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Possibility of Rationalizing the use of Water Resources in Egyptian Agriculture Rational use of Water (RUW) in Nile Delta

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Abstract: The agricultural sector faces several challenges is facing the natural increase in the used water for various purposes in the future. It is adequate to show that the agriculture sector in Nile Delta used to consume about 48 billion m3 / year to irrigate about 8 million feddan even in 2010. And starting from 2017, it will bear the burden of irrigation for about 11,374 million feddan, by quantities of water amounting to about 36.750 billion m3. It imposes the need to follow policies that make sure the rationalization of irrigation water consumption. And by contrasting the current water resources with the existing water uses, it becomes clear that the current water resources are less than the existing water uses by about 16.4 billion m3. And that the development of water resources is either by exploiting the water availability resources in the best use without losing and rationalizing their exploitation and increasing the efficiency use (vertical development of water resources) or by increasing of the water available resources and increasing the economic supply for it in the future (horizontal development of water resources). And as it becomes clear of this, the proportion of what horizontal development can give is estimated at 49% whereas, vertical development can grant about 51% of the savings resulting from the development of water resources.

Due to the variation of water resources, their sources, and their uses, drawing a plan for the future use of water resources is significant which, is necessary to understand and develop many policies, including the agricultural policy, which necessarily requires a water policy. Therefore, before setting a future water policy, consideration must be taken the clear contrast between the nature of water resources and a land resource, if that is possible. So that it would be possible to direct agricultural production activities towards this goal, as they achieve one of the main aspects of the development goals and realize benefit from the advantages of specialization and comparative advantage.

Keywords: Rational use of water (**RUW**) in Nile delta

1.1. BACKGROUND

Water may be a scarce, natural resource—a prerequisite for livelihood and survival. Increasing demand and simultaneously decreasing supply are intensifying the pressures

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on this precious resource on every continent. These pressures extend far beyond domestic borders, and their transboundary complexities are affected entire regions, making them a matter of high-level regional politics. Within the Darfur region in Sudan, access to water is a component of the regional conflict and a trigger of the humanitarian emergency there. Global climate change is further exacerbating these challenges through the increased severity and frequency of droughts and floods.

This chapter focuses on the Horn of Africa—one of the many regions experiencing the interaction and confluence of challenges in terms of political, social, economic, and environmental processes. Water and climate are essential aspects of those challenges. Although it's tempting to consider the management and development of water, agriculture, economy, and infrastructure as a technical, this can underestimate the highly political nature and strategic importance of those issues. These are often particularly important when water resource management was involved as it was sight along the Nile through Egypt, Ethiopia, and Sudan.

The Horn of Africa's 230 million people is vulnerable to the effects of global climate change as droughts and floods. If not well managed, the changes and challenges could affect regional peace and security. This chapter attempts to provide the international community and regional organizations with appropriate analysis to deal with various related complex issues. It links the technical and political aspects of water security and governance in the Horn of Africa, providing a unique insight into complex challenges. By analyzing these multidimensional challenges and political constraints, this chapter presents entry points for the international community to influence them.

This water should be used utility as a catalyst for cooperation. The multidimensional challenge of water security and governance in the Horn of Africa—one cannot be addressed alone. The chapter emphasizes the need to transform regional narratives about water resources and their management: from a source of competition and tension to a tale of shared problems and opportunities that must share multilateral solutions. To succeed, water security and governance need a comprehensive approach. As such, this chapter should be of great interest to policymakers, practitioners, and researchers alike. **Figure 1.1** shows the Nile River basin, including 11 countries.

The Horn of Africa—here defined as the member states of the Intergovernmental Authority on Development—is highly susceptible to the impacts of global climate change like droughts and floods. These impacts compound many of the region's social, political, and economic challenges and end in increased migration and displacement too as a loss of life. These risks are domestic and transnational and increase the chance of political tensions and violent conflict within and among countries. There's a need for countries within the Horn of Africa to rise to prevent and manage risks and to seek out a multilateral response at the regional level. This chapter presents a regional analysis of

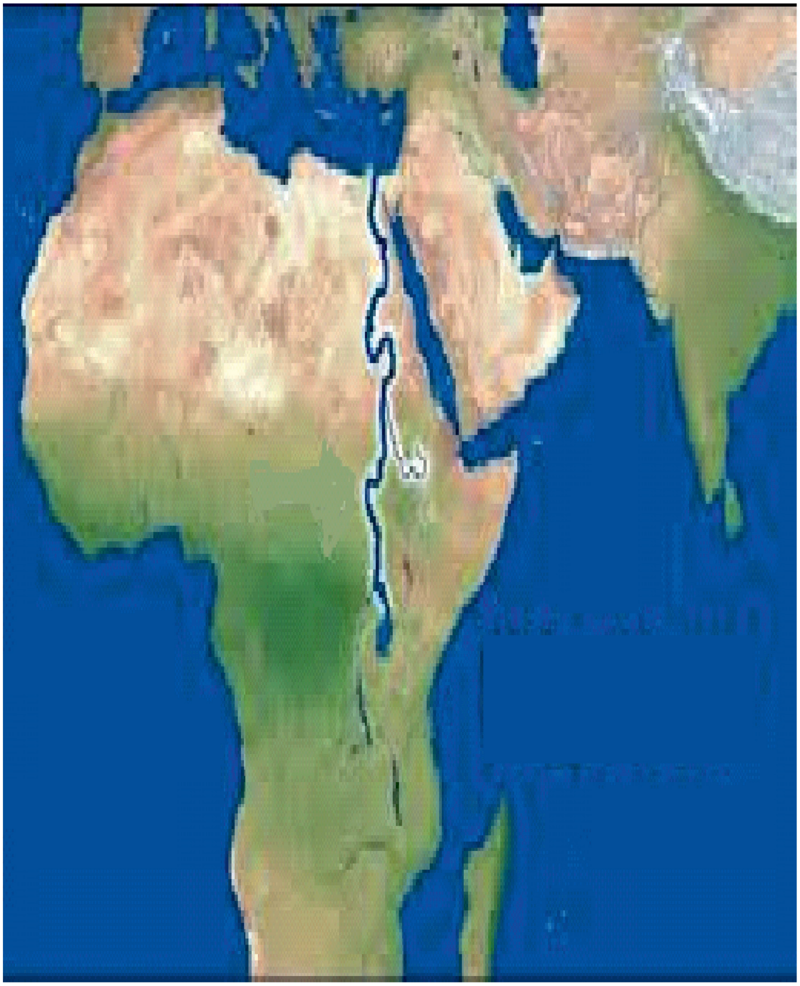

Figure 1.1: The Nile River basin, including 11 countries, (Hamada 2021)

environmental, peace, and security linkages within the zone with a selected specialization on water security. It provides entry points for the international community to deal with the multifaceted risk landscape within the Horn of Africa (Krampe et al., 2020).

1.2. SCOPE OF THE CHAPTER

This chapter can help as a "talking point" about the object of Water for Growth and Development in Africa. This chapter seeks to ask a very requisite question - how will water resources be managed and developed to market growth and cut this poverty in a very responsible way? The dynamics of water, growing, and poverty are complex and depend heavily on specific physical, cultural, political, and economic conditions. Growth has been absent although, the associated costs what are usually unforeseen, had yet to be met. In several countries, the long-term costs of growing water "today" and trying new investments aren't recognized, while it's unsatisfactory social and environmental guarantees. The immediate aim of this chapter is to stimulate discussion and enhance understanding of the importance of water resource management and development in Africa. It is an account-able voluntary process and poverty alleviation getting reality, so true can only be one among the various aspects that possess to be weighed and understood in water resource management. The broader neutral part of the chapter is that a constructive and inclusive dialogue would inform the disturbing trade-offs inherent in water management. And decision-makers should strive for a particularly acceptable balance between human aspirations for growth, poverty reduction, social and cultural integration, and environmental sustainability. The broader neutral part of the chapter is that the conduct constructive and inclusive dialogue will ease told the pesky trade-offs inherent in water management. And decision-makers should seek out the particular acceptable balance between human aspirations for growth and poverty reduction, social and cultural integration, and environmental sustainability.

1.3. WATER SECURITY HOTSPOTS: THE WHITE AND BLUE NILE RIVERS

The White and Blue Nile River basins are of core relevance for the Horn of Africa due to the interaction and confluence of several political, social, economic, and environmental processes. The Nile River—with its two major tributaries, the Blue Nile and the White Nile—is the main base of water, energy, and food. The Blue Nile is of importance to Egypt, Ethiopia, and Sudan intrinsically. The Nile has been a source of social and political tensions, with low-intensity conflict for many in the twentieth century **(Krampe et al., 2020)**. **Figure 1.2** shows the White and Blue Nile river basins.

Tensions associated with trans_ boundary water relations keep a possibility for violent conflict. The key contentious issue is the construction respecting the Grand Ethiopian Renaissance Dam (**GERD**) on the Blue Nile. The tensions among Egypt, Ethiopia, and Sudan around the building of the **GERD** became a part of the larger geopolitical playing field within the Horn of Africa. The tensions are likely to be further complicated by the compounding impacts of global climate change; if unaddressed at the regional level of pushes may amplify societal stress and relations and negatively affect political dynamics at the communal, bilateral, and regional levels.

Another complex set of security challenges is concentrated along the White and Blue Nile river, shared by Ethiopia and Somalia and to a slight extent by Kenya. Ethiopia and Somalia have real domestic interests within the White Nile River Basin's water resources and development. The region around the basin, marked by three decades of war and state collapse, depends on the river for agriculture, beverage, and hydropower.

Figure 1.2: The White and Blue Nile river basins, (Hamada 2021)

Despite the importance of water access, there has never been a bilateral agreement surrounding international cooperation over the rivers' usage. Domestic interests and interstate tensions as Ethiopia's role within the Somali war and state-building process inhibit the potential of trans boundary water cooperation within the White Nile River Basin. Thanks to the importance of water access interaction with socio-economic and political factors, global climate change will harm water access and later multidimensional security in Somalia **(Krampe et al., 2020).**

1.4. POLITICAL CONSTRAINTS

Two key constraints within the Horn of Africa are weak state institutions and capacity and the effects of an extended history of distrust among countries. These constraints negatively affect regional organizations, institutional arrangements, and initiatives. They also limit the choices for sustainable governance of water resources and anticipating and preempting other climate-related security risks within the Horn of Africa. National agendas and ambitions have handicapped the acceptance of shared interests at a regional level. A key priority indoors a region that's, dominated by significant transboundary lifelines like the White and Blue-Nile River basins, a regional perspective should receive more attention and become a key priority. However, to the way forward, it's significant to stay in mind that solutions can't be merely technical. There's a need for understanding and, where possible, to use lessons learned from elsewhere **(Krampe et al., 2020).**

1.5. GIVEN THE CONSTRAINTS AND BLOCKAGES, THREE KEY POINTS FOR THE INTERNATIONAL SOLUTION ARE IDENTIFIED

Change the narrative. There's a need to shift the regional stories around water resources and their governance—moving from a tale of competition and tension to at least one of shared problems and shared solutions. For this, it's necessary to spot a trusted leader and mediator that can shape the narrative around water, energy, and land and lift this narrative to the very best political levels. It'll be crucial to enable states to develop a joint vision for the region that stresses opportunities and implements cooperative solutions for the Horn of Africa.

Develop trans_boundary diagnostic analysis and a strategic action program. There's a need for more solid, shared and jointly accepted information. Reliable data can guide policies and decision-makers in handling the present challenges also better anticipate climate impacts and climate-related security risks. Trans_boundary diagnostic analyses are often wont to develop a strategic action program that supports actors in identifying clear priorities, identifying reforms, and resolving problems.

Establish a replacement institutional architecture. Despite many existing institutions, there's a need to replace the institutional architecture to manage water resources within the region. Currently, there's no suitable organization or framework which, will address the regional water management and security challenges within the Horn of Africa. A critical reassessment of the goals and structural set-ups of existing institutional frameworks and agreements is required, including active learning from other regions and basins in Africa **(Krampe et al., 2020).**

1.6. CONFLICTS WITHIN THE REGION

Aside from intrastate disputes and insurgencies (affecting all countries within the region, especially Somalia), the Horn of Africa features a long history of interstate disputes cross-border, violence, and border conflicts. Some are recent, like the Kenya and Somalia maritime border dispute (2014) over which country may rightfully control the resource-rich section of the Indian Ocean. This issue has been sending, to the International Court of Justice. A hearing is set for June 2020. Both countries have support from different international actors (France and the USA support Kenya, and Norway and the UK support Somalia—all to reasons of relationships and access to claims) which, complicates things. Yet it's interesting to notice that such disputes, despite cooperation and neighborliness, stay yet considered key by both governments for guiding the connection between Kenya and Somalia.

Another border dispute is between South Sudan and Sudan over territories rich in resources (oil and gas). The connection between South Sudan and Sudan has been tense since South Sudan's independence in 2011. In addition to internal power struggles in South Sudan, the more challenging was seeking an answer for border issues. Uganda may be a key player in this regard because it has supported South Sudan throughout the conflict. However, the main target is shifting from security to economic issues. South Sudan is additionally still facing an indoor dispute over the establishment of a unity government, although it has been one of the components of the peace agreement since 2018.

However, it has proven tricky to urge to an agreement. The November 2019 deadline has waited another 100 days. The danger of instability, with subsequent effects on the region, therefore, remains.

Additionally, disputes over resource allocation and access have also been significant within the region. For instance, the struggle for eastern Nile waters—involving mainly Egypt, Ethiopia, and Sudan—has an extended history. The conversation of fair and fair terms for water distribution has become hard with Ethiopia's build the Grand Ethiopian Renaissance Dam (**GERD**). The danger of escalation has led to offers for mediation by outside actors like the USA.

However, there is also excellent news about relations within the region and attempts to unravel conflicts. Ethiopian Prime Minister Abiy Ahmed has brought change to the zone, and therefore the country in terms of the potential to make new dynamics in domestic politics and regional relations, thus creating opportunities alongside risks and challenges. Challenges with low-level conflict and displacement stay in Ethiopia, and critics of Abiy's decision to merge the Ethiopian People's Revolutionary Democratic Front into one party are increasingly vocal. Ethiopian Prime Minister Abiy Ahmed also invested in relationships within the region, with the unexpected cessation of hostilities between Eritrea and Ethiopia and the signing of the Joint Declaration on Peace and Friendship. Another promising development was Eritrea's overture to normalize relationships with Djibouti and Somalia, although Djibouti has not agreed to normalize relations with Eritrea yet, and a few security challenges stay. It will be of great significance to verify any actual variation in regional politics with later steps during a region where the political culture is recognized by following the old saying 'The enemy of my enemy is my friend'. For now, issues around the border remain tense **(Lake and Morgan 1997).**

These challenges despite, there also are opportunities for regional cooperation to tackle the megatrends mentioned above. Horn of Africa states are active in 11 multilateral organizations: the African Union (**AU**), the European Union for Eastern and Southern Africa, the Community of Sahel–Saharan States, the East African Community, the Gulf Cooperation Council, **IGAD**, the Indian Ocean Rim Association, the International Conference on the good Lakes Region, the League of Arab States, the Nile Basin Initiative (**NBI**) and the Organization of the Islamic Conference. Together, they will create a variety of forums and potential entry points for regional cooperation **(Van Baalen and Mobjörk 2017).**

1.7. CLIMATE-RELATED SECURITY RISKS

Climate-related security risks are increasingly transforming the safety landscape within the Horn of Africa, with climate impacts, directly and indirectly, affecting the safety of communities and increasingly states and their diplomacy. The social and political contexts remain crucial in determining how climate impacts affect security. However, the tutorial community and policymakers are increasingly acknowledging these impact of the environment, natural resources, and global climate change on the region's conflict and security landscapes, and 'Disputes over who owns, controls or benefits from natural resources occur frequently' **(AU Panel of the Wise 2018).** These disputes can occur among states over trans-boundary resources and within the state over the precise allocation of local resources, like water, land, and energy. Water, land, and energy are non-traditional security issues. Those are critical for human, environmental, and state security **(Swain and, Öjendal 2020).**

Climate-related security risks facilitate new and exacerbate pre-existing socio-economic and political challenges and vulnerabilities. For instance, global climate change increases the likelihood of migration, creating human security risks for migrants and security issues for communities. As well suggests that global climate change is increasing the probability of tensions and violence.

Given the dimensions of the Horn of Africa, the climate differs throughout the region, and global climate change has diverse impacts counting on context. Towards the east, between northern Kenya and Djibouti, conditions are arid and semi-arid. In contrast, the western highlands are cool and moist. The varying states have been smooth by distinctive topography and three main climatic processes: the Indian Monsoon, the Intertropical Convergence Zone (**ITCZ**), and the El Niño–Southern Oscillation. These affect temperature and precipitation, which have changed during recent years. Temperatures have risen by about 0.28 degrees Celsius (°C) per decade since 1960, and rainfall patterns have become increasingly erratic and extreme, causing droughts and floods.21 Overall, projections show much-increased surface temperatures in East

Africa, with the very best warming in Kenya. Between (2006 and 2100), temperatures will likely increase by 0.2–0.5°C per decade **(Muhati et al., 2018).**

The impacts of global climate change are increasingly affecting the Horn of Africa, thereby amplifying pre-existing vulnerabilities like food insecurity and political instability. The demographic, political instability, conflict, poverty, and global climate change trends of the countries within the region are structural challenges that interact and drive each other. This region is experiencing a rapid increase. The population is estimated to exceed almost 440 million by 2050 from its current estimate of touch over 230 million. It is also experiencing more frequent food insecurity while degrading its natural resources for fields, livestock, water and energy, and destroying potential current and future options for resilience. As before indicated, there's a high level of political instability, and this instability, together with weak governance, puts stress on food security. For instance, in 2017, political instability, war, and dry resulted in widespread food insecurity, particularly in South Sudan **(Camberlin et al., 2017).**

Climate-related security risks within the Horn of Africa would need special attention; by regional and international actors. These must be reinforcing because an outsized percentage of the region's population relies on rain-fed agriculture as its primary livelihood. Rainfall patterns are getting more variable across the zone, and drought cycles are growing shorter. It is foreseeable as temperatures rise that agro-ecological zones will shift southward and leave areas of the north increasingly unsuitable for agriculture. The demand for available water is foreseeable to extend, resulting in increased vulnerability to water stress in large areas of the zone. These trends will further securities access to the used water, and the risks will play out on the domestic and transnational levels **(Baalen and Mobjörk 2014).**

1.8. DOMESTIC RISKS

Four pathways are particular specifically for East Africa that illustrates the connection between environmental change and violent conflict within the region: (a) worsening livelihood conditions, (b) increasing migration and changing pastoral mobility patterns, (c) tactical considerations, and (d) exploitation by elites.

Worsening livelihood conditions; Thanks to the harmful effects of adjusting weather patterns on agriculture and livestock, socio-economic hardships are unavoidable for farmers and herders. The high dependence on natural resources for food and income forms various grievances that make territorial tensions, which may cause territorial disputes. Worsening livelihood conditions can additionally push people towards joining armed groups and resorting to violence to resolve conflicts within the region. It is often evident in the case of Somalia, where abnormally high temperatures and drought are causing herders to sell more livestock than natural conditions. The oversupply of lowquality animals is triggering economic price shocks, and the population is so more vulnerable to livestock raiding and more susceptible to recruitment by armed groups **(Baalen and Mobjörk 2014).**

Increasing migration; Environmental challenges and associated socio-economic hardships end in people moving towards areas with higher endowments of natural resources. One of the foremost found migration hotspots concerns internal climate migration and particular internal rural to urban migration. As migratory patterns compile people of diverse backgrounds and ethnicities, there's a likelihood for tensions to heighten and escalate if they're not well-managed. For example, some areas in Darfur have seen increased precipitation alongside thicker vegetation cover leading to higher quantities of permanent and seasonal migration towards zones such have more favorable conditions **(Maystadt and Olivier 2014).**

These also include shifting pastoral mobility patterns, where climate change forces pastoralists to maneuver beyond traditional seasonal migration patterns toward new livestock and agricultural strategies. As a result, shepherds often end up in an unfamiliar area, searching pasture and water for their livestock, for example, in neighboring countries. The roots of the changing and unpredictable journeys contribute to increasing tensions on the ground between herders and between herders and farmers. The changing and unpredictable trekking roots further contribute to tensions over land among pastoralists and between herders and farmers. As for the changing movement patterns are experienced in north Kenya where grazing violence often found near well sites and open water sources. In these cases, raiding is profitable thanks to the high concentration of people and animals. People are vulnerable to sudden attacks by raiders, thanks to the landscapes anywhere there are wells **(Baalen et al., 2014).**

Tactical considerations; armed groups can choose conflict locations about their strategic ambitions and objective constraints like geographical distance, terrain, infrastructure, military capability, and the spatial distribution of resources. For example, in Ethiopia, Kenya, and Uganda, violence is usually followed by periods of wetness. Armed groups also can use climate impacts. And therefore, the resultant humanitarian must their advantage, as seen in Somalia with al-Shabab taxing aid and increasing its power by presenting itself as a de facto state actor **(Krampe and Eklöw 2019).**

Exploitation by elites; Political elites often exploit their power by occupying land after floods or droughts have displaced weakening marginalized groups. A prime example of how elites can abuse local grievances is evident in South Sudan and Sudan. After the war between the northern and southern parts of Sudan began at the beginning of the 1980s, the population, which was politically and ethnically divided, was also had a disability in the deep drought **(Van Baalen et al., 2011).**

1.9. TRANSNATIONAL RISKS

Climate change also exacerbates potential transnational security challenges, including those associated with water management. Consistent with data from the United Nations Environment Programme (**UNEP**), Africa has international transboundary river basins and 15 principal lakes that cross the political boundaries of two or more countries. The Nile Basin extends over 11 countries, and therefore the Nubian Sandstone Aquifer System is shared by four countries; both are of high relevance for states within the **IGAD** region. The expected variability in water availability requires cross-country collaboration. However, it also causes regional tensions. The political tensions between Egypt and Ethiopia (and Sudan to some extent) around the **GERD** exemplify the safety risks of cross-boundary resource sharing against a backdrop of adjusting climatic, geopolitical, and economic conditions **(Burke, J. et al., 1999).**

With climatic impacts like droughts and floods increasing in intensity, frequency, and duration, the Horn of Africa is affected by vulnerabilities contributing to increased pressures on natural resources within the region. Although not all disputes and tensions escalate into violent conflict, climate-related security risks increasingly pose a challenge to the broader peace and security context within the Horn of Africa. Most risks stemming from climate impacts are often relieved through effective and sustainable resource governance. State institutions capable of accelerating the resilience of communities to climate impacts also are crucial. For example, research has illustrated that 'lacking access to groundwater is related to a better risk of communal violence' and conditioned by precipitation levels, population density, and, importantly, state presence. A state's ability to mitigate the human security consequences of resource shortages can lessen the sequels of constrained access to groundwater on communal violence. However, sustainable management of groundwater resources is critical, additionally to sustained access. While groundwater access can cut the risks of conflicts, the danger of overexploitation has is elevated. And effective monitoring and management are highly hooked to social, institutional, and political factors. In addition, research on water scarcity and conflict has largely neglected groundwater. Future research should hence include groundwater, surface water, and precipitation. And further explore the connection between groundwater scarcity and conflict as conflict resolution **(Burke, J. et al., 1999).**

Relationships among countries within the region are tense and have long histories of disputes and even conflict. Climate-related developments can increase tensions during this complex security context. There's a need for confidence building, and a few positive evolutions have recently taken place. Although, there are water-related challenges that are negotiated, for an extended time, without a positive or satisfying result for the parties involved. The White and Blue Nile rivers are cases in point. These rivers run through large parts of the region and thus many countries, indicating the necessity for an agreement on water sharing, especially in sight of the uncertainties and vulnerabilities stemming from global climate change.

Building on initial analysis of the region's surface water (the White and Blue Nile River Basin and Lake Turkana Basin), also as groundwater and marine resources (ports and fisheries), the White and Blue Nile river Basin are specified being two critical security challenges in the Horn of Africa.

1.10. THE NILE BASIN PHYSICAL TRENDS

The Nile is the world's longest river, and every one of IGAD states except Somalia and Djibouti is a riparian state to the basin. The Nile covers one-tenth of the African continent by a catchment basin of 3 400 000 Square kilometers distributed unevenly throughout the region. The Nile Basin is, directly and indirectly, a source of livelihood for one-fifth of Africa's population—some 300 million people. Indeed, the Nile represents a considerable importance water resource for Egypt and Sudan. While Egypt accounts for fewer than 10 percent of the world of the Nile Basin, it holds almost one-third of the population of the Nile Basin—most of it concentrated around the lower Nile **(Nashwan and Shahid 2019). Figure 1.3** shows the Nile Basin average annual precipitation.

The basin has two major tributaries, the Blue Nile and subsequently the White Nile. The much shorter Blue Nile emerges from the Ethiopian highlands; it is the most water system of the Nile and a valuable source of water, energy, and food for Egypt, Ethiopia, and Sudan. Originating in Burundi, the White Nile flows through Tanzania, Lake Victoria, Uganda, and South Sudan and is supplying by a little stable flow of water from the mountains. The two tributaries converge on the brink of Khartoum, Sudan **(Swain 1997).**

The Nile is tributaries span multiple climate zones starting from humid equatorial and tropical climates in the Central African Republic to Sahelian (semi-desert) and desert climates within the south. These great extremes divide the riparian states into net users of water states that use more water than they receive) and net contributors of water states that receive more water than they use. Important-net water users include Egypt and Sudan. Ethiopia is that the key-net contributor, contributing quite half the entire water budget of the Nile. The Blue Nile features a high average variability of precipitation, and run-off with water from the Ethiopian highlands, fluctuating great between wet and dry seasons. That has significant implications for Egypt as an outsized net water user with an annual average of around 10 millimeters of rain and substantial evaporation in Egypt's desert heat, is very hooked into the water from the Nile **(Alhamshry, A. et al., 2019).**

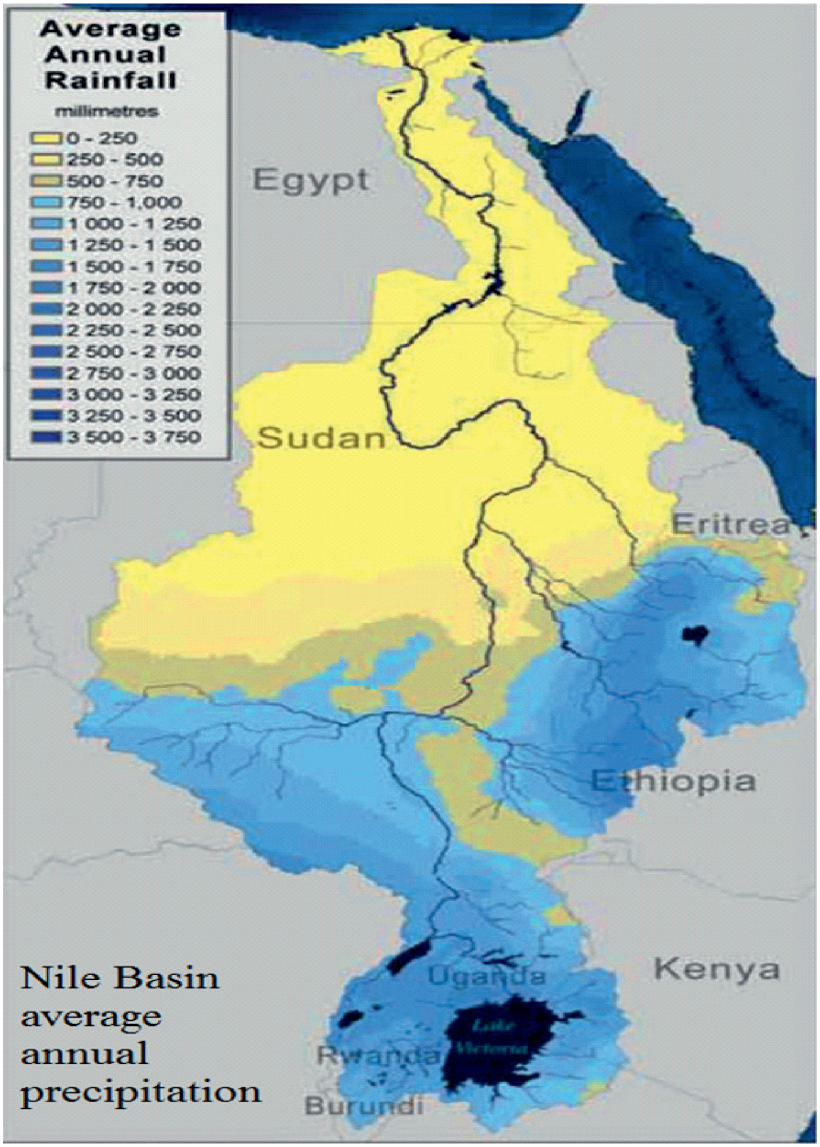

Figure 1.3: The Nile Basin average annual precipitation, (Hamada 2021)

1.11. SECURITY TRENDS

The Nile has been a long-standing source of social and political tensions for many within the 20th century. As an important resource for the economy and lifestyle within the region, transboundary water relations haven't translated into armed violence thus far. However, there are uninterrupted fears that the disputes will end in violent conflict if not resolved peacefully **(Jägerskog et al., 2014).**

The Nile Waters Agreement between Egypt and Great Britain; was signed in 1929 where Great Britain signed on behalf of Sudan with the other British colonies. The agreement included allocating large quantities of water to institutionalize the natural and historical rights that Egypt and Sudan believe they need. The agreement stipulated that any claim to the Nile by other riparian states would need to be addressed by Egypt and Sudan. As Ethiopia wasn't a celebration of the agreement, the country refused to acknowledge its validity. Kenya, Tanzania, and Uganda also contested its validity after their independence within the 1960s as they believed it to be a colonial agreement **(Cascão 2009).**

Thirty years later, in 1959, after disagreements between Egypt and Sudan over sharing the Nile and before Egypt's plans to create the High Aswan High Dam, the volumetric water allocations of the agreement were renegotiated. The division between the two upper river countries, Egypt and Sudan, and the lower river countries became greater, have been the downstream states were no longer included in the agreement. The agreement reinforced the view prevailing among the upstream states because they are incapable develop using their water resources in light of the influence of the powerful downstream countries **(Swain 2002).**

Ethiopia experienced a gradual increase in political power within the wake of the 'global war on terrorism' that increased US support (e.g. during the Ethiopian military intervention in Somalia in 2006). This development, along with the facility vacuum left in Egypt after the Arab Spring, provided Ethiopia with a strategic opportunity to independently develop its water resources, notably through facilitating the construction of the **GERD** in early 2011. Although the inspiring work of the **GERD** began slightly before Egypt's revolution, during the Arab Spring, the amount of turmoil in Egypt gave Ethiopia a chance to form the project public, thereby minimizing the danger of an instantaneous response by Egypt. The following tensions among Egypt, Ethiopia, and Sudan overextending water allocation from the Blue Nile became a critical security challenge within the region. As the main contributor of water within the Nile, providing a percentage of the annual flow, the Blue Nile is vital since rapidly increasing and increasing demand for food put pressure on governments within the region **(Swain 2011).**

The tensions around the unilateral building of the GERD have increasingly become a part of the larger geopolitical playing field within the Horn of Africa. Ethiopia finds construction of the **GERD** essential for its national development, as its use would immediately double Ethiopia's power output. These can give energy to its population and enable it to sell surplus energy to neighboring countries. The construction of the dam is perceived being a threat to the water system in Egypt and Sudan. Egypt has regularly threatened to use military power to guard its share of the Nile since Egypt fears that the development of the dam will give Ethiopia more power and control over the water system, thereby weakening Egypt's historical powerfully role within the region. Nevertheless, some studies suggest that Egypt may benefit from the dam because it would trap sediment upstream, thus protecting major reservoirs in Egypt and taking advantage of purchasing surplus electricity generated by the water. If those dams are not well-managed, increased groundwater extraction can increase the risks posed by sea-level rise in vulnerable areas like the Nile Delta in Egypt. Furthermore, this topography of the world around **GERD** is more suitable for storing the water than the desert terrain downstream with high evaporation rates. With the dam slowly nearing completion, becoming a reality, political tensions have increasingly centered on the plans to work this dam and the time frame to fill the reservoir. Egypt has proposed that Ethiopia fill this reservoir over a 12–21 year period, while Ethiopia suggests six years. The time it takes to fill its implications for the quantity of water this flows downstream: the longer the time, the more water is required. These have led to an open and heated dispute over water sharing resources among the Nile Basin countries **(Swain 2002).**

While the main issue is currently between Egypt, Ethiopia, and Sudan, previous attempts to control the Nile; were aimed at integrating the entire basin. The primary cooperative and intergovernmental partnership was the NBI. The 2015 Declaration of Principles on the Renaissance Dam between Egypt, Ethiopia, and Sudan marked a turning point in relations between the countries along the Blue Nile after several years of tensions. However, the declaration sparked controversy. There's no regard to historical water rights, and therefore the previous storage capacity of the **GERD** reservoir remains. Thus, Egypt understood to form a loss from the declaration **(Tawfik 2015).**

After a series of meetings at the top of 2019 and the start of 2020, there are several new developments. In October 2019, negotiations again reached a deadlock after Ethiopia rejected a proposal by Egypt to work the dam. This marks; the third time that negotiations have weakened since 2014. Nevertheless, the dispute appears to be entering a replacement phase with offers from external mediators: Russia and the USA, which is often not necessarily a positive development because it may introduce geopolitical ambitions. **Figure 1.4** shows the Nile Basin runoff map.

At the beginning of December 2019, the water ministers of Egypt, Ethiopia, and Sudan met in Cairo at the second meeting during a series of 4 designed to succeed in an agreement by mid-January. If unsuccessful, Egypt and Ethiopia may consider mediation with the USA and the International Bank for Reconstruction and Development as observers. However, Ethiopia's commitment to external mediation appears to be less than that of Egypt. It is a task for South Africa because the incoming AU chair should also not eliminate. While an agreement on the Renaissance Dam failed in reached during the fourth and final meeting, officials from the three countries announced that

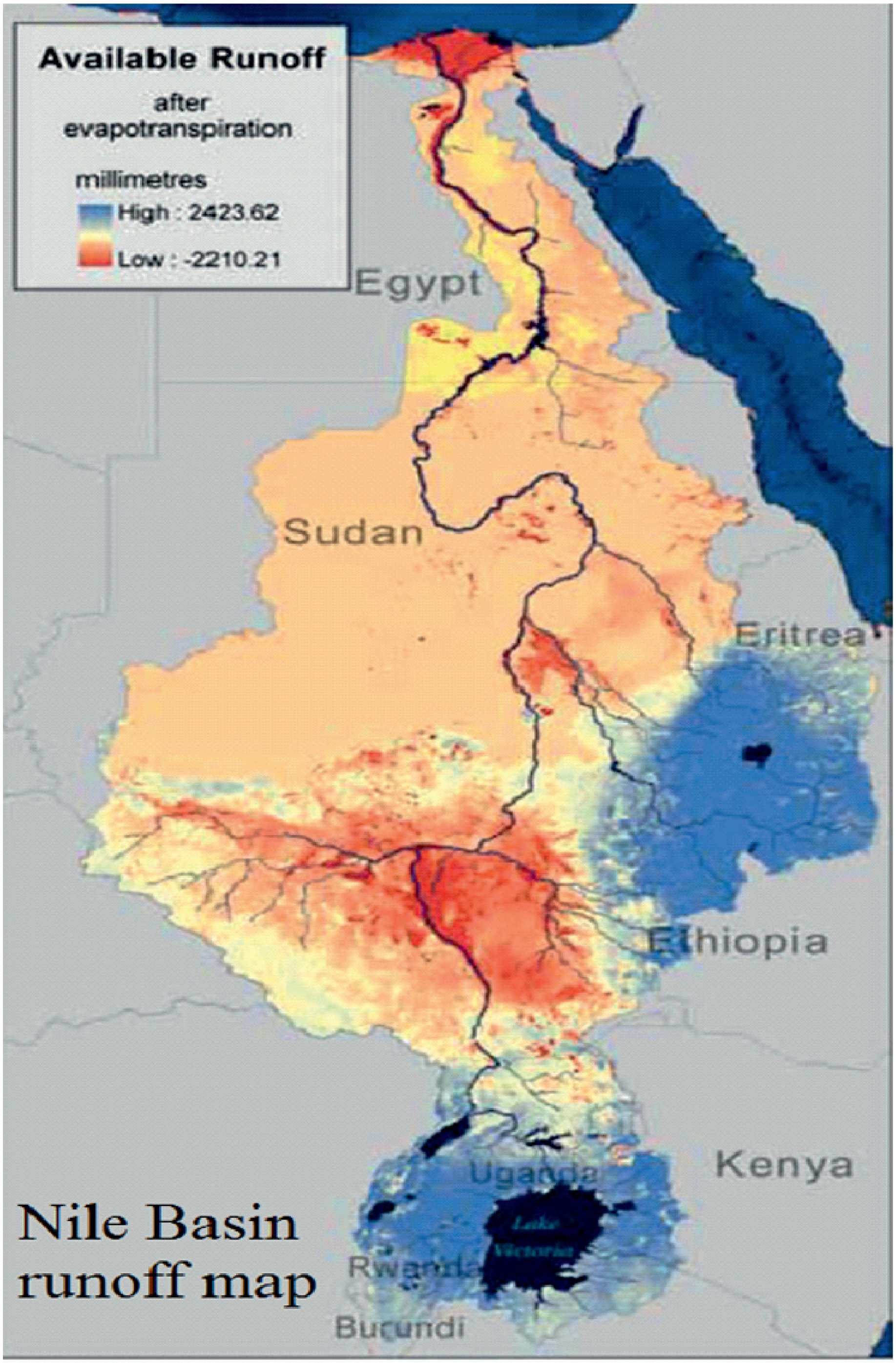

Figure 1.4 The Nile Basin runoff map, (Hamada 2021).

a preliminary agreement had been reached; in Washington DC in mid-January. The joint statement of the officials announced exceedingly several issues had agreed upon, including the timetable for filling the reservoir, to be signed on the first of next February. The result of this first deal and the way things between the countries progress remains to be seen **(Harb 2019).**

Part of the backstory to those developments has been Sudan's changing allegiance from Egypt to Ethiopia; the Sudanese Government has warmed to the utility of the **GERD**. That has further created a movement within the region's stalemate, challenging Egypt's role. A further challenge complicating the safety context is that the dependence on external funding. With China emerging as a financier for dam building within the basin and a spread of states—including China, India, and Saudi Arabia—increasing land grabbing, things, and geostrategic utility of the **GERD** and other Ethiopian dam-building projects became further complicated **(Earle. et al., 2015).**

1.12. CLIMATE IMPACT AND SOCIAL AND POLITICAL IMPLICATIONS

As global climate change is altering weather patterns, the region will experience higher climate diversity with rainfall and temperatures varying much. Nile Basin countries are predictable to witness significant changes in rainfall and temperature. Although the mean annual precipitation is predictable to extend within the region in many parts, the trend of more irregular and intense the fall of rain and an expected increase in temperature is unlikely to alleviate water insecurity within the zone **(Gelete et al., 2019). Figure 1.5** shows the Nile Basin population map.

The Nile Basin Water Resource Atlas stresses that Climate change isn't necessarily a threat to the water system; however, the uncertainty is excessively considerable. Global climate change directly affects hydrological patterns within the basin and indirectly affects energy, food, and agricultural production within the region. A recent study shows the far-reaching implications that different climate scenarios would have: a ten percent decrease in precipitation is predictable to steer to 19 percent less run-off within the Torrid Zone and 30 percent less run-off within the arid zones. In contrast, a ten percent increase in precipitation would cause 14 percent more run-off within the Torrid Zone and 22 percent more run-off within the barren zone. Located within the ITCZ, the Blue Nile Basin has highly erratic and seasonal rainfall. While future temperature and sediment load are predictable to extend, the fall of rain and stream flow are predictable to decrease. These predictions are severely problematic because the Blue Nile is the substantial water supplier of the Nile, on which Egypt and Sudan are highly dependent **(Hasan et al., 2008).**

The high dependence on water resources to satisfy the stress of the rapidly growing population, which is heavily reliant on agriculture for its livelihood, will further raise

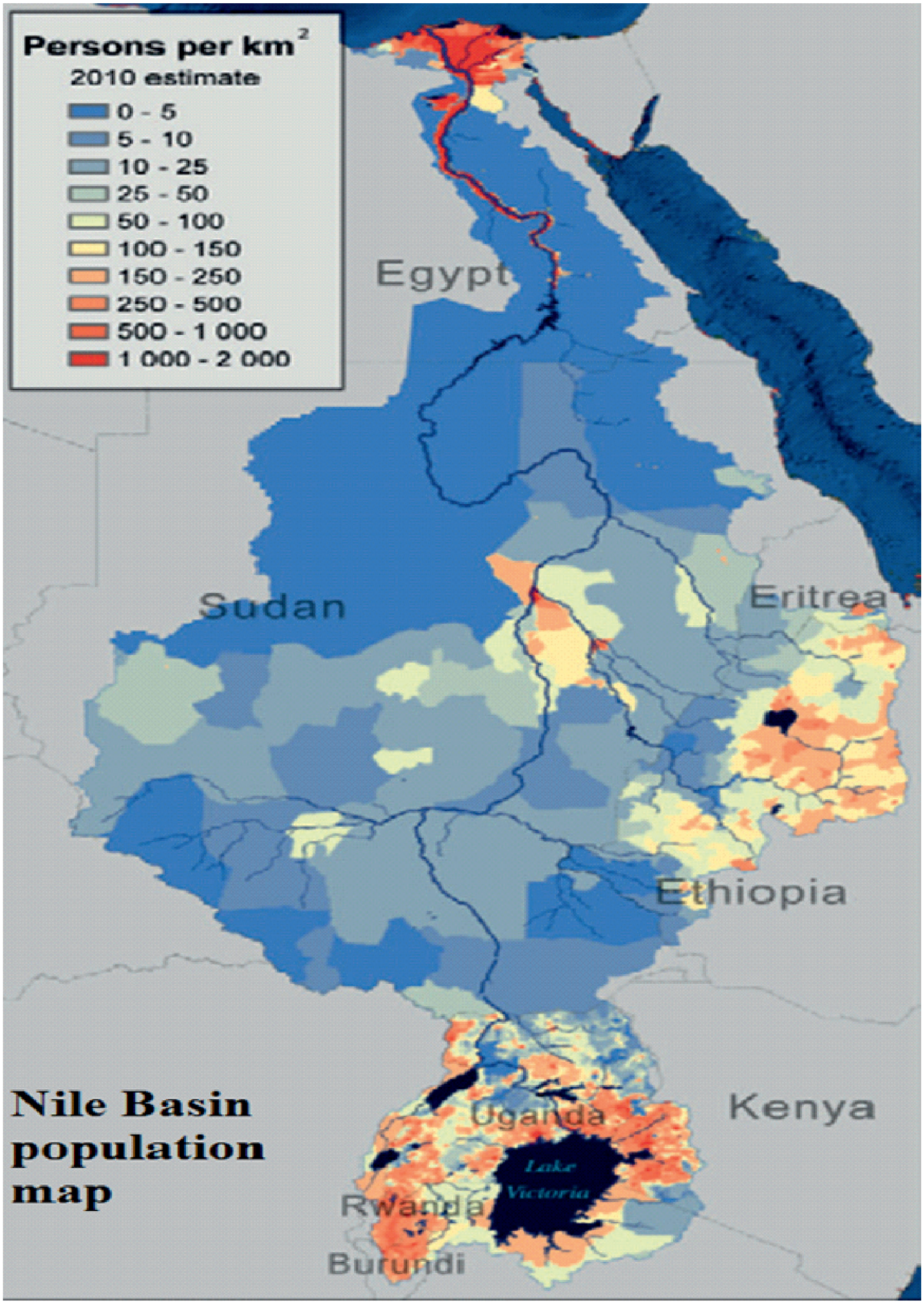

Figure 1.5 The Nile Basin population map, (Hamada 2021).

pressures on the water within the future. As a neighborhood where 80 percent of the population within the Nile Basin depends on irrigation, the intensification of climatic variability will compound current social and political tensions. Changing farming cycles make it difficult for farmers to plan once they plant crops. Climate pressures and resource mismanagement have amplified the migration of groups within the region. Internal power struggles associated with global climate change include worsening livelihood conditions and increased migration.

Thus, climatic pressures are likely, to further inflame local grievances, which previously extended to the national level and undermine the capacity and legitimacy of states. Samples of local grievances include rivalries among the 80 ethnic groups present in Ethiopia which, increased after Prime Minister Abiy Ahmed took office in 2018. In April 2019, 3.2 million people were internally unsettled, about 2 million of whom; were torn after Abiy took power. The government started the voluntary return of **IDPs** as of April 2019 and reported that 1.8 million have returned as of June 2019 **(UNOCHA 2019).**

With most countries within the region already experiencing drought and food insecurity, these conditions will worsen and thereby further contribute to communal, bilateral, and regional tensions (**IOM 2019**).

1.13. ARRANGEMENTS AND INITIATIVES TO CONTROL FRESHWATER RESOURCES

While there are multiple arrangements and initiatives to control freshwater and marine resources, constraints limiting natural resources governance and related climate resilience within the Horn of Africa remain. These constraints are often political. If not mitigated, they will end in increased tensions and enhance the potential for conflict and give towards increased human insecurity. Two key constraints within the Horn of Africa are weak state institutions and institutional capacity, and therefore the historically high level of distrust among countries. These factors limit the opportunities for regional approaches. Together, and with a myriad of regional organizations, they supply opportunities for countries to use different options to market their interests **(krampe et al., 2020).**

The issue of weak state institutions and institutional capacity may be a key constraint for the region just as an entire. With limited means to develop and implement preventive and forward-looking policies, this affects the ability of countries to influence the challenges of global climate change and environmental degradation. Within nations, governance-related issues cause a scarcity of confidence in governments. That is often a specific issue for handling climate-related security risks. To tackle such cases associated with global climate change, governments must supply and plan for livelihood alternatives.

In addition, governance structures must leave the event of coping mechanisms at the national or international levels. Yet, weak state institutions and institutional capacity can affect the social and economic constructions of nations and subnational groups (such as; ethnic, religious, and regional groups), who are, or feel, marginalized in their access to resources and services. Also, relationships and cooperation among countries can become subordinate to the importance of governments staying in power. In some states, the main objective regarding internal stability within nations, or power relations between countries, complicates the event of international initiatives to deal with problems at the regional level. Interference in internal affairs in other countries has resulted from a historically high level of distrust among states within the Horn of Africa. It's also contributed to difficulties in water governance and regional cooperation on water resources. Water has been a political tool for over a century within the Nile Basin; it is particularly significant during a region. Water has been a political tool for more than a century within the Nile Basin. It is especially notable during a zone closely connected with the Nile for water, which is understandable for countries involved in conflicts with other nations. The choices of different countries regarding the problems of access to water and governance resources on their territory may have negative impacts (social, political, economic, and environmental) on other countries **(krampe et al., 2020).**

Examples of such effects are as follows

- Ethiopia's decision on the port of Berbera undermines the position of the Somali government as it results in de facto recognition of Somaliland
- The Somali and Kenyan governments are unilaterally pursuing their interests within the Indian Ocean and have embarked on obtaining exploration licenses that support their maritime boundary claims, which remain in dispute.

The decision of Ethiopia to create the **GERD** affects the potential water consumption of Egypt and Sudan:

- The independence of Eritrea immediately made Ethiopia a landlocked state in dire need of access to port outlets for commercial and security purposes.
- The development of (regional) initiatives will raise questions about who should be brought to the negotiating table.
- Some countries (Eritrea) demonstrate little interest in multilateral initiatives, thereby blocking regional solutions for regional challenges.

These influences are background conditions that define regional political relationships and thus are room for maneuver on issues related to water and climate. Therefore, these portions should combine into regional analyses. The image is further complicated by increasing regional particularly the Red Sea, and extra-regional geopolitical interests. The investments of Gulf States, especially Saudi Arabia and therefore the UAE, within the Horn of Africa, are really. They relate to investments in logistical and commercial infrastructure (e.g. ports and dams) and industrial-scale farming. The dependence on external financial resources and funding has opened the door to new investments. The scramble for ports and military presence within the Red Sea region is one example that brings money and new commercial activities. These new investments need exerting political influence by the external actors to guard them. Alongside high levels of development help, this offers external actors the means of influencing regional political, economic, and security-related developments. Similarly: important is that the introduction of disputes originally external to the region (such Saudi Arabia and therefore the UAE versus Iran or Qatar, or China versus India and USA); creates new challenges that also constrain sustainable natural resources governance and climate resilience **(Krampe et al., 2020).**

1.14. REGIONAL ORGANIZATIONS AND COOPERATION

It is during this context that regional organizations operate. Given the number of organizations, sometimes with overlapping mandates and divergent composition of member states, countries within the region can pick and choose different organizations to deal with issues. Important regional organizations, including the AU and **IGAD**, are experiencing challenges in this area. While **IGAD**, as a regional economic community, would be best positioned to require several issues associated with the consequences of global climate change, the organization is restricted; in its financial and political capacity. In a way, **IGAD** has developed interested and potentially effective tools to assess political- and conflict-related risks with the Post-Conflict Reconstruction and Development, and therefore, the Conflict Early Warning and Response Mechanism. Yet, the follow-through is limited in terms of putting issues on the agenda, and its dependence on donors may be a substantial constraint to putting together sustainable mechanisms. The capacity of the **IGAD** has long been stilted by Ethiopians role in leading the organization as its chair. Under Abiy, Ethiopia has opened the way for further institutional development by abandoning its position as **IGAD** chair. The organization resumed the rotating chair position by electing Sudan as its chair. However, Ethiopia remains a dominant actor within IGAD through the new secretary, which might provide new opportunities for regional cooperation **(Krampe et al., 2018).** The lack of clear mandates, roles, and missions for organizations within the region, notably the African Union and the Intergovernmental Authority on Development, also contributes to limited effectiveness. The current setup is not conducive to quick agreements on procedures or perhaps strategies for action. A transparent separation of tasks among the organizations to facilitate the adequate level of devolution of power, also as complementarity, would be welcome.

Notwithstanding the supply of several institutions, new organizations have been purposing as to how forward. However, as was already concluded concerning existing organizations, they have to be inclusive concerning the key players. Otherwise, new exclusions could diminish diplomatic options at the regional level. For instance, foreign ministers from Djibouti, Egypt, Eritrea, Jordan, Saudi Arabia, Somalia (not Somaliland), Sudan, and Yemen signed a charter for a Council of Arab and African Coastal States of the Red Sea and the Gulf of Aden at a gathering in Riyadh on 8 January 2020. However, neither Ethiopia nor the UAE has been called: while the UAE is seemingly supportive, Ethiopians position concerning; this new initiative is not yet clear.

Water-sharing agreements between Egypt and Ethiopia might be indirectly inhibited; in this way. In the meantime, **IGAD** has established a task force to debate the Horn of Africa's regional engagement with the Red Sea Council, and thence the shape of the regional schedule might emerge. However, the broader Red Sea/Gulf of the Aden region is increasingly becoming important in terms of territorial competition and cooperation, security dynamics, and geopolitics. This region also includes a large part of the Nile Basin and thus the Juba–Shebelle Basin. It will become increasingly important to also specialize in trans-regional institutions, and thus the role they will play; accordingly **(IGAD 2019a)**.

All these different issues mean there's a considerable challenge to find entry points for handling the challenges associated with natural resources governance—including water—and enhancing resilience. Whereas no country has gone to war over water, it's also clear that no organization seems to be capable of handling the problems on its own. The result may be a further deterioration of relations and the security of issues **(IGAD 2019b).**

1.15. NOT JUST TECHNICAL SOLUTIONS

The situation indicates there's insufficient room for purely technical solutions. The overview of issues points out an attempt to deal with trans-boundary water challenges during this region must be grounded in political analysis. Especially the high political value of water within the zone suggests the necessity for high-level political engagement geared towards cooperation **(UNEP 2005).**

While approaches must take political interests and issues into consideration, defining the problems in terms of problem-solving and confidence building at the national, bilateral, and regional levels going be the key. Where possible, lessons learned from elsewhere should be identified and utilized in providing the region with how forward. It is also substantial to create and stick to what is already available to improve already defined decisions, frameworks, and structures as the best way forward. The new arrangements should be comprehensive in terms of; membership and integration of existing mechanisms.

Today's problems are supposed to be minor compared to long-term issues. The analysis above on water security and governance within the two rivers basins indicates a need for unusual narratives that concentrate on shared problems and, therefore, shared solutions. The challenges revolve around natural resources, including water, land, and energy, relevant to the integrity of ecosystems as social and economic stability. Political leadership is required to beat the present issues and supply a foundation of trust. They are solutions to deal with basins that could be otherwise considered essential for any future steps in terms of cooperation **(UNEP 2005).**

It is, therefore, necessary to spot a trusted leader and mediator who can create agenda around water, energy, and land and lift the talk to a better level that needs more cooperation. This lead person may, for instance, be an accepted politician who is capable of acting beyond national interest. The task will be to; facilitate a shared vision event for the region that allows for collaborative solutions for the Horn of Africa.

Having a regional vision; on cooperative solutions may alleviate the lack of trust between countries, which has proven to be an obstacle to regional cooperation. This lack of confidence can be partly due to the necessity to specialize in non-sensitive and political issues so that a straightforward solution is also not possible. To create trust with a regional vision, broadening the scope of topics would leave different dialogues in several areas starting from security (borders and cross-border problems) to environmental, economic (resources and their management, and a vision for economic development for the region), and cultural issues. Integrating environment security, and thus water, land, and energy challenges, is critical for such a platform to identify trade-offs and opportunities to commercialize livelihood opportunities and protect security. Performing toward confidence-building measures could also be a practical and necessary way forward within the Horn of Africa context. **IGAD** might be one of the platforms for assisting in regional dialogues. These may have potential spillover effects in terms of the effectiveness of the **IGAD** as an actor facilitating collaborative solutions **(UNEP 2005).**

1.16. DEVELOP TRANSBOUNDARY DIAGNOSTIC ANALYSIS AND A STRATEGIC ACTION PROGRAMME

Although leadership is vital, there's also a requirement for more solid, shared and jointly accepted information. Data is sensitive for the countries, the region, and governments. Data is usually available, only nationally and not shared nor regionally validated; this complicates a broader dialogue. There's a requirement for reliable information which will guide policies and decision-makers in handling the challenges of global climate change and climate-related risks. A cross-diagnostic analysis (**TDA**) may be a methodology. Diagnostic analysis may be an approach; that has been used by the United Nations Environment Program in the past, in other parts of the planet (as the Mediterranean), and by other organizations in many different contexts. Diagnostic analysis may help provide more solid scientific and technical analysis. Diagnostic analysis may help provide environmental impacts within the Horn of Africa and particular geographic areas. This information should usually be for SAP development. This information should usually be for **SAP** development. It should be a negotiating policy document that sets clear priorities for action and outlines policies, legal and institutional reforms, as well as the investments required to address and solve priority problems of trans boundary waters **(UNEP 2005).**

Step 1: Lead and coordinate. To organize and know, a **TDA/SAP** requires a political process that includes the various stakeholders. Give the sensitivities within the area. This process should be led; by an independent actor who can facilitate full stakeholder participation; and joint fact-finding and transparency; cross-policy development and progressive consensus building; risk management; inclusion of partnerships; coordinated actions, and government commitment.

Step 2: Build and share knowledge. A replacement narrative could leave the organization of a series concerning consultations and collaboration meetings among the stakeholders. The preparation phase is substantial for providing and building consensus, starting with information sharing. Such a process would require follow-up activities of a concrete and practical nature, such as:

- Appointments of regional and national coordinators, also as teams
- Information and data collection and analysis to supply references for preparing the **TDA**
- Impact assessment to analyze the relative importance of various impacts on the region, and identification/prioritization of trans boundary problems associated with the environment and global climate change
- Stakeholder analysis to verify interests of groups and individuals
- Institutional analysis of what exists and how formal and informal mechanisms often used for actual decision making in the change process
- Legal and policy analysis to supply the idea for recommending legal and policy reforms, especially on a regional level

Step 3: Define the key risks and responses. For this to figure, and to vary the narrative:

- A review of the priority trans boundary issues associated with global climate change and risk should make, and approve by the regional coordinators and teams to use as reference material for establishing the vision statements for the priority environmental problems.

- Regional policy objectives should be the indicator and targets to define the strategic program actions for mitigating the environmental problems and should be established.
- Joint feasibility studies should administer to spot the simplest feasible options for managing the identified problems.
- Identification and expression of intent to implement feasible options selected by governments and other relevant actors expressed and noted.
- Technical consultations should be administered and reported at the political level, to the line and agree on the short- and medium-term operational objectives, to spot the specified national and regional institutional frameworks, and to spot jointly accepted monitoring and evaluation indicators for implementation of the **SAP**.

Step 4: Build confidence. Ideally, these activities should end in incremental partnerships on the idea of agreed should joint benefits in environmental management. In parallel with these technical and political processes, the **TDA/SAP** should want, to identify financial needs and potential financing mechanisms. Furthermore, investing publicly in consultation and international partnerships is vital.

1.17. ESTABLISH A REPLACEMENT INSTITUTIONAL ARCHITECTURE

Despite previous comments about the number of organizations, the creation of ' a state of the art' institutional structure for managing water resources within the region may be a third temporary entry point that must consider. While some organizations, such as Planet Bank, are heavily involved. There is currently no appropriate organization or framework; that comprehensively addresses the specific water management and security challenges within the Horn of Africa. There may also be a need for a critical reassessment of the objectives and structures of existing institutional frameworks and agreements. Lessons can learn from other regions and basins in Africa, for example, the Zambezi River Stream Commission on a regional management strategy, or Organization pour la Mise en Valeur du Fleuve Sénégal as an example of one of the most successful basin models. It might be up to a lead agent to line up a structure to share and evaluate elements and potential added value of this model for the river basins within the Horn of Africa. Joint evaluation and knowledge sharing could lead to a far better understanding of the challenges in terms of water management from national perspectives and contribute to further confidence-building.

There are constraints and opportunities associated with this process-oriented approach. Financial constraints are a challenge for improving things. Additional funds will be required to establish new river basin committees which will collect, monitor, evaluate and validate data using joint methodologies. The **AU** Continental Early Warning System (**CEWS**) provides a chance in study terms. The prevailing data and analyses of **CEWS** may already include environmental and climate-related indicators, or this data could additionally add. **CEWS** already exists and is developed and accepted by the region. Using it might leave linking and integrating climate-related security risks and issues to a commission within the continental peace and security architecture. That primarily requires the willingness of member states to vary the utilization of this data. The **AU** Permanent Representatives Committee is the CEWS mandated audience **(krampe et al., 2020)**

Identification of **CEWS** data related to climate risks, for example, can provide input for different types of dialogue about how to manage impact at the national or regional level. That is might also imply the necessity to spot new funding sources that enable going beyond the present frameworks. The Juba-Shabelle Basin is a stimulating area and entry point because it lacks such a framework. But also finding cooperative solutions for the Blue Nile, and, within the end of the day, the Nile Basin, would require the desire to finance a replacement basin commission that involves Egypt, Ethiopia, and Sudan.

The suggested method is again the four-step approach, as mentioned above, of performing from jointly gathered, shared, validated, and accepted data for deciding. And it should include measures that will build confidence with a transparent lead role from a non-partisan actor **(Krampe et al., 2020).**

1.18. CASE STUDY: THE NILE DELTA, EGYPT

Agriculture is the significant and essential consumer of water in the Arab Republic of Egypt, as the percentage of agricultural use of water resources in 2015 amounted to about 46,031 billion m3 / year, which is equivalent to 83,692% of the total using **(Al-Ashmawy 2000)**, and the agricultural sector is not only the notable consumer of limited water resources, it is the main reason for its loss as a result of the use of irrigation systems that have specially features that have implications for the use and management of water resources, the lack of irrigation water in canals and canals, especially at their ends, and the stability of Egypt's share of the Nile water, and with the significant increase in population numbers, as Egypt's population growth rate is currently About 3.057% **(ECAPMS 2001),** may result in a decrease in the per capita share of water, and since the Egyptian agricultural sector is the chief consumer of water in the production of agricultural and non-food crops, the occurrence of any shortage in the amount of water available to it will have a significant impact on reducing The volume of local agricultural production, which negatively affects water security and, by extension, Egyptian food security. Where the agricultural sector faces the chief challenge facing the natural increase in the use of water for various purposes in the future, and it suffices to indicate that the agricultural sector used to consume about 48 billion m3 / year to irrigate about 8 million feddans in 2010 and starting from 2017 it will bear the burden of irrigation About 11,374 million feddans, with quantities of water amounting to about 36,750 billion m3, which imposes the necessity of developing projects and programs that achieve a reduction of water loss across the Nile River and development the use of groundwater, rain, agricultural drainage water and treated sewage water **(ECAPMS 2021)**, it is also necessary to follow policies that ensure Rationalizing the consumption of irrigation water, and the possibility of differentiation between cultivation areas in light of the limited water resources, to reduce the consumption of irrigation water so that irrigation water can be provided, to meet the expected increase in demand for it for various purposes in the future.

METHODOLOGY

The research expands and formalizes the Conceptual Foundations of Advance Agriculture (**CFAA**) is drawing on pervasive notions and concepts of agricultural growth and institutional and physical economics. To focus specifically on the adaptability/length of the resilience of advanced agriculture, recognizing that this is the least developed in the economic literature, it is a mixture of conceptual analyzes that includes conceptual and empirical analyses, policy analyses, and aspects of a case study. To demonstrate that is these pervasive concepts have strong real international applicability. The case observation method will provide concrete clarifications of conceptual and theoretical frameworks. It deliberates in the over-generalized scope of the agricultural, environmental, and socio-economic conditions. That is faced by agricultural planners and policymakers today. The case study assesses the problems of measuring vulnerability to changing conditions and the damage caused by water shortages. Addressing the topics of strengthening resilience and the impact of a previous introduction of distinguished policy measures, researchers, economists, and policymakers will discover an interpretation and operationalization of the concepts of resilience and resilience in the context of agricultural growth for food security. A combination of systematic analyzes of advanced agriculture with empirical analyzes based primarily on an observed case of the Nile River Delta.

The research was organized according to a plan as follows: 1. a conceptual framework, 2. a definition of the idea of advanced agriculture, its technology, 3. its predominant components. This aspect links the most important talents of the advanced agricultural model with intermediate financial principles. It seeks to show, by what means, the ideas of resilience, adaptability, innovation, generation, and institutions; relate to all the distinctive and economic concepts of advanced agriculture. The next part is a case study of the Nile River Delta (Egypt) from the economics of agricultural growth geared towards clarifying the economic basis for advanced agriculture in expressing vulnerability and increased resilience. It makes it easy to differentiate responses to build adaptive capacity in agricultural policies, systems, and standards. It addresses policy problems related to changing conditions and the damage caused by water shortages. It gives a high-level view of the advanced model of agriculture, which is mainly based on economic principles. The cultivated area and the yield of an acre are affected by many biological, technical, political, and economic factors, the quality of agricultural land, the production methods used, and the amount of water available to irrigate crops. Therefore, the main objective of this study is an attempt to rationalize the use of water resources in Egyptian agriculture through the possibility of differentiating between cultivated areas to maximize the net return of the water unit in light of the limited water resources.

RESULTS AND DISCUSSION

Current water resources and their uses in the Arab Republic of Egypt

Existing water resources mean the amount of water currently available that can be used directly for irrigation, industry, navigation, and domestic purposes, without the need for new projects to deliver it to sites of use. As it is clear from the data of; **table (1)** that: the volume of the current water resources amounted to about 85.2 billion m^3/year, of them about 57.5 billion m^3 flow from Aswan from the Nile waters, and about 8.3 billion m^3 of groundwater, and about 1.4 billion m^3 of rainwater, and about 8.5 billion m^3 of reused wastewater. And the rest is from other sources. It is also evident that the total amount of fresh water available in Egypt in 2007-2008 amounted to about 72.36 billion m^3/year that the Nile water represents 76.7%, while the rest of the sources account for about 23.3%. In 2015-2016 an increase in what water represents the Nile to the total freshwater resources reached 85.6%. As it is evident from the data of the previous table that the volume of current water uses amounted to about 101.54 billion m^3/year, of which 97.5 billion m^3 are consumption uses, or 96.1% of the total current actual uses, and 4.1 billion m^3 non-consumptive uses, or 3.9% of the current user. That confirms the necessity of preserving Egypt's share of the Nile waters at present. Develop plans and policies to increase Egypt's share of the Nile water in the future. That is done through investment projects to benefit from wasted water in the Nile Basin countries. The need to manage water in a way; that maximizes its use, and work to reduce waste; rationalize the water use in Egypt for various purposes.

The current water balance and the possibility of developing water resources in the Arab Republic of Egypt

Early economists such as Marshall, John Stuart, and Adam Smith, and Ricardo believed that water was a productive element available in nature, which led to not being given enough attention in their writings. And with the increase in population, water consumption increased in various uses, whether for personal consumption or agricultural or industrial expansion and others. That has increased the water demand. Which; has thus become a rare item that requires maximum satisfaction in its various uses. And access to the optimal uses of limited resources through the optimal distribution of those resources among the different use **(Al Mahdi 2013).** As it is clear from all the above that: the volume of the current water resources amounted to about 85.2 billion m^3/year, of them about 57.5 billion m^3 flow from Aswan from the Nile waters, and about 8.3 billion m^3 of groundwater, and about 1.4 billion m^3 of rainwater, and about 8.5 billion m^3 of reused wastewater. And the rest is from other sources. It is also evident that the total amount of freshwater available in Egypt in 2007-2008 amounted to about 72.36 billion m^3/year, meaning that the Nile water represents 76.7%, while the rest of the sources constitute about 23.3%. In 2015-2016 the increase in what the Nile represents to the total freshwater resources was 85.6%. It is also evident from all the above that: full total current water uses amounted to about 101.6 billion m^3/year, of that about 97.3 billion m^3 are for consumer uses, and about 4.3 billion m^3 are for non-consumptive use. By comparing the current water resources with the current water uses, it is clear that the existing water resources are less than the current water needs by about 16.4 billion m^3, as evidenced by the data in **Table (1).**

Table 1: Current water resources and their uses in the Arab Republic of Egypt in 2015/2016

Available water resources	*Quantity*	*%*	*Available water resources*	*Quantity*	*%*
Water resources from the Nile River	57,5	67,5	Water uses for agriculture	81.7	81,4
Water resources from groundwater	8,3	9,4	Water uses for drinking purposes	11,7	11,5
Water resources from rain water	1,4	1,6	Water uses for industrial purposes	2,9	2,9
Water resources from wastewater	8,5	12,9	Water uses for fisheries purposes	0,1	0,1
			Uses for navigation, electricity and budgets	4,2	4,1
Total available water resources	85,2	100,0	Total current water uses	101,6	100,0

Data source: (1) ECAPMS (2021) (2) MWRI (2021)

And that the development of water resources either by making the best use of available water resources without wasting and rationalizing their exploitation, and increasing the efficiency of water resource use in the agricultural sector (vertical development of water resources). Or expand the increase of these water resources, and increase the economic supply of water resources in the future by increasing water resources from its various sources (horizontal development of water resources). It is also evident from **Table (2)** that the percentage of what horizontal development can save is estimated at 49%, while vertical development can provide about 51% of the savings resulting from the development of water resources **(MWRI 2015)**. It is also clear that the amount of water that can be increasing throughout the implementation of the Upper Nile projects is about 18 billion m^3, divided equally between Egypt and Sudan, of which Egypt's share is about 9 billion m^3. And the amount of groundwater can be increased by about 4.9 billion m^3/year. And the total rainwater resources can be increased by about 1.2 billion m^3/year. And the amount of water can be increased by about 5.6 billion m^3 after implementing wastewater development projects **(MWRI 2015).**

Table 2: The possibility of developing the current water resources in the Arab Republic of Egypt in 2015/2016

Horizontal development of quantitative water resources	*Quantity*	*%*	*Vertical development of quantitative water resources*	*Quantity*	*%*
Nile water development	9,0	43,5	Improvement of existing irrigation holes	5,4	17,0
Groundwater development	4,9	23,7	Review of existing canals sectors	3,5	11,0
Rainwater development	1,2	5,8	Adjust the hydrograph	3.0	9,5
Wastewater development	5,6	27.1	The use of modern irrigation methods	6,8	21,5
			Reducing evaporation losses from water tanks	10.0	31,5
			Attention to water extension	3.0	9,5
Total savings provided by horizontal development	20.7	100,0	Total savings provided by vertical development	31.7	100,0

Data source: (1) MWRI (2021)

As for the second trend of developing water resources by rationalizing the current use of water resources and reducing water losses, it is possible to save an estimated amount of water of 5.4 billion m^3. By improving the existing irrigation holes and following the method of proportional water allocation, it is possible saving an amount of water estimated at 3.45 billion m^3. By reviewing the existing canals sectors, bridge standards and paying attention to the cleaning of the canals, it is possible to save an estimated amount of water estimated at 3 billion m^3. By adjusting the water limits to maximize production from the water unit, it is possible saving an amount of water estimated at 6.8 billion m^3. By using modern irrigation methods and attention to agricultural extension, it is possible saving an amount of water estimated at 3 billion m^3. By reducing evaporation losses from water reservoirs, it is possible saving an amount of water estimated at 3 billion m^3. By making farmers aware of the need for night irrigation, it is possible to save an estimated amount of water of 3 billion m^3. By paying attention to water extension and educating farmers about the need to standardize their cultivation on subsidiary canals, it is possible to save an estimated amount of water of about 3 billion cubic meters **(MWRI 2017).**

Current water uses in the agricultural sector

The problem of water achieving savings in water resources is one of the main obstacles to implementing any national agricultural plan or agricultural development program. Water resources are developed either by making better use of available resources or by working to increase these water resources. The best use of the available resources can be via rationalizing their exploitation and increasing their efficiency in the agricultural sector (vertical development of water resources). Increasing these water resources can be by increasing the economic supply in the future by increasing water resources from its various sources (horizontal development of water resources). As it is clear from the data of **Table (1)** that the agricultural sector is the largest consumer of the current water resources, as the percentage of agriculture use amounted to about 81.4% of the total existing water use in Egypt. That underscores the need to manage water in a way that maximizes its utilization. And work to reduce waste and rationalize its use for various purposes, especially agricultural uses. It is clear from **Table (3)** that the average amount of Nile water flowing from Aswan in the first period (1992-2003) amounted to about 52.7 billion m^3/year. It decreased during the second period (2004-2015) to about 50.4 billion m^3/year with an average decrease of about 2.3 billion m^3/year. Which; represents about 4.33% of the amount of water flowing from the Aswan runoff in the first period.

It also became clear from the same table; that the standard deviation of the amount of Nile water flowing to Aswan during the first period was about 2.8 billion m^3/year. And It rose for the second period to about 7.1 billion m^3/year`. It means that the amount of Nile water flowing into Aswan during the second period was more dispersed than was during the previous period. And it is confirmed; by the coefficient of variation, which amounted to about 0.8 for the first period. And the coefficient of variation increased during the second period to about 2.0. It is also evident from the same table that the average irrigation water in the outskirts of the canals for the first period was about 43.9 billion m^3/year, with a standard deviation 5.1 billion m^3/year and a coefficient of variation of 1.4. The average decreased in the second period about 42.3 billion m^3/year, a decrease of about 1.6 billion m^3/year, and a standard deviation of about 4.4 billion m^3/year. And a coefficient of variation became 1.2. And it is lower than that in the first period, which means that the irrigation water flow is more stable in the second period than in the first? While, the average flow of irrigation water in the field for the first period was about 39.4 billion m^3/year. With a standard deviation were 6.0 billion m^3 / year. And a coefficient of variation was 1.7. This average decreased in the second period to about 36.9 billion m^3/year, a decrease about 2.5 billion m^3/year, a standard deviation of 4.2 billion cubic meters, and a coefficient of variation of 1.2. It means that the flow of irrigation water in the field is more stable in the second period than in the first period.

It also noted from the previous table that the average total loss during the Nile water journey from Aswan to the field amounted to about 13.3 billion m^3/year during the first period with a standard deviation of 1.0 and a coefficient of variation of 3.6. Losses for the second period increased to about 13.5 billion m^3/year with a standard deviation of 4.3 billion m^3 and a coefficient of variation of 1.2. The difference between the averages of the two periods is -0.3 billion. Thus, the percentage of total losses for the first period was about 25.2%. This percentage of losses increased to about 26.4% for the second period. It is clear from the above that the amount of Nile water flowing from Aswan and during its journey through the river and canals until it reaches the agricultural fields is exposed, to the loss of a large amount of water amounting to about 13.5 billion m^3/year. That imposes on the economic planner the need to search for the reasons for this loss. And determine the extent to which did can reduce the volume of water. And use these water savings to meet the needs of old farmland. And; determine the possibility of agricultural expansion in new lands.

Table 3: The evolution of the amount of irrigation water used for the three Lugs crops and fruits in the Arab Republic of Egypt during the time period (1992-2015)

Year / Variables	*Quantity of irrigation water*			*Total loss*	
Year / Variables	*At Aswan*	*At the mouth of the canals*	*At the field*	*Quantity*	*% the amount of waste*
1992	56.2	51.4	49.6	6.6	11.7
1993	56.2	53.2	49.2	7.0	12.5
1994	56.5	41.8	43.9	12.6	22.3
1995	56.9	49.1	48.1	8.8	15.5
1996	50.2	49.6	36.6	13.6	27.1
1997	50.2	37.6	34.9	15.3	30.5
1998	50.2	40.9	34.9	15.3	30.5
1999	50.2	39.7	34.5	15.7	31.3
1999	50.2	39.7	34.5	15.7	31.3
2000	50.2	39.9	34.7	15.5	30.9

Year / Variables	*Quantity of irrigation water*			*Total loss*	
Year / Variables	*At Aswan*	*At the mouth of the canals*	*At the field*	*Quantity*	*% the amount of waste*
2001	50.2	40	34.8	15.4	30.7
2002	51.8	40.7	35.4	16.4	31.7
2003	53.7	42.5	36.6	17.1	31.8
Average	52.7	43.9	39.4	13.3	25.2
Standard deviation	2.8	5.1	6.0	1.0	-
Coefficient of variation	0.8	1.4	1.7	3.6	-
2004	55	43.6	37.9	17.1	31.1
2005	46	35.4	29.8	16.2	35.2
2006	59.7	48.1	42.1	17.6	29.5
2007	61	48.1	42.1	18.9	31
2008	62.1	48.9	42.8	19.3	31.1
2009	50	39.2	34.6	15.4	30.8
2010	51.2	42.7	37.8	13.4	26.2
2011	43.2	37	30.9	12.3	28.5
2012	40.1	36.9	32.1	8	20
2013	46	43	37.8	8.2	17.8
2014	46.6	43.6	37.9	8.7	18.7
2015	44.2	41.2	36.8	7.4	16.7
Average	50.4	42.3	36.9	13.5	26.4
Standard deviation	7.1	4.4	4.2	4.3	-
Coefficient of variation	2	1.2	1.2	1.2	-
The difference between the two averages	2.3	1.6	2.5 -	0.3-	1.2

Data source: (1) ECAPMS, Various enumerates, (1992/2015).

The possibility of rationalizing the use of water resources in the agricultural sector:

(a) The strategy for developing and managing water resources in light of the current water variables: Egypt has followed a strategy to develop and manage water resources, aiming to reduce the waste of available water resources, and rationalize consumption that the winter blockage period has reduced to 14 days instead of 25 days. In the meantime, water installations and releases of water discharges are maintained beyond the needs of agriculture, industry, and drinking to achieve a sufficient depth for river navigation. This water failed by discharging it into the sea. The irrigation network in Egypt was divided in the year 1994/1995 into three major regions: Upper Egypt, Middle

Egypt, and the Delta, this led to a reduction in the amount of water discharged into the sea to about Less than 1 billion m3/year, and in the following year, the irrigation network was re-divided into four regions: Upper Egypt, Middle Egypt, East, and Central Delta, and West Delta, and this led to a decrease in the amount of water discharged into the sea to about 265 million m3/year, and so on until it became the amount of water erupted into the Mediterranean sea does not exceed 100 million m^3/year. As well as rationalizing the groundwater use as the figures indicate that its safe use is in the range of about 7.5 billion m^3/year although the factual use is about 4.1 billion m^3/year. As well as developing irrigation systems in the old lands in the valley and the delta, what the figures indicate can be obtained about 5 billion m^3/year water from this development. The rationalization programs include the reuse of agricultural drainage water. Figures signify that its quantities are estimated at 12 billion m^3 /year. Wastewater that; can be reused in agriculture was estimated at 7.5 billion m^3/year. That depends on the quality and possibility of use, such as direct; use or mixing with canals water. As well as from the sources of irrigation water rationing is the use of wastewater after treatment, and the numbers indicate that the quantities of initially treated wastewater do not exceed 1 billion m^3/year. And one of the means of rationalizing the uses of irrigation water is to reduce the areas cultivated with crops that are voracious in water consumption, like sugar cane and **(Amer and Abdel Khaleq 2003)**.

(b) The possibility of differentiation between cultivation areas in light of the limited water resources: To decrease the use of water in cultivating, it can differentiate between cultivation zones by using the same amount of water and estimating the size of the increase in production, as a try to introduce the water resources when differentiating between cultivation zones. It is clear from **Table (4)** that the productivity of the water unit in Lower Egypt is higher than that of Upper Egypt, except for winter potatoes, dry fenugreek, sugar beet, garlic, and vegetables in winter. From **Table (4)** too noted that the highest crops for this season in terms of the size of the increase in the productivity of the water unit Alfa-alfa, permanent Alfa-alfa, tomatoes, onions, wheat, and barley, which estimated at 4,87, 3.74, 2.23, 1.43, 0,71 and 0.51 kg/m^3 respectively. Winter potatoes and garlic were the lowest crops in this season in the productivity of the water unit, with the increase estimated at 1.11 and 0.53 kg / m^3, respectively. In the summer season were green fodder, sugar cane, vegetables, onions, cotton, and maize were the highest crops in terms of the increase in the productivity of the water unit as it was estimated about 5,34, 5,20, 3,83, 2.78, 1.46, and 1.35 kg/m^3 each respectively. Crops of sesame and soybeans were the minimum crops in the productivity of the water unit in this season, where the output predestined around 0.19, 0.46 kg/m^3 any respectively. In the Nili season, were onions, vegetables, and maize were the highest crops in terms of the increase in the productivity of the water unit as it was estimated about 2.85, 2.53, and 1.27 kg/m^3 each sequentially. But, sorghum was the lowest crop in the productivity of the water unit in this season, where the output predestined around 0.91 kg/m^3 sequentially.

Economic losses can also be determined, by estimating the difference between the amount of water used in agriculture in Lower Egypt and the amount of water used in Upper Egypt, by assuming the same amount of water used. And can also estimate the difference between the volume of production obtained from agriculture in Upper Egypt and agriculture in Lower Egypt by imposing the cultivation of the same Space. As it can be seen from **Table (5)** that the savings in water for some of the winter season crops, which are wheat, barley, beans, lentils, chickpeas, alfalfa, and winter vegetables (greenhouses), amounted to about 485,64, 2,22, 6,91, 0.17, 1.25, 4.23, and 11.24 million m^3, respectively. Note that the chickpea crop can be grown in central Egypt. And that the abundance of water is for some summer crops, which are rice, maize, peanuts, Sunflowers, and vegetables amounted to about 77.43, 368.66, 7.13, 1.32 and, 32.77 million m^3 each respectively. Knowing that, the rice crop can cultivate in middle Egypt. And that the abundance of water is for some Nili season crops, which is Shami maize Nili and sorghum Nili amounted to about 30.16 and 0.05 million m^3 each sequentially. As a result of cultivating some crops of Upper Egypt in Lower Egypt and not imposed cultivating in the same zone. As for the amount of increase in production for some winter season crops, which are wheat, barley, beans, lentils, chickpeas, alfalfa, and wintergreen vegetables, it was estimated at 357.67, 1.14, 1.43, 07.0, 0.22, 18.62, and 0.05 thousand tons each, respectively, assuming the same amount of irrigation water was using. And that the amount of increase in production for some summer crops, namely rice, maize, peanuts, sunflowers, and, vegetables was estimated at 69.01, 219.65, 0.98, 0.18, and 9.59 thousand tons each, respectively. And that the amount of increase in production for some of the Nili season crops, which are crop Shami Nili and sorghum Nili crop, was estimated at 39.26, 0.03 thousand tons each, respectively.

The economic return from rationalizing the use of water resources in the agricultural sector

Due to the variation of water resources, their sources, and their uses, drawing a plan for the future use of water resources is significant which, is necessary to understand and develop many policies, including the agricultural policy, which necessarily requires a water policy. Therefore, before setting a future water policy, a set of considerations must take, into account. Physical, state, technological and natural conditions have great importance and a clear impact when drawing up water policy **(Abdel-Wahab 2006).** The availability of data on the current and future supply of water resources should be considered and taken into account. The current demand for water resources and physical capabilities related to augmentation and preservation must be vital, and rationalization of water resources as political considerations; If the water exploitation will use outside the country's borders, such as the **Jong lei Canal project** in Sudan.

And the economic and special considerations related to the water supply of agriculture, without affecting other sectors such as electricity, navigation, industry, etc., as well as the extent to which society accepts the distribution of the burden of project construction costs with comparing costs with the return from water, and reaching the most efficient use of available water resources to achieve the economic goals of the agricultural sector.

When taking into account: the technical considerations that determine the water rationing and the water needs of different crops, according to the different zones of the Republic, and taking into account the clear contrast between the nature of water resources and land resources by considering the water resource as a mobile and mobile resource, unlike land resources, which characterized by stability **(Mostafa 2001).** As it can be seen from the table (6) that the savings in water for some of the winter season crops, which are wheat, barley, beans, lentils, chickpeas, alfalfa, and winter vegetables (greenhouses), amounted to about 485.64, 2.22, 6.91, 0.17, 1.25, 4.23, and 11.24 million m^3, respectively. Know that the chickpeas crop can cultivate in middle Egypt. And that the abundance of water is for some summer crops, which are rice, maize, peanuts, Sunflowers, and vegetables amounted to about 77.43, 368.66, 7.13, 1.32 and, 32.77 million m^3 each respectively. Know that the rice crop can cultivate in middle Egypt. And that the abundance of water is for some Nili season crops, which is Shami maize Nili and sorghum Nili amounted to about 30.16 and 0.05 million m^3 each sequentially. As a result of cultivating some crops of Upper Egypt in Lower Egypt and not imposed cultivating in the same zone. By estimating this economically, the value of economic return that can get hold of estimated at 834,238.34 million pounds in the winter season. While what can get hold of in the summer season is estimated at 167,482.68 million pounds, and whatever can get hold of in the Nili season is valued at 71791.17 million pounds when distinguishing one; between cultivation areas.

Table 4: The productivity of the water unit for some crops of the crop composition in Lower Egypt and Upper Egypt and the amount of increase or decrease between Lower and Upper Egypt, for the average period of time (2013-2015)

Crops / statement	*Rationed water*		*productivity per feddan*		*productivity of the water unit*		*The increase in the regulations of Upper Egypt m3 / acre*	*Decreased productivity of the water unit of Upper Egypt kg / acre*
	Lower Egypt m3 / acres	*Upper Egypt m3 / acres*	*Lower `Egypt tons / acres*	*Upper Egypt tons / acres*	*Lower Egypt Kg / m3*	*Upper Egypt Kg / m3*		
				Winter Season				
Wheat	1813	2627	2.82	2.22	1.56	0.84	814	0.71
Barley	1366	1941	1,63	1,33	1,19	0,69	574	0,51

Municipal beans	1628	2426	1,40	1,23	0,86	0,51	797	0,35
Lentils	966	1345	0,96	0,80	1,00	0,59	379	0,40
Chickpeas	1546	2264	1,01	0,88	0,65	0,39	718	0,26
Lupine	1039	1457	0,74	1,01	0,71	0,70	419	0,01
Dry fenugreek	1546	2264	0,66	1,08	0,43	0,48	718	(-0,05)
Sugar beet	2198	3253	21,23	32,33	9,66	9,94	1055	(-0,28)
Perennial alfalfa	2516	3834	29,67	30,88	11,80	8,05	1318	3,74
Clover Mulching	898	1211	13,01	11,64	14,49	9,61	312	4,87
Onions	1771	2460	15,03	17,35	8,48	7,05	689	1,43
Garlic	1771	2460	7,24	11,37	4,09	4,62	689	-0,53
Winter potatoes	1394	1908	10,70	16,76	7,67	8,78	514	(-1,11)
Tomatoes	1394	1908	17,72	20,00	12,71	10,48	514	2,23
Vegetables	1394	1908	11,32	17,40	8,12	9,12	514	(-1,00)
Greenhouse (winter green)	1394	1908	0,01	0,01	0,01	0,00	514	0,00
Summer Season								
Cotton	3757	5195	5,50	5,79	1,46	1,11	1438	0,35
Rice	5505	6106	4,55	4,01	0,83	0,66	602	0,17
Damian corns	2659	3560	3,59	3,05	1,35	0,86	901	0,49
Fine corn	2719	3676	1,97	2,43	0,72	0,66	957	0,06
Sugar cane	7256	10523	37,70	48,56	5,20	4,62	3266	0,58
Onions	3700	5029	10,29	22,96	2,78	4,56	1329	(-1,78)
Peanuts	2796	3781	1,43	1,30	0,51	0,34	985	0,17
Soybeans	2913	3939	1,35	1,50	0,46	0,38	1026	0,08
Sesame	2796	3781	0,54	0,58	0,19	0,15	985	0,04
Sunflowers	2179	3021	1,08	0,97	0,50	0,32	842	0,18
Green fodder	2324	3223	12,42	14,26	5,34	4,42	899	0,92
Vegetables	2821	3904	10,80	10,49	3,83	2,69	1083	1,14
Nile Season								
Damian corn	2358	3205	3,00	1,89	1,27	0,59	847	0,68
Fine corn	2358	3205	2,15	1,62	0,91	0,51	847	0,41
Onions	2970	4159	10,53	16,27	3,55	3,91	1190	(-0,37)
Vegetables	2681	3664	6,77	11,41	2,53	3,12	983	-0,59

Numbers in parentheses indicate the amount of increase.

Data source: (1) ECAPMS, Bulletin of Agricultural Statistics (2020).
(2) ECAPMS, Annual Bulletin of Irrigation and Water Resources Statistics (2021).

Table 5: The amount of water savings and the increase in the amount of production as a result of a comparison between the different agricultural regions for the average time period (2013-2015)

Crops / statement	*The percentage of increase in the productivity of the water unit in Lower Egypt (1)*	*The percentage of increase in the water ration of an acre per feddan in Upper Egypt (2)*	*The area cultivated in Upper Egypt (One thousand feddans)*	*The amount of irrigation water in Upper Egypt (million m3)*	*The increase in production in the case of using water for agriculture in Lower Egypt (thousand tons) (3)*	*The saving in water in the case of agriculture in Lower Egypt (million m3)*
			Winter Season			
Wheat	0,71	814	596,39	1566,78	357,67	485,64
Barley	0,51	574	3,86	7,49	1,14	2,22
Municipal beans	0,35	797	8,66	21,01	1,43	6,91
Lentils	0,40	379	0,44	0,59	0,07	0,17
Hummus (Central Egypt)	0,26	718	1,74	3,93	0,22	1,25
Lupine	0,01	419	0,17	0,25	(-0,05)	0,07
Dry fenugreek	(-0,05)	718	2,30	5,21	(-0,97)	1,65
Sugar beet	(-0,28)	1055	7,39	24,04	(-81,99)	7,80
Perennial alfalfa	3,74	1318	161,48	619,08	(-194,16)	212,82
Clover Mulching	4,87	312	13,53	16,38	18,62	4,23
Onions	1,43	689	25,08	61,70	(-58,38)	17,28
Garlic	-0,53	689	1,81	4,46	(-7,49)	1,25
Winter potatoes	(-1,11)	514	2,29	4,37	(-13,88)	1,18
Tomatoes	2,23	514	50,43	96,24	(-114,81)	25,93
Vegetables	(-1,00)	514	66,51	126,92	(-404,59)	34,20
Greenhouse (winter green)	0,00	514	21,86	41,72	0,05	11,24
			Summer Season			
Cotton	0,35	1438	4,78	24,82	(-1,38)	6,87
Rice (Central Egypt)	-0,85	602	128,64	785,53	69,01	77,43
Maize	0,49	901	409,21	1456,79	219,65	368,66

Crops / statement	*The percentage of increase in the productivity of the water unit in Lower Egypt (1)*	*The percentage of increase in the water ration of an acre per feddan in Upper Egypt (2)*	*The area cultivated in Upper Egypt (One thousand feddans)*	*The amount of irrigation water in Upper Egypt (million m3)*	*The increase in production in the case of using water for agriculture in Lower Egypt (thousand tons) (3)*	*The saving in water in the case of agriculture in Lower Egypt (million m3)*
Sorghum	0,06	957	212,20	780,11	(-97,80)	203,15
Sugar cane	0,58	3266	285,39	3003,03	(-3100,04)	932,18
Onions (Central Egypt)	(-1,78)	1329	3,54	17,79	(-44,81)	4,70
Peanuts	0,17	985	7,24	27,36	0,98	7,13
Soybeans	0,08	1026	1,33	5,22	(-0,20)	1,36
Sesame	0,04	985	9,49	35,88	(-0,32)	9,34
Sunflowers	0,18	842	1,57	4,73	0,18	1,32
Green fodder	0,92	899	38,64	124,53	(-70,90)	34,72
Vegetables	1,14	1083	30,26	118,13	9,59	32,77
	Nile Season					
Maize	0,68	847	35,62	114,15	39,26	30,16
Sorghum (Central Egypt)	0,41	847	0,06	0,20	0,03	0,05
Onions (Central Egypt)	-0,37	1190	3,60	14,99	(-20,69)	4,29
Vegetables	(-0,59)	983	8,26	30,27	(-38,36)	8,12

1) The increase in the productivity of the water unit in Lower Egypt in relation to the productivity of the water unit in Lower Egypt (the amount of decrease in the productivity of the water unit in Lower Egypt / the productivity of the water unit in Lower Egypt)
2) The increase in the water ration of the feddan in Upper Egypt in relation to the Lower Egypt regulation (the amount of the increase in the Lower Egypt canon / the water regulation in Lower Egypt)
3) The increase in production in the case of using TFS the amount of water used in Upper Egypt for agriculture in Lower Egypt (the amount of water used for agriculture in Upper Egypt * decrease in the productivity of the water unit in Upper Egypt)
4) The abundance of water in the case of the cultivation of Upper Egypt in the same area planted in Upper Egypt (the amount of water used for agriculture in Upper Egypt - (the area cultivated in Upper Egypt * the water regulation in Lower Egypt)

Numbers in parentheses indicate the amount of deficiency.
Data source: Compiled and calculated from the data of Table (4).

Table 6: The economic value of the increase in production (million pounds), for the average time period (2013-2015)

Crops / statement	*Feddan productivity of Lower Egypt tons / acre*	*Feddan productivity of Upper Egypt tons / acre*	*The percentage increase in the productivity of the water unit in Lower Egypt (1)*	*The water supply in Lower Egypt, m3 / acre*	*Water codified Upper Egypt m3 / acre*	*The percentage of increase in the water supply per feddan in Upper Egypt (2)*	*The cultivated area in Upper Egypt (thousand acres)*	*The increase in production in the case of using water for agriculture in Lower Egypt (thousand tons) (3)*	*Price per ton (pounds)*	*The economic value of the increase in production (million pounds)*
Winter Season										
Wheat	2.82	2.22	0.6	1813	2627	814	596.39	291248.39	2753.33	801903.8
Barley	1.63	1.33	0.3	1366	1941	574	3.86	656.32	4025	2641.67
Fava beans	1.4	1.23	0.17	1628	2426	797	8.66	1143.71	5193.55	5939.93
Lentils	0.96	0.8	0.16	966	1345	379	0.44	27.6	7837.5	216.29
Hummus (Central Egypt)	1.01	0.88	0.13	1546	2264	718	1.74	157.33	6326.67	995.4
Lupine	0.74	1.01	-0.28	1039	1457	419	0.17	-19.71	5953.33	(-117.37)
Dry fenugreek	0.66	1.08	-0.42	1546	2264	718	2.3	-693.46	5309.68	(-3682.03)
Sugar beet	21.23	32.33	-11.09	2198	3253	1055	7.39	-86515.1	378.52	(-32747.70)
Perennial alfalfa	29.67	30.88	-1.2	2516	3834	1318	161.48	-255890.32	3866	(-989271.96)
Clover Mulching	13.01	11.64	1.38	898	1211	312	13.53	5814.7	3866	22479.65
Onions	15.03	17.35	-2.33	1771	2460	689	25.08	-40219.29	1041	(-41868.28)
Garlic	7.24	11.37	-4.13	1771	2460	689	1.81	-5162.6	1779	(-9184.27)
Winter potatoes	10.7	16.76	-6.06	1394	1908	514	2.29	-7133.83	1361	(-9709.14)
Tomatoes	17.72	20	-2.28	1394	1908	514	50.43	-59029.93	1540	(-90906.10)
Vegetables	11.32	17.4	-6.08	1394	1908	514	66.51	-208011.23	1815.33	(-377609.73)
Greenhouse (winter green)	0.01	0.01	0	1394	1908	514	21.86	25.51	2415.33	61.61
Summer Season										
Cotton	5.5	5.79	-0.29	3757	5195	1438	4.78	-1989.42	1245	(-2476.82)
Rice (Central Egypt)	4.55	4.01	0.54	5505	6106	602	128.64	41539.32	2136	88727.99
Maize	3.59	3.05	0.54	2659	3560	901	409.21	197877.13	322	63716.43

Crops / statement	*Feddan productivity of Lower Egypt tons / acre*	*Feddan productivity of Upper Egypt tons / acre*	*The percentage increase in the productivity of the water unit in Lower Egypt (1)*	*The water supply in Lower Egypt, m3 / acre*	*Water codified Upper Egypt m3 / acre*	*The percentage of increase in the water supply per feddan in Upper Egypt (2)*	*The cultivated area in Upper Egypt (thousand acres)*	*The increase in production in the case of using water for agriculture in Lower Egypt (thousand tons) (3)*	*Price per ton (pounds)*	*The economic value of the increase in production (million pounds)*
Sorghum	1.97	2.43	-0.46	2719	3676	957	212.2	-93627.23	331	(-30990.61)
Sugar cane	37.7	48.56	-10.86	7256	10523	3266	285.39	-10125932.7	400	(-4050373.09)
Onions (Central Egypt)	10.29	22.96	-12.67	3700	5029	1329	3.54	-59536.42	1041	(-61977.41)
Peanuts	1.43	1.3	0.13	2796	3781	985	7.24	960.78	681	654.29
Soybeans	1.35	1.5	-0.15	2913	3939	1026	1.33	-208.39	4336	(-903.59)
Sesame	0.54	0.58	-0.03	2796	3781	985	9.49	-311.46	1478	(-460.33)
Sunflowers	1.08	0.97	0.12	2179	3021	842	1.57	154.61	3764	581.94
Green fodder	12.42	14.26	-1.83	2324	3223	899	38.64	-63708.73	3866	(-246297.95)
Vegetables	10.8	10.49	0.32	2821	3904	1083	30.26	10389.54	1328.45	13802.04
Nile Season										
Maize	3	1.89	1.1	2358	3205	847	35.62	33244.17	2157.14	71712.42
Sorghum (Central Egypt)	2.15	1.62	0.53	2358	3205	847	0.06	28.55	2758.33	78.76
Onions (Central Egypt)	10.53	16.27	-5.74	2970	4159	1190	3.6	-24618.04	1041	(-25627.38)
Vegetables	6.77	11.41	-4.64	2681	3664	983	8.26	-37705.82	1361	(-51317.62)
The total economic value of the increase in production (million pounds)										1073512.20

(1) The increase in the productivity of the water unit in Lower Egypt in relation to the productivity of the water unit in Lower Egypt (the amount of decrease in the productivity of the water unit in Lower Egypt / the productivity of the water unit in Lower Egypt)

(2) The increase in the water ration of the feddan in Upper Egypt in relation to the Lower Egypt regulation (the amount of the increase in the Lower Egypt canon / the water regulation in Lower Egypt)

(3) The increase in production in the case of using TFS the amount of water used in Upper Egypt for agriculture in Lower Egypt (the amount of water used for agriculture in Upper Egypt * decrease in the productivity of the water unit in Upper Egypt)

1.19. CONCLUSION

Egypt has followed a strategy to develop and manage water resources, aiming to rationalize consumption of available water resources that the winter blockage period has reduced to 14 days instead of 25 days, and has been divided the irrigation network in Egypt into four regions: Upper Egypt, Middle Egypt, eastern and central delta, and the western delta. And, has been decreasing the amount of water discharged into the sea to about 100 million m3. And, by comparison between cultivation areas in light of the limited water resources, it becomes clear that the productivity of the water unit in Lower Egypt is higher than in Upper Egypt. The savings in water for some of the winter season crops, which are wheat, barley, beans, lentils, chickpeas, alfalfa, and winter vegetables (greenhouses), amounted to about 485.64, 2.22, 6.91, 0.17, 1.25, 4.23, and 11.24 million m^3, respectively, With knowing that, the chickpeas crop can cultivate in middle Egypt. And that the abundance of water is for some summer crops, which are rice, maize, peanuts, Sunflowers, and vegetables amounted to about 77.43, 368.66, 7.13, 1.32 and, 32.77 million m^3 each respectively. With knowing that, the rice crop can cultivate in middle Egypt. And that the abundance of water is for some Nili season crops, which is Shami maize Nili and sorghum Nili amounted to about 30.16 and 0.05 million m3 each sequentially. As a result of cultivating some crops of Upper Egypt in Lower Egypt and not imposed cultivating in the same zone. As for the amount of increase in production for some winter season crops, which are wheat, barley, beans, lentils, chickpeas, alfalfa, and wintergreen vegetables, it was estimated at 357.67, 1.14, 1.43, 07.0, 0.22, 18.62, and 0.05 thousand tons each, respectively, assuming the same amount of irrigation water was using. And that the amount of increase in production for some summer crops, namely rice, maize, peanuts, sunflowers, and, vegetables was estimated at 69.01, 219.65, 0.98, 0.18, and 9.59 thousand tons each, respectively. And that the amount of increase in production for some of the Nili season crops, which are crop Shami Nili and sorghum Nili crop, was estimated at 39.26, 0.03 thousand tons each, respectively, with a total of about 717.903 thousand tons. By evaluating this economically, the value of economic return that can get hold of estimated at 1073512.20 million pounds per year, If the difference between the cultivated areas. Due to the variation of water resources, their sources, and their uses, drawing a plan for the future use of water resources is significant which, is necessary to understand and develop many policies, including the agricultural policy, which necessarily requires a water policy. Therefore, before setting a future water policy, consideration must be taken the clear contrast between the nature of water resources and a land resource, if that is possible. So that it would be possible to direct agricultural production activities towards this goal, as they achieve one of the main aspects of the development goals and realize benefit from the advantages of specialization and comparative advantage. **The**

research recommends that the possible solutions to rationalize the use of water resources in agriculture are as follows:

- Reconsidering the existing crop formations to increase the area invested in higher-yielding crops.
- Developing field irrigation systems and the water transport system to rationalize water use and reduce losses.
- Replant different crops in the most efficient area of the water unit.

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