and mitigation.

Nations and communities in these regions will continue to suffer the most as climate impacts accelerate. Implementing CSA approaches and interventions will increase food productivity and availability, enhance the resilience of agricultural systems and farmers so that they can adapt to climate change, and devise mitigation strategies to ensure a decrease in the contribution of agriculture to global emissions.

BOX 4

Implementation of CSA requires five crucial action points

1. Expanding the evidence base for CSA
2. Supporting enabling policy frameworks

3. Strengthening national and local institutions
4. Enhancing funding and financing options
5. Implementing CSA practices at the field level

Source: FAO, 2021b

BOX 5

CASE STUDY: LIVESTOCK AND DAIRY DEVELOPMENT PROJECT, BANGLADESH

This project aims to improve productivity, market access, and resilience of livestock farmers by improving animal health, and address climate mitigation by improving emission intensity. It promotes climate-smart livestock farming by promoting improvements in feeding strategies, animal health, breeding, manure, and waste management, as well as low-emission technologies for activities such as milk chilling and transport. Activities also include increasing producers' access to markets and decreasing transaction costs along the value chain.

Source: WORLD BANK, 2020

Importantly, in the context of riverine areas, river basins, and watersheds, CSA has many benefits. Case studies of implementation (in boxes) in various riverine areas, based on the five action points, highlight the role of this approach toward the achievement of climate and sustainable development goals. It is estimated that there will be a 50% increase in the demand for food by 2050 and this demand will not be met by existing practices (FAO, 2017), especially with the additional impacts of an ever-changing climate. The presented case studies show that CSA is well placed to enable the transformation towards more productive, sustainable, and climate-friendly agriculture and food systems. River basins in Asia and Africa will benefit from climate-smart crop production that makes use of good quality and well-adapted varieties of seeds, integrated pest management, adopting conservation agriculture, sustainable mechanization, and efficient water use (FAO, 2017) to increase productivity. For livestock farming – a major contributor to emissions (at 14.5% of total GHG emissions) – a sustainable level of grazing can enable the growth of deep-rooted grasses and herbaceous species that can sequester carbon. In addition, improved feed management, shifts in breeds, and silvo-pastoralism can provide benefits for both adaptation and mitigation (FAO, 2017). Similar benefits can be achieved by the inland and coastal fisheries and aquaculture sectors that implement CSA options to promote water resource management, improved feed management, and selection of high-quality breeds. Sustainable land and water management that incorporates soil management, rainwater harvesting, reusing wastewater, efficient irrigation practices, and watershed management procedures (FAO, 2017) can be beneficial options for overall river basin management.

Because CSA is an integrative approach, practices such as agroforestry, crop-livestock, fish-crop, and fish-livestock, among other context-specific applications, can serve as important and sustainable production options. Using circular economy concepts of increased recycling and reuse can assist in eliminating waste and pollution while regenerating ecosystems.

Such practices, combined with a greater understanding of ecosystem dynamics, application of technological innovations, and promotion of indigenous practices, can increase the resilience of farmers as well as food systems. Enhanced adaptive capacities and resilience will assist them in managing trade-offs that are likely to emerge under new climate conditions and due to market fluctuations (FAO, 2017).

Axiomatically, on-ground activities must be participatory, involving women and marginalized communities. Furthermore, enhanced institutional capacity and enabling political and policy environments are essential for CSA activities to be successful.

These are just some of the approaches and on-ground examples that point to the effectiveness of climate-smart agriculture as a sustainable and climate-friendly option to increase agricultural productivity, contributing to food security and water availability. Its application in the riverine basins of Asia and Africa is already offering benefits, and further implementation will only enable the populations, ecosystems, and landscapes of these regions to increase food security, and adapt to and mitigate the impacts of climate change.

23.5 CONCLUSIONS

Undoubtedly, the world will have to adapt to climate change while simultaneously increasing food production for a rising population. In particular, the riparian economies of Asia and Africa will need to sustainably manage river basins and watersheds as the world warms, the hydrological cycle changes, and temperatures and precipitation increase. The population of these regions is extremely vulnerable to climate variability and will be the most affected by future changes in climate. This would result in the agrarian populations of Asia and Africa, including those in river basins, experiencing food insecurity and water scarcity in the face of extreme weather events, sea-level rise, high temperatures, heavy rainfall, and drought, all of which will influence livelihoods, infrastructure, and economies.

To counter these effects, there is a need for solutions that can increase crop productivity, enable farmers, production systems, and ecosystems to adapt to climate change, and provide solutions to mitigate the contribution of food systems to GHG emissions. Climate-smart agriculture is an approach that provides these triple benefits by implementing innovative, technologically advanced, and participatory activities (including women and marginalized groups) that also incorporate indigenous practices. It aims to increase crop productivity in a sustainable manner, through integrative soil, water, crop, and livestock management. While it identifies synergies, it also manages trade-offs between different options. Because it incorporates the landscape approach together with ecosystems-based adaptation and sustainable agriculture management to provide environmental and biodiversity benefits, it contributes to increased adaptive capacities and resilience. Finally, it also implements mitigation options to reduce the GHG emissions that contribute to climate change. The potential of CSA to increase food security, manage water availability, increase resilience, and mitigate climate change can ultimately contribute to the achievement of the Sustainable Development Goals (SDGs).

NOTES

1. A period with abnormal soil moisture deficit, which results from combined shortage of precipitation and excess evapotranspiration, and during the growing season impinges on crop production or ecosystem function in general.
2. https://indianexpress.com/article/india/heavy-rain-lashes-coast-of-odisha-imd-issues-red-alert-7504997/ and https://www.indiatoday.in/india/story/people-dead-heavy-rain-odisha-record-rainfall-bhubaneswar-puri-1852471-2021-09-14
3. Water cloudiness.
4. Freshwater withdrawal as a proportion of available freshwater resources (UN SDG Report, 2021).
5. Glacial lake outburst floods.

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