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The Sahel: Population origins, acculturation, conflict and prospects for regional integration

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Abstract

This research explores population origins, acculturalization processes, and conflict in the Sahel by scrutinizing relevant scholarly research in the region. This scrutiny revealed that, the populations of the Sahel are genetically composed of heterogeneous origins of Arabs, Eurasian, Africans, and Berber, and who were subjected to diverse acculturalization processes of Arabicization, Islamisation, diversification, "Berberization", and identity formation, and who are experiencing various forms of conflicts sourced from climatic, political, social, and resource – based factors. The research proposes some regional integration prospects for the Sahel to alleviate the impacts of vast heterogeneity of population origins, diverse acculturalization processes, and severe conflicts.

Keywords: Sahel, ethnic heterogeneity, Aculturalization, conflict, regional integration

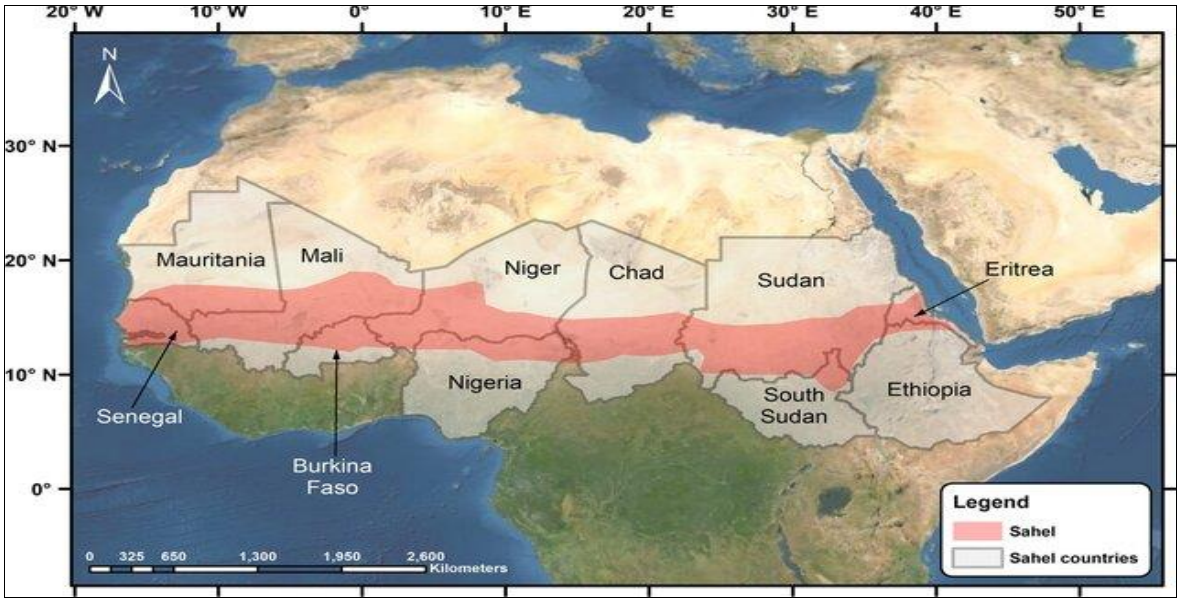
Introduction

The Sahel is an aggregation of ecologically fragile countries with contradictory livelihood of pastoralism and sedentary agriculture, and admixture of heterogeneous origins of population. Although the Sahel was subjected to diverse aculturalization processes; it failed in creating a homogeneous cultural cohesion, which consequently produced, in association with many other factors, a complex of endless conflicts threatening its political stability and others' African and European countries. Therefore, this research works on exploring population origins, acculturalization processes, and conflict in the Sahel to reflect relevant problems, in order to find a way for repressing their future encroachment in the African continent and elsewhere world widely. This was done by proposing some regional integration prospects.

Regional integration is the collective agreement of the nation-states to cooperate to achieve peace, stability, and wealth via economic and political integration to ultimately initiate a single market as the midpoint of that integration (carleton.ca/ces/eulearning). Based on that, an effective regional integration could work for the Sahel in order to improve low income levels and Low agricultural productivity, alleviate poverty and high dependency on biomass for energy, reduce loss of soil nutrients and organic matter, and promote ranks of the Human Development Index, all of which will alleviate the negative impacts of heterogeneity of population origins, acculturalization processes and conflicts (Figure 5).

The location and environment of the Sahel

The Sahel extends south of Atlas Mountains and east and south of the Mediterranean Sea to approximately 10° N (Hoelzmann, P. *et al*. 2004) [60]; and from the Atlantic Ocean to the Red Sea coast (Čížková *et al*. 2017) [37], stretching 5000 km and is a home to over 150 million people. In most instances, it is divided into Western Sahel, including parts of Senegal, Mali, Northern Ghana, Mauritania, Niger, Northern Benin, Upper Volta, Chad, Northern Nigeria, and Eastern Sahel, including some parts of Sudan, Eretria, and Ethiopia (Figure 1).

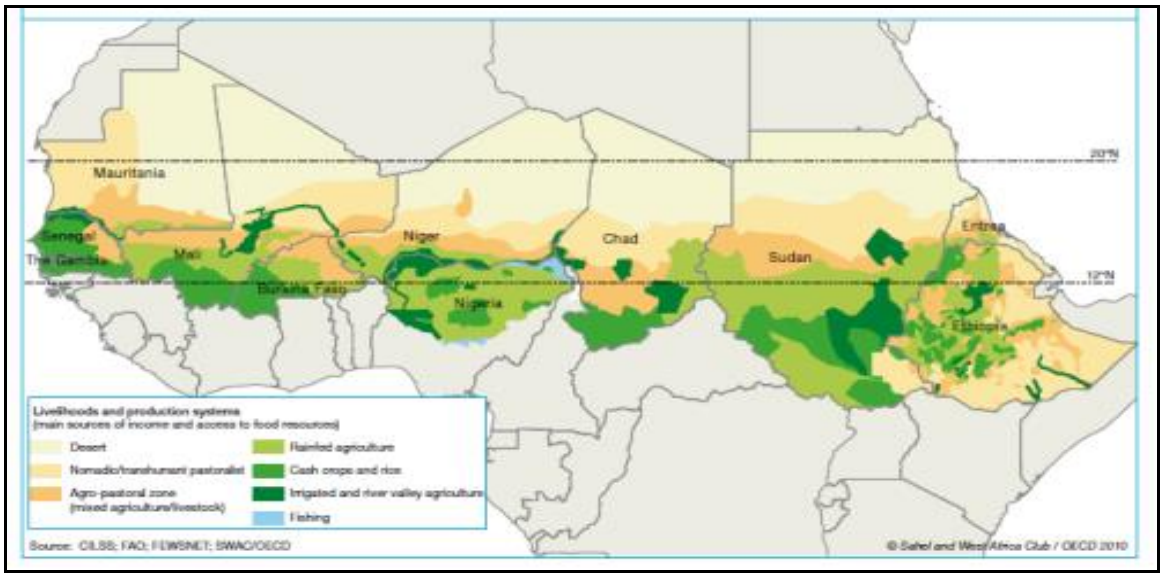


***Source*:** Al-Saidi *et al*. 2023

Fig 1: The Sahel region and countries

The Sahel is a broadly zonal pattern (Hoelzmann, P. *et al*. 2004) [60], between the dry Saharan and savannah climates (Mensching, 1982) [72], characterized with extreme environmental uncertainty (Scott, 1979) [100], manifested in extreme temperature, seasonal and unimodal distribution of summer rainfall (Rain, 2024) [90], that progressively become drier with more erratic rainfall (Benjaminsen *et al*. 2012) [19], which produced a transitional zone between the spare Saharan vegetation and thickly wooded savannah.

The Sahel was settled earlier by population and lately, formed a corridor for migrations across Africa between Eurasians penetrating from northern Africa southwards and sub-Saharan Africans migrating northwards, and between nomadic pastoralism and sedentary farming (Černý *et al*. 2021, 2023) [33], who learned to survive by exploiting its inherent qualities and its micro-environments productive capability and productivity (Scott, 1979) [100], which is depending upon a single unpredictable annual rainy season (Cooper, 2018) [39], that determined only one rainfed cropping season (Rain, 2024) [90], and associated livelihood systems (Figure 2).



***Source*:** Climate Change Profile: West African Sahel. 2018. https://www.preventionweb.net

Fig 2: Livelihood systems in the Sahel

The origin of Sahel population

Populations of the Sahel are originally of Arabs, non-Arabs, or admixtures between both. The Arabs are genetically diverse (Teebi *et al*. 2005) [110], as they received substantial gene flow from various continents (Abu-Amero *et al*. 2007) [4]. There is a long-standing relationship between the Arabs and sub-Saharan Africa (Salim 1985) [98], where the social structure of ancient Arabia is like that of the Western Sudan, which was premised upon blood kinship (Willis, 1979) [112]. The mitochondrial DNA variation of populations from the Near East and Africa, have a very high frequency of African lineages present in the Yemen "Hadramawt", where more

than a third was of clear sub-Saharan origin, while the other Arab populations carried ~10% lineages of sub-Saharan origin (Richards *et al*. 2003) [92], more evident by admixture of North Africans and Near Eastern/Arabians.

The genome-wide diversity of North Africans suggests for mixture of ancestral populations related to current Africans and Eurasians with more affinity towards the out-of-Africa populations than to sub-Saharan Africans (Fadhlaoui-Zid *et al*. 2013) [48], and the North Western Africans are genetically closer to Iberians and to other Europeans than to African Americans (Bosch *et al*, 2000) [24], contrasting the East-African populations who have a particular haplotypes that was almost exclusively to them (Rosa *et al*. 2004) [93]. Those who bear maternally inherited haplotypes of Eurasian ancestry do not morphologically differ from those whose maternal ancestry is from sub-Saharan (Kleisner *et al*. 2019) [64].

The exposures of the African Sahelian populations to pathogens have likely contributed to their genetic differentiation for HLA genes (Černý *et al*. 2018) [31], such as that between sedentary farmers and pastoralists (Černý *et al*. 2018) [31], where bidirectional flow of people in the Saheldid not erase features peculiar to the original populations such as those of the Chad Basin's (Černý *et al*. 2007) [34]; which broadly divided the genetic diversity by a north–south axis (Shriner *et al*. 2018) [103].

The Tuareg has ancestors from the Garamantes of the Libyan Fezzan, and have kinship with the Beja of Eastern Sudan (Pereira *et al*. 2010) [86]. The Fulani population experienced admixture between a West African group and a group carrying both European and North African ancestries (Vicente *et al*. 2019) [116]. This was likely coupled with newly adopted herding practices resulted in genetic adaptation in contemporary Fulani genomes (Vicente *et al*. 2019) [116]. The most of the haplotypes of Fulani nomads belong to haplogroups of West African origin (Černý *et al*. 2006) [35]. It failed to show significant departure from neutrality for mtDNA when contrasted with farmers who show more heterogeneity than pastoralists (Černý *et al*. 2011) [29]. Also, there is a higher gene flow between the Arabic pastoralists and neighboring farmers in the eastern part of the Sahelthan between the Fulani pastoralists and their sedentary neighbors in its western part (Čížková *et al*. 2017) [37].

The acculturalization of the Sahel population

Trade relations between Black Africa and the Arabs dates back to at least twelve centuries ago (Pearl, 1984) [84], as some Arabic manuscripts were found in Mali, Niger, and Nigeria (Nobili, 2011) [77]. Following ancient Bedouin incubation, Arab migrations in the 7th century CE, spread across the Middle East (WEBB, 2016) which proceeded to a process of Arabization which was mainly a cultural process (Pearl, 1984) [84], and accomplished by the processes of Islamisation which began between the early twelfth and fourteenth centuries.

The process of "Berberization" began in the early medieval period among northwest Africans (Rouighi, 2011) [95], and appeared in distinguishing between Blacks, Berber of the Southern and Central Sahara, and the 'Whites', including the Arab Muslim who originated in North Africa or the Middle East, (Bruce, 2024) [67], particularly in urban centers which are controlled by various cultural and intellectual biases (McIntosh, 1993) [71]. This situation was influenced furthermore, by slavery trade and some forms of servility in Sub-Saharan during the early nineteenth century and onward (Lydon *et al*. 2016) [67]. The Arab played important roles that gave rise to recurring stresses and strains, where he Black and Arab coreligionists are seen today as an incipient transnational community (Pearl, 1984) [84].

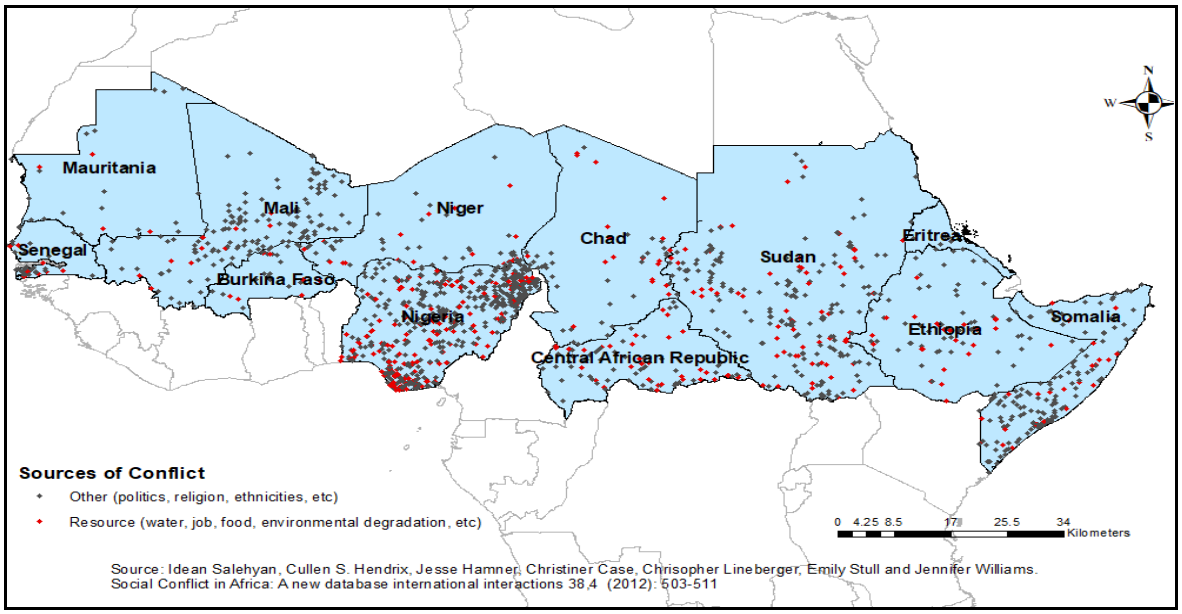
The Sahel has experienced further aculturalization process inclining the process of diversification associated with the spread of agro-pastoral food-producing subsistence lifestyles (Čížková *et al*. 2017) [37], the process of identity formation of the 'Sudanic identities' associated with Islamic identities and administrative tribalism in the twentieth-century, and the process of polarization of 'Arab' and 'African' identities associated with new forms of external intrusion and internal violence (De Waal, 2005) [41].

The French selected an aggressive way of assimilation in the Sahel during its colonization. In the early 1950s, French culture was viewed as a "tool aimed at cultivating African loyalty, while in 1960, cultural assistance became explicitly transactional where the African countries that were expected to remain loyal to France received culture in return" (Gerits, 2019) [51]. France continued to wield considerable power and influence in these countries politically, economically, socially, and culturally (Martin, 1985) [69].

Conflicts in the Sahel

The countries of Niger, Mali, Mauritania, and Chad have experienced forms of conflict since their independence in 1960, such as that between black Africans and Arabs (Sebastian, 2019) [102], and rebel of Tuareg in Mali in 1962–64 and 1990–94 (Keita, 1998) [63]; who also have uprisings in Niger (Sebastian, 2019) [102], which increased following the fall of Libya in 2011 by inflow of armed fighters (Akinola *et al*. 2023) [9]; and the fled of people to northern Chad (Ammour, 2012) [12]; increased violent clashes between sedentary farming communities and 'Arab' nomads (Tar, 2006, Rothbart *et al*. 2016) [107, 94] which can be traced to the 1930s and 1980s (Ted, 2004) [9], and the sustained armed conflict between the armed forces and its allied proxy militia drawn from Arab ethnicity and some armed liberation Movements (Tar, 2006) [107].

These conflicts have disrupted the sensitive ethnic and political balances (Yehudit, 2013) [123], livelihoods of the population (Brottem, 2020) [27], which caused difficulties to the livelihood of pastoralists who lost their cattle (de Bruijn, 2016) [40], or changed their livestock raising and movement of herds (Bassett *et al*. 2007) [17], responses to crises by either increasing sedentarization or herds mobility, and negatively affecting system of the pastoralist laborers (Bovin, 2000) [25]. The sources of conflicts by in the Sahel are shown by figure (3), and will be discussed here.



***Source*:** Mirzabaev *et al*. 2021 [73]

Fig 3: Major sources of conflict in the Sahel

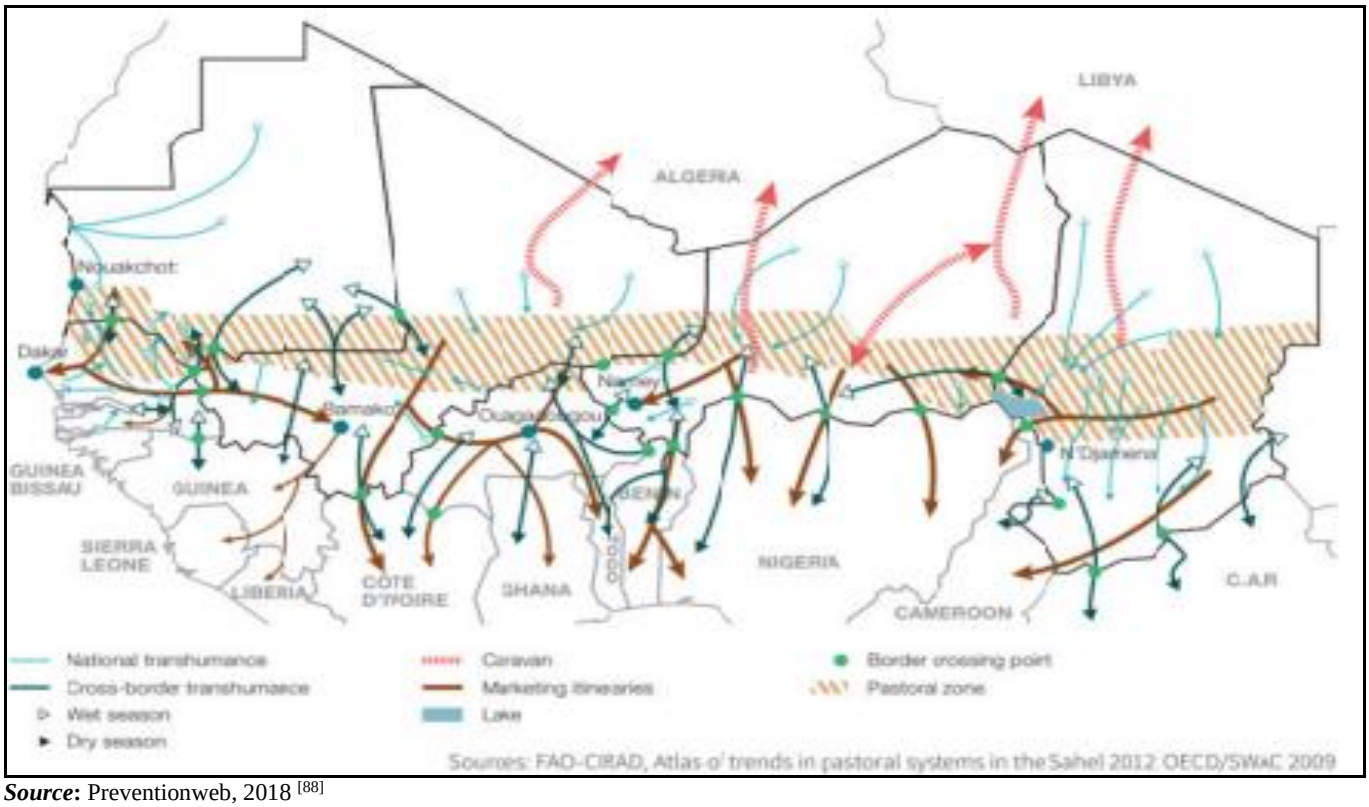
The manifestation of climate anomalies in the Sahel according to Mirzabaev *et al.* (2021) [73] appear in rise of average of temperature between 0.6-0.8 °C, which is slightly higher than the global average increase; increase in the number of warm days/nights and decrease in number of cold days/nights; reduction in cumulative rainfall; severe multiyear droughts in the 1970s and 1980s with a 30% decrease in rainfall which did not return to the pre- 1960s level since the 1980s; lengthening of the dry season with rainfall less frequent, of shorter duration and with greater intensity; and increase in frequency and severity of extreme rainfall events and flooding (Preventionweb. 2018) [88]. Also, the Sahel experienced an increase in surface flow despite relative drop in precipitation, and flooding contributed to soil erosion which caused crop yield and production losses. Table (1) further shows these climatic anomalies in the West Sahel.

Table 1: Climate change in West Sahel countries

	Temperature (increase)	Precipitation [41]	Rainfall pattern	Extreme Events
Burkina Faso[42]	3-4°C (2080-2099)[43] Temperatures will increase in the north at a relatively higher rate than in the south.	Models inconsistent; likely less rainfall;	Increase in climate variability; longer dry periods and drought	Increase in temperature and drought conditions
Chad[44]	1.0-3.4°C by 2060s 1.6-5.4°C by 2090s[45]	-15 mm to +9 mm per month by the 2090s[46]	The amount of rain that falls in 'heavy' rainfall events is projected to increase in southern Chad but decrease in northern Chad; increase in drought	Heat wave durations to increase over all of Chad by 2065 and 2100 with central-northern Chad to experience the largest increases in the length of heat waves
Mali[47]	1.2 to 3.6°C (2060) 1.8 to 5.9°C (2090)[48]	Models inconsistent; likely less rainfall	Erratic rainfall	More frequent and longer droughts
Mauritania[49]	0.5 to 2°C (2040)	Models inconsistent; likely less rainfall in eastern areas	Erratic rainfall	Increase in sea level rise and flooding; coastal erosion; increased saline intrusion, largest cities at risk
Niger[50]	1°-1.6°C between 2020-2049[51] 2.3°-2.6°C between 2020-2049	Models inconsistent	Rainfall is projected to begin later in the rainy season	Increase in drought frequency; Heat wave duration increase by middle and late 21st century
Nigeria (North/ Northeastern)[52]	1.1°-2.5° C by the 2060s 1.4°-4.6° C by the 2090s[53] warming will be greater in the northern part of Nigeria.	Models inconsistent; north and south variability with drier north; [54]	Lower and erratic rainfall in the north	Heat wave duration projected to increase by middle (2046-2065) and late 21st century (2081-2100); largest increase in length of heat waves in northern Nigeria

***Source*:** Preventionweb, 2018 [88]

This climatic scenario has affected pastoralists groups who faced pressures on shear natural resources (Ekpemerechi, 2020) [45], suffered famine (Asseburg, 2013, Kamrany, 1975) [16, 62], and loss of property and livelihoods amenities, acute malnutrition and high mortality-rates (Greene, 1974) [55], and obliged to migrate into humid Sudan-savanna zone (Fricke, 2004) [50], across state borders (Brottem, 2016) [28], and break down of their transhumant routes (Figure 4), and trespassing into farmlands (Afamefuna *et al*. 2021) [6].



***Source*:** Preventionweb, 2018 [88]

Fig 4: Transhumance of nomads in the Sahel

The resource- based conflict is associated with responses to development policies (Signe *et al*. 2022) [104], resource allocation (Benjamin, 2011) [18], unequal development (Hassan, 2010) [59], disparities of wealth distribution derived from scarce resources, farmland expansion (Oyama, 2014) [81], agricultural encroachment that obstructed mobility of herders and livestock (Benjaminsen *et al*. 2012) [19], and States' policies that have resulted in marginalization of pastoral nomads (Asseburg, 2013) [16].

The Sahelian countries are classified by the World Bank (according to Mirzabaev *et al*. 2021) [73], as low income countries; with Low agricultural productivity; high dependency on biomass for energy which has led to massive deforestation, loss of soil nutrients and organic matter. Most of the countries in the region are in the bottom ranks of the Human Development Index (Unemployment and under-employment levels are high, and about 42% of the population is still below the international poverty line (Table 2).

The chances of livelihood of pastoral communities are linked to the complexity of the activities engaged in to insure access to resources (Thébaud *et al*. 2001) [111], however, they are faced with the negative discourse surrounding pastoralism in development policies (Thébaud *et al*. 2001) [111]. This was associated with the emergence of pastoral sedentarization projects in the colonial period regarding pastoralists' destructive impact on the environment (Pedersen *et al*. 2010) [85], and concurrent with colonial requirements which have weakened the transportation routes of regional exchange in products of the Sahel to the markets of the Mediterranean (Cooper, 2018) [39].

Table 2: Key socio-economic characteristics of the West Sahelian countries

Country	Population (2018, in millions)	GDP per capita (2018, current USD)	Poverty headcount ratio at 1.90 USD a day (% of population, various years[2])	Share of agriculture, forestry, and fishing in GDP (%, 2018)	Main exports
Senegal	16	1522	38	17	fish, groundnuts, petroleum products, phosphates, cotton
Mauritania	4	1189	6	26	iron ore, petroleum, gold, copper, gypsum, fish
Mali	19	900	41	39	gold, cotton
Burkina Faso	20	715	38	28	gold, cotton, livestock, sesame
Niger	23	414	45	39	uranium ore, livestock, cowpeas, onions
Nigeria	196	2028	54	21	petroleum and petroleum products, cocoa, timber
Chad	15	728	38	45	petroleum, cattle, cotton, gum arabic
Sudan	42	977	13	32	gold; petroleum and its products; cotton, sesame, livestock
South Sudan	11	1120	43	10	petroleum
Eritrea	4	396	53	14	zinc, copper, precious metal ore
Ethiopia	109	772	24	31	coffee, qat, gold, leather products, livestock, oilseeds

***Source*:** Mirzabaev *et al*. 2021 [73]

The modern states tend to make pastoralism more controllable and taxable through these sedentarization projects (Pedersen *et al*. 2010) [85], contradicting that conflict is one of property rights (van den *et al*. 1995) [115], and the fact that, population movements balance social obligations with vocational or entrepreneurial activities (Rain, 2024) [90], and also that, livestock movements provide employment for many and improve production and productivity of milk production and herds fertility (Timpong-Jones *et al*. 2023) [112].

The increasing pressure on pastoral livelihoods, due to persistent encroachment on pastoral space, have changed the livestock husbandry and produced reduction in labor investment of herding and livestock productivity (Turner *et al*. 2008) [113], in situations where the majority of farm peasants and pastoralists are unable to make the continuing investments required to halt drought-aggravating processes (Andrew, 1984) [113], where the Janjaweed attacks in Darfur (Olsson *et al*. 2013) [79] have made of militia salaries a coping mechanism for survival (Flint, 2009) [49], where the Arab of Darfur have addressed economic fragility for their rebel (Flint, 2009) [49].

Conflicts related to political factors are common in sub-Saharan Africa (Salome, 2011, Benjaminsen, 2016) [99, 20], where the instability of the Sahel is reflected in the global fragile state index (Preventionweb, 2018) [88], substantially influenced by colonialism, neocolonialism, the Cold War, and the collapse of the Soviet Union (Willemse, 2005) [120], and opportunistic behavior of rural actors (Benjaminsen *et al*. 2012) [19], such as the communal violent conflict between non-state groups organized along a shared communal identity relates to state-based violence (Brosché *et al*. 2012) [26], and when armed forces remain the pre-eminent political actor in some countries such as Chad and Mauritania, while sections refuse to accept civilian rule such as in Burkina Faso, Mali and Niger (Elischer, S. 2019) [46]. There are conflicts initiated by net attackers groups who are separate into pro- and anti-political violence based on the groups to which they are close (Walther *et al*. 2016) [119]. They differ in scale and form of governance between countries and at the sub-national level within the same group (Rupesinghe *et al*. 2021) [96]. They all have resulted in accumulated exceptional political instability in the Sahel (Walther, 2017) [118].

The counterinsurgency governance mechanisms failed at fully implementing its principles in the Sahel since it insists on a set of power relations and configurations (Charbonneau, 2021) [36], further damage by international assistance on counterterrorism and corruption through ill-designed development programs (Akinola *et al*. 2023) [9], and the fragility of states which created platform for non-state armed actors to penetrate (Nathaniel, 2020) [76], such as the pro-government militias in Darfur to become key political players in the Sudanese state (Ahmed, 2022) [8], led to massive displacement of populations (Olsson *et al*. 2013) [79], ethnically-motivated violence (Tar, 2005) [106].

Conflict in eastern Chad, north-eastern Central African Republic, and Darfur are actually form one regional conflict system rather than three distinct conflicts (Giroux *et al*. 2009) [53]. It caused regional crises centered on their borders (Lee *et al*. 2010) [66], when the Sudanese government is using the violence in Darfur to wage proxy wars in Chad and the Central African Republic (Jennifer, 2010) [61], where the effectiveness of the Chadian forces stems from refined and modified nomad and warlord structures (Tchie, 2023) [108], and where intra-regional discrepancies have been largely obscured by characterizations of a regional and trans-national crisis (Dowd *et al*. 2013) [43], in a situation of

disability of regional countries to control their Saharan reaches (Harmon, S. 2015) [58]. This enabled France to conduct military operations since 2013 which were viewed by African Sahelian public opinions as a deeply political issue over their country's sovereignty (Guichaoua, 2020) [57].

The educated elites of the Arab Sudanese have founded for political Arab nationalism and the Sudanese nation-state (Willemse, 2005) [120]. The systematic marginalization and ineffective administration have created pockets of ungoverned territories that were exploited by armed groups (Nyadera *et al*. 2019) [78], such as the Janjaweed militia which was armed the by the Sudanese Arm Forces to fight rebellion in Darfur (Tar, 2005) [106], and to absorb defectors from rebel constituencies into their ranks when incumbents by militias (Voller, 2023) [117], In addition, ethnicity was exploited by political or religious elites to reinforce the idea of diversity to the point to become a conflict (Willemse, 2005) [120], fueled by issues of political marginalization (Benjamin, 2011) [18].

The sociological factor influences conflict in the Sahel (Salome, 2011) [99], where the livelihoods of pastoral communities are linked to the nature of conflicts and co-operation between ethnic groups (Thébaud *et al*. 2001) [111].

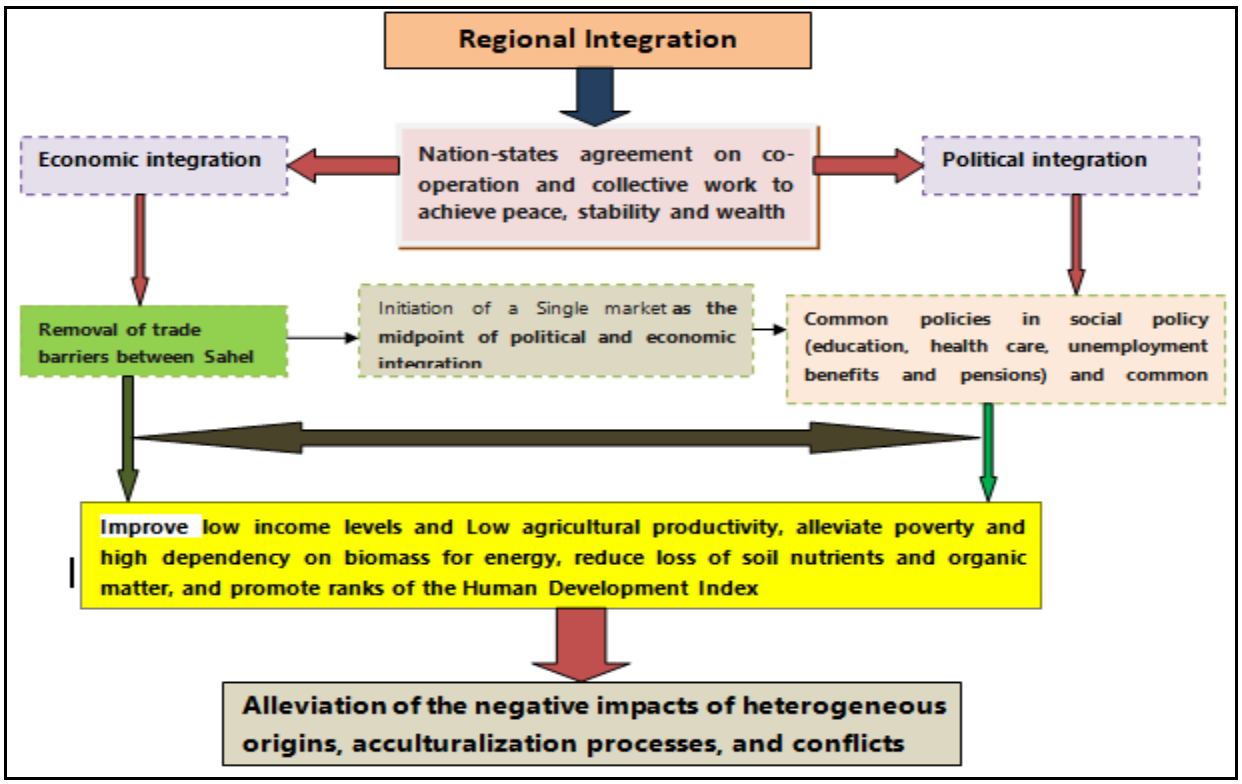
Ethnic defection and pro-government militias are two recurring features of ethnic conflicts there (Elischer, S. 2019) [46], and local conflicts have been interlinked with the aims and interests of governments and opposing groups, army factions and militant organizations (Grawert, 2008) [54], such as the situation in Darfur where conflicting ethnic populations lived in relative proximity (Scott, 2006) [101], and where the Arab of Darfur addressed social neglect for their rebel (Flint, 2009) [49].

Tribalism hides behind a secular façade or in a religious guise (Zain, 1996) [24], and is maintained despite development and modernity (Musa, 2018) [75]. The social cohesion and resilience is expressed geographically through asset-spreading and complex social networks (Rain, 2024) [90].

Population growth and migration are primarily responses to relocation of populations previously displaced by colonial labor migrations and the re-integration of herding and farming production systems. The mobility of some pastoralists groups, such as Fulani's, are related to extensive social networks and social ties (de Bruijn, 2016) [40], while the Kanemi polity often has been attributed to the sole initiative of Saharan herders (Conte, 1991) [38], such as negotiations between Hausa elders and pastoral Tuareg to avoid direct confrontations (Oyama, 2014) [81], in situation of festering culture of impunity is responsible for the spiraling violence between farmers and pastoralists (Emmanuel *et al*. 2021) [47].

Regional integration in the Sahel

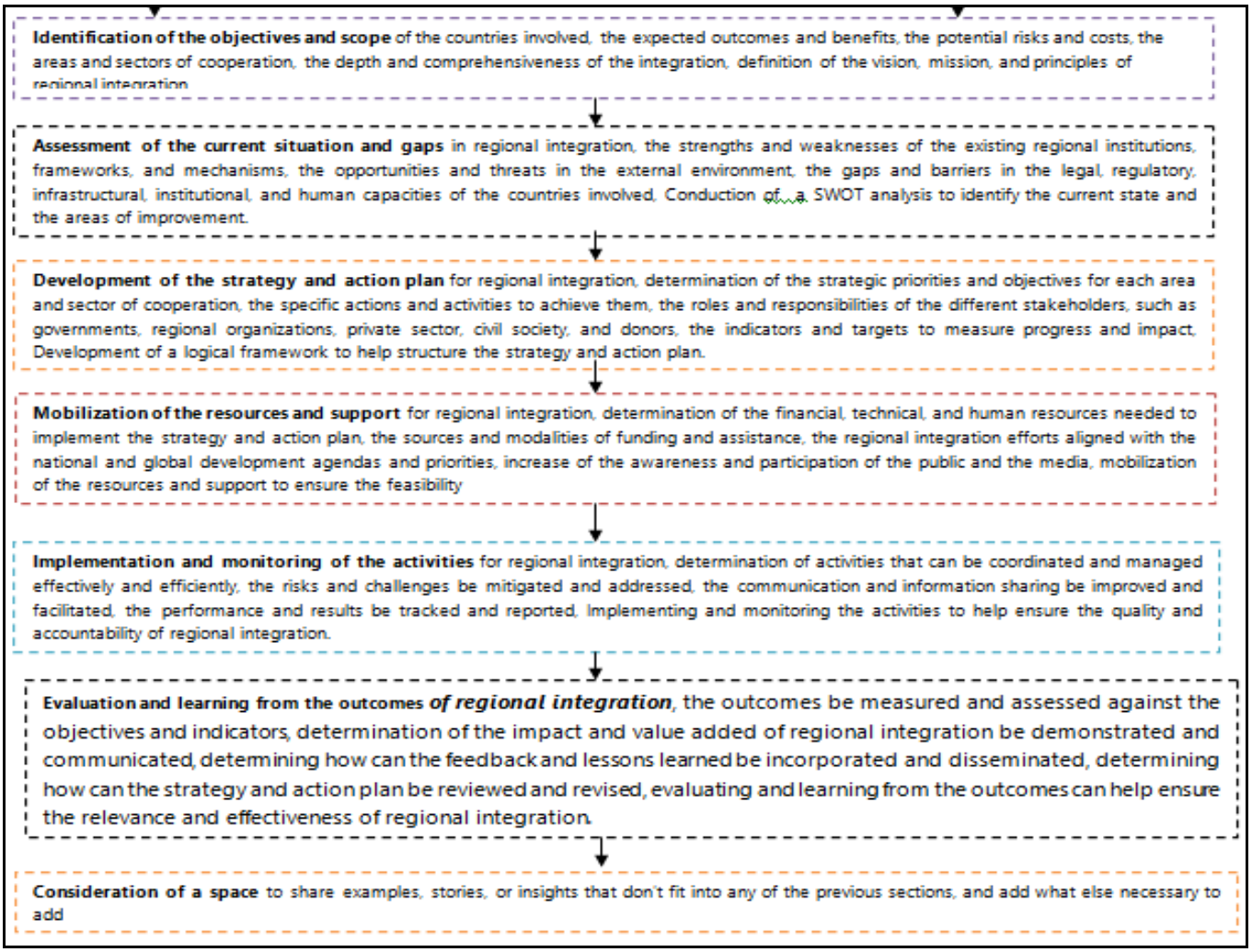
The figures of (1); (2); (3) and (4); provided information on the geographic extension of the Sahel; types of livelihood zones; mobility in the pastoral zone across national transhumance and a cross-border transhumance; while table (2) provided the key socio-economic characteristics of the West Sahelian countries. This information could build for regional integration in the Sahel (Figure 5), objecting to improve Low agricultural productivity, alleviate poverty and reduce low income level, high dependency on biomass for energy, reduce loss of soil nutrients and organic matter, and promote ranks of the Human Development Index. These prospects will help to curb the negative repercussions of heterogeneous origins, acculturalization processes, and conflicts.



***Source*:** The author (2024)

Fig 5: Prospects for regional integration in the Sahel

The employment of this information into regional integration prospects in the Sahel requires six sequential steps (Figure 6). They are respectively; identification of the objectives and scope; assessment of the current situation and gaps; development of the strategy and action plan; mobilization of the resources and support; implementation and monitoring of the activities; evaluation and learning from the outcomes of regional integration, besides a space for any future additions.



***Source*:** The author (2024), based on https://www.linkedin.com/advice.

Fig 6: Sequential steps of implementation of prospects of regional integration in the Sahel

The implementation of regional integration prospects could achieve good results to the Sahel, to overcome its current and future problems and challenges. Here, the experiences of arid and semi arid environments could be beneficial.

The prospects of integrated adaptation measures to climate change enhanced the resilience of small and marginalized farming communities in arid India (Singh *et al*. 2021) [105], and the oasification prospect can combat desertification and control land degradation and enhance ecological restoration and land rehabilitation (Xue *et al*. 2019) [122], while quantification of integrated impact assessment of climate change for adaptation approaches can improve productivity at a regional level and, improving food security at a national level (Ahmad *et al*. 2023) [7]. The valuation approach can stimulate forest conservation activities to prevent degradation and save forest ecosystem in arid lands (Majdalawi *et al*. 2015) [68], and also, ecological security assessments can provide a basis for the construction of regional ecological security patterns (Pan, *et al*. 2022) [83], where the employment of remote sensing data can work for regional scale monitoring to achieve high-precision drought monitoring at that scale (Zhang *et al*. 2023) [32].

These prospects could be further coupled with growing of drought-tolerant plants (Abdelhak *et al*. 2021) [1], to restore natural grazing service which can be a sustainable approach to simultaneously improve food security and water sustainability in arid landscapes (Abdullah *et al*. 2022) [3], with protection of forests through the plantation and firefighting with the use of geographic information systems (Abdelhak *et al*. 2021) [1], and land suitability analysis (LSA) to identify appropriate and sustainable land use strategies to enhance the land's potential (Anusha *et al*. 2023) [14], and appropriate indicators of land-cover modifications in this arid region (Diouf *et al*. 2001) [42], and differentiated policy of rangeland management and animal husbandry particularly as they consider social and ecological contexts (Easdale *et al*. 2012) [44]. The prospect of integrated farming systems enhanced production, income

and livelihood; minimizing risk associated with farming in arid and drier semi-arid regions (Rathore, *et al*. 2019) [9], where a strong connection exists between rural livelihoods and sustainable land and ecosystem management (Bizikova *et al*. 2015) [21].

The prospect of integrated stream networks in arid regions require appropriate models (PilbrimmIL *et al*. 1988) [87], such as the hydro-economic models that can integrate ecological and social aspects in water management programs to secure minimum stream flows and implementing sustainable irrigation policies (Blanco-Gutiérrez *et al*. 2013) [22], where watersheds, when considered as dynamic systems, could work as functional units for planning and management strategies in arid lands (Alvandi *et al*. 2021) [11]. This could become more vital when water harvesting techniques were identified in suitable areas for their implementation (Grum *et al*. 2016) [56], as it was confirmed that they improved sorghum yields, for example, in semi-arid areas of Zimbabwe (Kugedera *et al*. 2022) [65], and dealt with problems of water scarcity and supply in some other semi-arid region (Cirilo *et al*. 2017) [37], which could become more impacting by interdisciplinary and environment-oriented education and training programs (Qian *et al*. 2003) [89].

Conclusions

This research tackled some of the important problems and challenges in the Sahel that are threatening its present and future stability and development. The contribution of the proposed regional integration prospects by this research might be limited, unless worldwide perspectives promote the view to the Sahel as a region requires sustainable developmental interventions and not external political interventions. This is essentially required to achieve the Sahel regional stability so as to redress its international threats since the Sahel became a corridor for illegal international migration and a source for warrior mercenaries.

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