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Editor's Choice

Science in times of war: reflections from Sudan

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ABSTRACT

The war that erupted in Sudan on 15th April 2023 between the Sudanese Armed Forces (SAF) and Rapid Support Force (RSF) resulted in widespread destruction of national infrastructures, including the educational and research systems. Based on the personal experiences of the authors, this paper discussed the impact of the war on science and community of scientists who remained in Sudan during the war, including the resultant challenges, opportunities offered, and future perspectives.

Clearly, the war brought about unquantifiable devastation on professional and personal lives of scientists; internal and external displacement and separation of scientists, colleagues, and families; loss of research and teaching resources; loss of jobs and financial instability; and host of negative psychological, emotional and social issues. Given that more than 10.4 million Sudanese were forcibly displaced, among them scientists, the educational system has been hampered. Available data indicate that in Khartoum State, 39% of governmental and 73% of non-governmental universities were occupied by RSF, whereas it was 10% of governmental and 8% of non-governmental universities in Gezira state. This contrasts with 3% of governmental and 5% of non-governmental university in South Darfur. Some universities and colleges were partially or completely damaged, while in some it was not possible to determine the damage. This has led to complete shutdown of the universities, forcing students to find expensive alternative ways to continue their education or abandon it altogether. Scientists and science in Sudan faced many challenges, which are difficult to overcome.

While efforts to restore infrastructure and physical capital will be challenging, the social, psychological, and emotional devastation might be even more intricate. Revitalizing policies and international efforts are needed to support the recovery of the entire educational systems and research infrastructures, as well as the wellbeing of scientists.

KEYWORDS:

Scientist, research, psychological, displacement, infrastructure, impact, conflict, Sudan, war

INTRODUCTION

Sudan is a country in Northeast Africa. Since December 2018, the political environment in the country has been unstable, which worsened during the COVID-19 pandemic, taking a great toll on the educational systems. On 15th April 2023, the ongoing Sudanese civil war broke out between the Sudanese Armed Forces (SAF) and Rapid Support Force (RSF), which has greatly added to the precarious situation in the country. Although the war started in Khartoum, within 16 months it spread to Kordofan, Darfur, Gezira, and Sinnar states, and parts of White Nile state[1]. Economically, politically, and socially, the war has inflicted unquantifiable human suffering, destruction of essential infrastructures, and wanton looting of both state and individual properties. It is estimated that more than 10.4 million Sudanese have been displaced as a result of the war, internally and externally. Most people had to flee under difficult circumstances.

The war resulted in widespread destruction of the country's infrastructure, and educational systems, including the main building of the Ministry of Higher education (MHE)[2]. Given the difficulties associated with conducting onsite assessments of the impact within conflict zones, there remains limited understanding of the immediate and long-term impacts of the war on the educational system and research infrastructures in the country, particularly in the areas more severely affected. Nevertheless, to assess the impact of the war on medical institutes, an online survey for in-conflict-affected regions of Sudan were used to bridge the knowledge gap[3]. The study showed that the war had a devastating effect on medical education process[3]. The current paper, based on the authors' observations and opinions from witnesses, aimed to describe the impact of the ongoing war on the educational system, research infrastructures, and scientists who remained in Sudan as the war raged.

The Impact of War on Science and Scientists

Professional and Personal Struggles

When the armed conflict erupted, the main focus was on survival and meeting basic needs. Initially, most scientists assumed that the conflict would last no more than a week, but gradually they started to think about leaving. In fact, the predominant opinion among them was that no one knew how long the war will continue; hence, it is better to leave because the future of research has become precarious. The war also resulted in severe economic impacts for both the government and ordinary people of Sudan. The financial situation of university scientists was significantly affected. Most of them were subjected to theft by RSF, leading to lost cash savings and personal properties, including cash, cars, and jewelry. Additionally, the government reduced the salaries for all university staff due to new economic arrangements, placing heavy burdens on them as the rising inflation rate aggravated the situation.

The complicated situation and instability in the conflict zones occupied by RSF forced many scientists to leave their homes to safer states or flee to neighboring countries as emigrants or refugees. According to the United Nations High Commissioner for Refugees (UNHCR)[4], 10.4 million persons were forcibly displaced, 8 million internally and 2.2 million fled to Egypt, Chad, Ethiopia, Eretria, South Sudan and Uganda. Among those that fled the country were scientists and students, which left a void on the educational system. As an example, Sudan is home to more than 70 medical schools with an annual intake of more than 5,000 students[5], representing 23% of medical schools in Sub-Saharan Africa. However, it has suffered a crippling shortage of doctors following decades of health care worker migration, documented since the 1960s and continuing today[5]. The displacement and migration of scientists in general have also resulted in a significant brain drain.

The war has caused great hardship for scientists, including limited access to essential teaching resources, research labs and other research infrastructures. Many schools and universities have been damaged or destroyed, leaving students without proper facilities to continue their education. The impact of the war on students is profound, being among the most vulnerable groups affected by the conflict. The disruption of education due to forced displacement and the lack of teaching resources has put the future of countless young Sudanese at risk. The scarcity of textbooks, learning materials, and technological resources has further hindered the educational process, making it difficult for students to reach their academic potential.

Psychological Impact

The impact of the war on individuals, particularly scientists and students, cannot be understated. Many young people witnessed violence and experienced trauma, human rights violations, physical and psychological suffering, which affected their mental health and ability to concentrate on their studies. During the conflict, many people, including school kids and students, were captured and taken away from their homes. For example, a group of students from the Faculty of Engineering at the University of Khartoum camped on the university campus when the fighting began. They were trapped for over a week and faced tremendously challenging circumstances. The immediate and long-term impact of such a siege will be difficult to fully decipher.

Scientists also found themselves in precarious situations, especially those who could not evacuate their families and remained in areas under RSF's control. They suffered greatly from aggression and physical assault by RSF soldiers. Additionally, valuable data, software programs, ongoing scientific papers, and publications were completely lost, directly impacting the scientists physically and mentally. Direct contact with colleagues who remained in Khartoum and Gezira states revealed that they were subjected to different levels of psychological and emotional conditions, which affected their mental health, leading to depression, loneliness, and anxiety for many. They endured the continuous noise from machine guns, artillery, and air bombing day and night. They also felt unsafe inside their homes, not knowing when intruders could break in and threaten them with machine guns and forcefully take away their belongings.

One of the authors of this paper had a personal experience with this when a group of RSF soldiers broke into his house in the early morning of June 3rd, threatened him with rifles, and carted away many of his personal belongings, including his work laptop. The loss of this laptop was considered one of the biggest setbacks in his career, as it contained 15 years of research, ongoing scientific papers, prepared lectures, presentations, recorded lectures, and valuable electrical engineering simulation programs. The loss of all research was one of the major effects of the war on the educational system. Unfortunately, many scientists were lost their lives during the war as a result of being hit by live bullets during army robbery and looting. The accumulated sorrows from these events may take time to heal.

Universities and Research in Sudan

Over the past 30 years, there has been a significant expansion of universities in Sudan, with an increasing number of students enrolling. Various institutions affiliated to different ministries are conducting research in Sudan, with the Ministry of Higher Education and Scientific Research (MOHESR) being the central responsible organization. According to the Scopus databases, there are 55 research institutions in Sudan, most of which are universities and colleges. These include the National Center of Research (NCR), the Federal Ministry of Health, the Sudanese Atomic Energy Commission, the Agricultural Research Corporation, and the Sudan Veterinary Research Administration. The majority of these institutions are located in Khartoum and Gezira states, with at least one governmental university in each of the other states. Available data indicate that in Khartoum State, 39% of governmental and 73% of non-governmental universities were occupied by RSF, whereas it was 10% of governmental and 8% of non-governmental universities in Gezira state. This is in contrast to 3% of governmental and 5% of non-governmental university in South Darfur; 5% of both governmental and non-governmental universities in North Kordofan State; and 5% of governmental and 0.9% of non-governmental universities in the White Nile State.

Destruction of infrastructure

Universities have been caught in the crossfire of the war, resulting in the loss of classrooms, laboratories, libraries and many other properties of the institutions. The consequence of this is that it has created a widespread destruction of the national educational infrastructure. Most of the universities and colleges in the conflict areas totally or partially suffered extensive damage, looting, and burning. There are also places where the institutions have been destroyed by shelling. A particular example is the Sudan University of Science and Technology, which was severely impacted. At the College of Forestry and Range Science, staff offices, laboratories, computers, and vehicles were either destroyed or stolen altogether. The experimental farm

at the College of Animal Production was devastated and animals were slaughtered. Similar incidents were reported at other universities and research institutions. Table 1 illustrates the current situation of some universities and colleges. As a result of this destruction, many institutions are unable to operate normally, leaving students with no choice but to find alternative ways to continue their education or abandon it altogether. Currently, all universities and research centers in Sudan are completely shut down.

Table 1. Summary of the current situation of some Sudanese universities and colleges

Name of institution	Remarks	Level of damage and mode of teaching
Sudan University of Science and Technology	Under occupation by RSF and use as military base	Not possible to determine the damage. Online lecturing
University of Khartoum	Under governmental control	Not possible to determine the damage. Online lecturing
Omdurman Islamic University (Fitihab branch)	Under occupation by RSF and use as military base	Completely damaged and looted Online lecturing
Omdurman Islamic University (Thora branch)	Under governmental control	Minor damage Online lecturing
Omdurman Ahlia University	Under governmental control	Completely damaged and looted
Nyala, Zalingi and Ginana Universities	Under occupation by RS	Major damage and looting Struggle to restore academic programs
Gazira College of Technology	Under occupation by RSF and use as military base	Completely damaged and looted Online lecturing

* Source: International Institute for Democracy and Electoral Assistance (IDEA) 2023

Remote Administration

The closure of universities as a result of the war interrupted administrative work, including displacement of key administrative staff. This has disrupted the management and coordination of educational activities. Consequently, communication and coordination of activities between administrative staff and academic deans and head of departments are primarily performed virtually using online platforms. Shutting down the internet and communication services by RSF made it difficult for all administrators and academic heads to gather in same platform at same time, slowing down many academic processes. Many institutions were struggling to maintain records, manage admissions, and ensure the continuation of academic programs. Fortunately, most of the universities have had back up academic records of their students which helped in issuing the certificates of graduates upon request.

Academic Continuity

The complete shutdown of the universities directly affected students' graduation, including termination of degree research projects, as some students were on the verge of completing their projects and graduation just before the war started. A pitiable case occurred at the College of Forestry and Range Science when final year students who had completed their three weeks of camping in the field submitted their research reports. Unfortunately, the submitted documents were damaged before they could be assessed by the staff. It is worth mentioning that this component covers three subjects (nine credit hours) in the curriculum. Forced displacement due to the war thus interrupted academic programs and research continuity. Scientists and researchers struggled to find new means of livelihood and safety. Ongoing postgraduate programs and planned scientific research with partners were unfortunately stopped and put to a standstill after the war broke out. Postgraduate Ph.D. and M.Sc. programs in various fields ceased immediately.

Some research associated with post graduate students, such as laboratory experiments, and ongoing academic publications were lost. Collaboration with industrial partners was also affected by the war. Data regarding all

previous experiments were lost. Additionally, some of the postgraduate students who had completed their thesis work and were just waiting for the defense lost their hardware prototypes and experimental models. Libraries, which are critical for academic research and education, were not spared from the devastation. Many of them were looted or destroyed, leading to the loss of valuable books, journals, and research materials. This loss severely impacts the ability of students and scientists to access information and conduct research, hindering academic progress and innovation. The war will also negatively affect the way the scientists perceive their future roles, perform outreach programs and community services, relationships with colleagues and other actors, such as students and officers. Before the war, there was a sense of collegiality and acknowledgement of diverse cultures at every turn across institutions. It is therefore concerning that this might no longer be the case, even after the war. During the war, members of the scientific community took varied positions concerning the incident, but some of them found themselves affiliated to either side of the warring parties. One wonders how the situation will look like when two former colleagues (now enemies) meet again at their workplace. Will they forgive each other and overlook the miserable experiences that occurred during the war and continue their work? This strain could affect the quality of education and hamper progress.

DISCUSSION

Reflection on the impacts of the war and prospects

As the war continues and expands, the situation may lead to substantial shift in educational programs and research agenda. Evidence reveal that many educational programs and research projects implemented by Sudanese universities are not pertinent to the industry. Due to the war, most graduates realized the need for training in fields that offer opportunities for self-employment. Hence, one predicts a great change in prioritizing educational and research programs that might result in the downing of some essential programs. Scientific and educational institutions will need to reconsider the nature of their research projects and curricula (content and delivery) to be more practical-oriented and directed more towards solving problems.

Regarding the future of scientists and science in Sudan after the war, one would say that restoring infrastructure or physical capital might be much easier and faster than human capital. Definitely, the human capital is more than a collection of scientists. Retaining human capital requires building teams of talented, motivated, and high caliber scientists. However, the success of such teams is interconnected with the existence of an encouraging research environment. It goes without saying that conducive environment is a prerequisite for effective performance of researchers. During the war, damage was not limited to institutions, the destruction extended to staff's accommodation and personal properties, including vehicles, computers, and references. Unfortunately, lack of interest as a response to stress and upset might propagate among scientists (especially young) as the war continues.

The lack of a stable learning environment and the constant threat of violence have left many students feeling hopeless about their future, diminishing their motivation to pursue education. The instability and uncertainty have led to a significant increase in dropout rates, as students struggle to adapt to new environments and to face financial hardships. The displacement of administrators from their offices hampered academic continuation.

Power blackouts and other technical challenges, such as lack of internet and communication issues, have also disrupted the educational system. The well proven digital leaning platforms established during the COVID-19 pandemic helped in delivering the theoretical lectures and scientists and students becoming familiar with it. The shutdown of internet services affected the platform. Most platforms depend mainly on recorded lectures, which the students can download them when the internet is available. Some of the universities started using virtual laboratories to deliver practical work in the field of applied sciences. Most scientists lost their laptops and recording facilities, which makes it difficult to record lectures. In addition, sometimes they needed to walk long distances to an area with internet facilities in order to upload lectures, risking their personal safety. The challenges of performing practical work and training, especially in engineering and medical disciplines, are crucial because most

laboratories have been destroyed, as well as closure or destruction of factories and workshops where the students were trained.

A researcher said: If war stopped tomorrow, "I don't think I could just go back to my college. Too much damage has been done". In fact, the bitter reality is that not all scientists displaced due to the war are planning to return home after the war ends. Additionally, the instability caused by the war motivate**s** many researchers to move to places offering greater safety. However, as the battlefield expands, circumstances cause others to go for other income-generating activities outside of academia, thereby quitting their research. The lack of stable governance and funding has further exacerbated these challenges, making it difficult for institutions to function effectively.

Since 2019, Sudanese universities have experienced academic anarchy due to political instability and COVID-19 outbreak. Nonetheless, this situation encouraged universities to introduce e-learning systems. Subsequently, when the war started, universities already had some expertise in the field and most of the universities established e-learning platforms. In the reality of the war, the universities' administrations are now focusing on the continuation of under-graduate programs through the established e-learning. The universities man**a**ged to introduce solutions to some of the challenges and many universities started their academics programs online, in safe states or abroad.

Some Sudanese universities have already relocated some of their classes (specifically, senior medical students) to other countries[8,9], a very expensive alternative. Moreover, many universities developed Memorandum of Understanding with sister universities in safer states. Such initiatives have facilitated many universities to accomplish the practical parts of their curricula. Furthermore, some Sudanese universities even established branches abroad. Nevertheless, immediate intervention is needed[10]. As a limited number of displaced scientists were fortunate to join research projects in their respective recipient countries, one anticipates those can conduct scientific diplomacy and contribute to developing international scientific partnerships. If those scientists remain temporal, returning scientists will contribute to the diffusion of knowledge and skills which can also benefit scientists who stayed at home.

CONCLUSION

The ongoing war in Sudan has resulted in an unstable and insecure situation. The impact on the educational systems and research institutions is great. Scientists have been forced to flee their homes due to the war, leading to migration and financial constraints as they struggle to overcome physical and psychological abuse. The destruction of infrastructure has further complicated the situation, resulting in the closure of all universities and research centers in most affected areas. This has caused a significant setback in the nation's educational and research progress. The complete shutdown of universities and the migration of scientists and highly qualified professionals have depleted the nation's intellectual resources, jeopardizing the future of many young Sudanese. There is also concern that the stress and trauma experienced by scientists, especially the younger ones, may lead to a lack of interest in their work as the war continues. It is imperative for the government of Sudan to establish strategic plans and policies for recovery, not only of infrastructure and properties, but also the psychological, emotional and social wellbeing of the scientific workforce. The recovery of the educational system will require universities to conduct research related to continuous development and peaceful coexistence. Efforts should be made to restore records, student data, administration, and academic records. The international community must recognize the critical importance of protecting education during times of conflict. Immediate support should be provided to displaced scientists and students, damaged educational infrastructure rebuilt, and measures be taken to ensure the continuity of education and other scientific activities.

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CONFLICT OF INTEREST

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AUTHORS' CONTRIBUTIONS

All authors conceptualized the research and wrote the main manuscript. All the authors reviewed the manuscript.

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