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Security Implications of Climate Change in the Sahel Region: Policy considerations

Philipp Heinrigs

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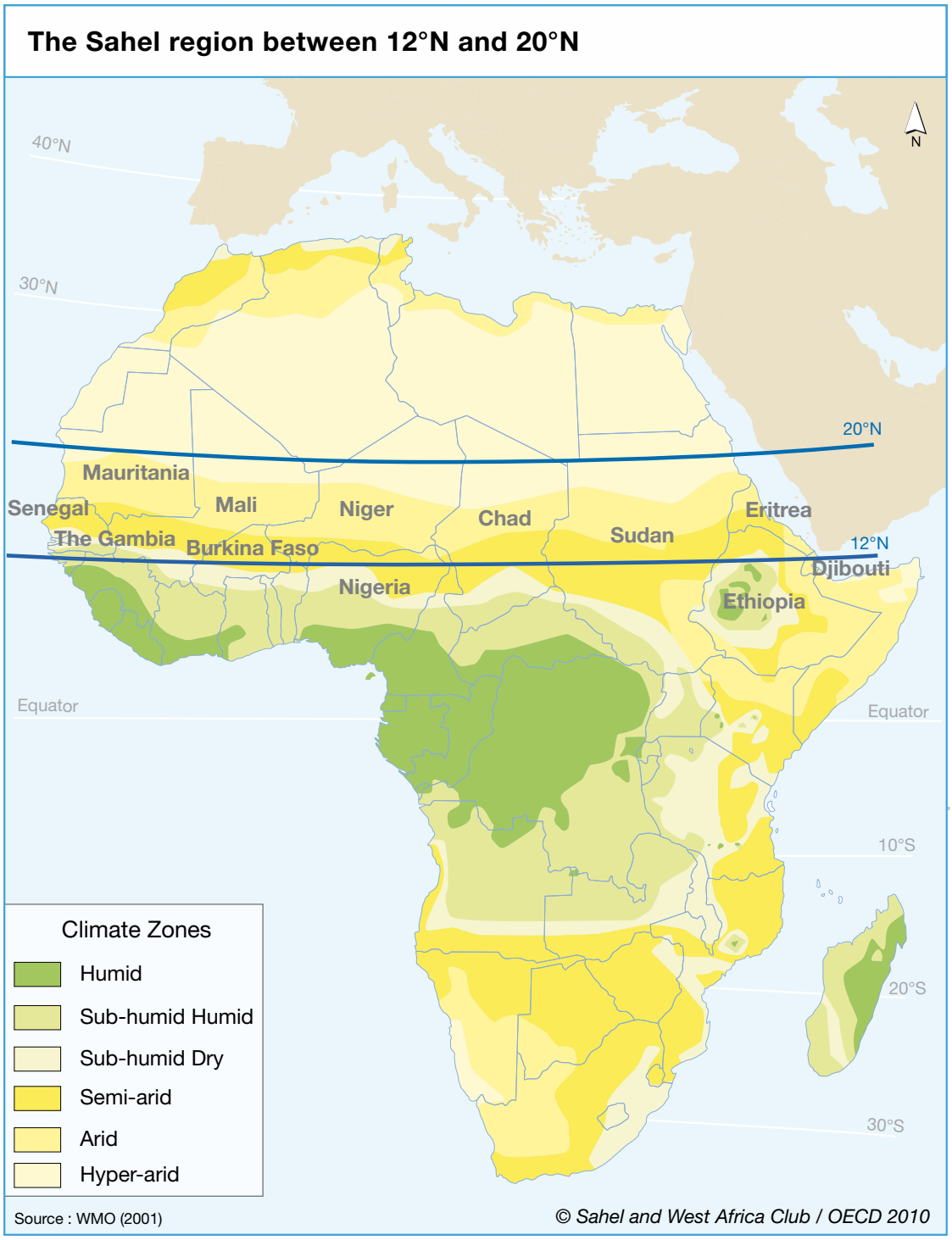


Figure 1

The Sahel region between 12°N and 20°N

We defined the Sahel as the area of Africa lying between 12°N and 20°N. This area shares two climatic characteristics: one rainy season per year and August as the month of highest precipitation.

The area covers all or part of 12 countries from the Atlantic coast to the Red Sea: Mauritania, Senegal, The Gambia, Mali, Burkina Faso, Niger, Nigeria, Chad, Sudan, Ethiopia, Eritrea and Djibouti

Executive Summary

Climate change and its impact have dominated international policy agendas and public attention in recent times. The focus on the security implications of climate change has helped to bring climate change to the realm of international policymaking by placing it as a key threat to state and global stability. Recent events in the Sahel, drawing attention to its role in the development of international terrorism and illegal trafficking and its particular vulnerability, place this region of Africa at the centre of global security concerns. The project 'Security implications of climate change in the Sahel region' aimed to increase understanding of the linkages and impacts of climate change and security and on how climate change could contribute to insecurity in the future. This paper summarises and brings together the conclusions of the analyses carried out and identifies key issues for policy makers, specific interest for future work and gaps and uncertainties in existing research.

The climate of the Sahel has always been characterised by its extreme seasonal and decadal variability of rainfall. Rainfall variability in this region is likely to be driven by complex interactions between several processes and no process in isolation appears able to explain all the observed variability. Despite the large effort put into establishing the cause of the severe and long lasting drought period at the end of the 20th century, a full consensus on its origin has not been reached in the scientific community. These uncertainties as well as the large variability make climate projections for the Sahel particularly challenging and lead to significant disagreement between climate model projections. This is particularly true for precipitation where models disagree even on the direction of change (greening vs. drying). Given these uncertainties and awaiting more robust models, policies should focus on management of and lessen the impact of climate variability. The possible options range from improving seasonal forecasting, to investing in increasing observational capacity.

Our analysis of security events in the Sahel highlights the absence of a generaliseable and direct impact of climate change on security. It also found no deterministic relation between environment and security dynamics. Environmental variables are of secondary importance at best compared to political, historical and economic variables. We used a broad definition for security including 'human security' issues such as food crises and low-scale localised tensions, as well as more traditional concepts of security such as violent conflict and state security. This approach appears more instructive and constructive for the following reasons: first, it covers a more relevant range of potential security implications of climate change and second, it highlights the need to focus the policy debate on developmental, environmental and economic aspects. In this context, livelihoods and food security appear to be the most prominent transmission mechanisms between climate variables and security.

The transmission from climate variables to security via livelihoods and food security are based on two particular characteristics. First, the impact of climate and climate variability (in particular rainfall) on livelihoods and food security is direct and second, both are sensitive to sudden events. The great vulnerability of the Sahelian population to climate change is linked to its high dependence on agricultural activities and absence of alternative income earning activities. In the Sahel agricultural production is predominantly rainfed and therefore particularly

sensitive to climate variability. Addressing these impacts require integrating the long-term features of climate change in national and regional development strategies. As concerns agricultural production opportunities to develop portfolios of climate resilient measures at different costs and time scales are ample.

Based on the analyses following policy considerations have been derived:

- Manage uncertainty: develop strategies that allow for better management of and lessen the impact of climate variability, options range from reducing certain forms of uncertainties (improved seasonal and long-term forecasting) to smoothing impacts (improved water management, more efficient management of food insecurity).
- Promote open and constructive dialogue: dealing with climate change requires multilateral regulatory mechanisms. Taking into account national concerns and policy choices – including those in the Sahel – is key to developing effective multilateralism. Bilateral and multilateral dialogue between Sahelian and OECD countries as well as at promoting dialogue at the level of regional African institutions should figure among priorities. International partners should support efforts towards the formulation of regional agendas and climate change policy responses, a cornerstone for enhanced coordination and effectiveness of activities. Propose a dialogue process on integrating environmental variables into the monitoring and analysis of early warning mechanisms.
- Integrate climate change in development strategies: climate change impacts are a development concern and investment in development is the best instrument for promoting peace and security. Development strategies dealing sustainably with vulnerability to climate change should be based on an analysis of interactions between all vectors of change: climate change, population dynamics, migration, trade and economic development.

1 Introduction

1.1 Origin and context

Climate change and its impact have dominated international policy agendas and public attention in recent times, reaching a peak at the United Nations COP15 Conference in Copenhagen, December 2009. Climate has always directly influenced the life of human beings. Over the past decade, however, a new focus on the possible impacts of climate change in all its myriad forms and aspects has emerged, including security implications.

Although, theories of scarcity-induced insecurity have been around for centuries, technological innovations, human ingenuity and adaptation, and growth in international trade over the past decades appeared to have overcome many traditional scarcities. Recently, however, these have resurfaced amongst other trends, with the effects of climate change being seen to be posing new threats to security and development. Given the lack of research on regional level impacts the French and British governments expressed the need to deepen understanding of what security implications of climate change could be in the Sahel. The Sahel is a region that is considered particularly vulnerable[1] and that is gaining increasing attention due to security, energy and broader geopolitical interests, underlined by the recent statements of the Foreign Affairs Council of the European Union.[2] As the International Panel on Climate Change states in its fourth Assessment Report, "…[Africa] is one of the most vulnerable continents to climate change and climate variability, a situation aggravated by the interaction of 'multiple stresses', occurring at various levels, and low adaptive capacity." (IPCC AR4, 2007).

The project 'Security implications of climate change in the Sahel region', co-ordinated by the Sahel and West Africa Club Secretariat/OECD, aimed to increase understanding on the linkages between climate change and security in the Sahel and on how climate change could contribute to insecurity. Given the complex processes that influence insecurity, a range of thematic analyses in the fields of climate science, geography, history, socio-economics and security were carried-out over the course of the project. In this paper we summarise and bring together the conclusions of these analyses and identify key issues for policy makers, specific interest for future work and gaps and uncertainties in existing research. For an in-depth analysis of the arguments presented in this paper we recommend to refer to the individual papers that have been produced over the course of the project:

- "Sahelian climate: past, current, projections",
- "A review of past security events in the Sahel 1967 – 2007",
- Case studies: "Agro-pastoral conflict in southwest Burkina Faso"; "Senegal-Mauritania conflict: Settlement dynamics and competition over land and resources"; "The Afar rebellion: geopolitical motivations and control over land and resources",
- "Security and environmental variables: The debate and an analysis of links in the Sahel",
- "Impact of rainfall variability on security in the Sahel",
- Analysis and mapping of key socio-economic trends and environmental variables.

1 The IPCC defines vulnerability as a function of the character, magnitude and rate of climate change and the variation to which a system is exposed, its sensitivity and its adaptive capacity.
2 Council declaration 26 July 2010 and European Council Conclusions on the Sahel, 26 October 2010.

1.2 Approach and Methodology

We looked at existing research in the fields of climate science, human and environmental geography, socio-economics and security to provide a detailed overview of past trends and main characteristics. This work was then complemented with multidisciplinary regional analyses to examine the link between climate and security variables in the Sahel and to shed light on the existing evidence and current limitations of our understanding. A working group of specialised technical institutions from Africa and OECD countries has been set up to provide detailed analysis and data on key features and feedback on outputs. These institutions cover a wide span of expertise in climate science, environment, food production and security. These are: the African Centre of Meteorological Application for Development (ACMAD); the African Union, Peace and Security Department; BRGM-Geoscience for a sustainable Earth; the Permanent Inter-State Committee on Drought Control in the Sahel (CILSS) and its Agro-Hydro-Meteorological Regional Centre (AGRHYMET); the Commission of the Economic Community of West African States (ECOWAS); the Food and Agricultural Organisation of the United Nations (FAO); Famine Early Warning Systems Network (FEWS NET); Intergovernmental Authority on Development (IGAD) and its Climate Prediction and Applications Centre (ICPAC) and Conflict Early Warning and Response Mechanism (CEWARN). Technical workshops were organised in Dakar, Senegal (November 2009) and during the COP 15 United Nations Conference on Climate Change in Copenhagen, Denmark (December 2009) bringing together a larger group of experts. In addition, over the course of the project a series of meetings and interviews have been organised to enrich and orient analyses and to collect data, notably: AGRHYMET (Niamey), CEWARN (Nairobi), FAO (Rome), FEWSNET (Washington and Niamey), ICPAC (Nairobi). The project design allowed for an iterative process giving the opportunity throughout to revisit parameters and questions posed by the analysis.

1.3 Analytical components

The starting point for the analyses was to define the underlying assumptions about climate change in the region. The Sahel is particularly challenging for climate scientists, leading to a high level of uncertainty on expected climate change impacts. Our partner, the UK Met Office Hadley Centre, using recent research on climate and climate variability and new data, provided an assessment of key drivers of climate and climate variability in the Sahel. The analysis included an evaluation of main characteristics of current climate, seasonal, annual and decadal variability of climate, model performance and uncertainty. Also, the Hadley Centre provided scientific advice on the strength and weaknesses of the information and how it can and should be interpreted, notably in relation to the other analyses carried-out. (SICCS, "Sahelian climate: past, current, projections"; UK Met Office Hadley Centre 2010). The two main results of the climate analysis are: first, the key characteristic of Sahel climate is the extreme seasonal and decadal variability of rainfall and second, significant disagreement between climate model projections for the Sahel (particularly for precipitation), with some predicting a greener Sahel and others a drier one. Both imply a significant degree of uncertainty.

We also carried-out a historical analysis of 23 security events that took place over the last four decades. The definition used for security included all aspects that impact global and state stability. This broad definition enabled the analysis to look beyond solely violent

conflict, and consider 'human security'[3] issues such as food crises and low-scale localised tensions (SICCS "A review of past security events in the Sahel 1967 – 2007", 2010, SWAC/ OECD). Selection of events was based on geographic (affecting at least one country of the coverage are) and temporal (having taken place between 1969 and 2007) criteria. The analysis involved the disaggregation of security events identifying underlying, triggering and aggravating factors, notably focusing on the role played by environmental factors that are dependent on climate such as desertification, soil degradation and scarcities. In addition, three case studies were conducted focusing on livelihood issues ("Agro-pastoral conflict in southwest Burkina Faso"; "Senegal-Mauritania conflict: Settlement dynamics and competition over land and resources"; "The Afar rebellion: geopolitical motivations and control over land and resources" 2010, SICCS, SWAC/ OECD).

Next, the results from the historical analysis were compared to the theoretical literature on environmental security. The objective was to identify if the hypothesised transmission mechanisms in the scientific literature are confirmed by the historical analysis in the Sahel. The study "Security and environmental variables: The debate and an analysis of links in the Sahel" (SICCS, SWAC/OECD 2010) highlights the complexity of variables intervening in conflict dynamics and that environmental variables only play a secondary role at best, arguing in favour of interpreting climate variables without deterministic relation in insecurity dynamics. These results were confirmed by the econometric model we specified estimating the impact of rainfall variability on security. Based on data provided by the Met Office Hadley Centre, monthly precipitation observations 1901 – 2006, and the historical security analysis we calculated sensitivities of transmission variables, as well as the role of socio-economic variables in explaining vulnerabilities (SICCS, "Impact of rainfall variability on security in the Sahel"; SWAC/OECD 2009). The results underline the importance of socio-economic variables in determining security vulnerabilities.

This questions a move positing climate change as a key state security concern rather than human security. The analyses showed that using the concept of human security is both more instructive and constructive for the following reasons: first, it covers a more relevant range of potential security implications of climate change in the Sahel and second, it highlights the need to refocus the policy debate on developmental, environmental and economic aspects and thereby allowing for the design of policy responses that reduce potential impacts and vulnerability.

The discussions at the technical workshop in Dakar confirmed this analysis, with the conclusion that an analysis of climate change impacts on human security aiming to define concrete policy responses should focus on food security and livelihoods. The ensuing analyses confirmed that livelihoods and food security appear to be the most prominent transmission mechanisms between climate variables and human security. First, the impact of climate and climate variability (in particular rainfall) on livelihoods and food security is direct and second, both are sensitive to sudden events, such as droughts and floods, and thereby aggravating impacts. Climate projections indicate that extreme events will become more frequent in the future.

Our analysis and mapping of socio-economic and environmental variables such as population and demography, natural environment and resources, economy and livelihoods, agriculture and food security have provided the contextual setting of main trends and characteristics of the Sahel. Integrating the potential impacts of climate change on food

3 Human security is an emerging paradigm for understanding global vulnerabilities. The traditional notion of national security is challenged by arguing that the proper referent for security should be the individual rather than the state. Human security includes aspects like; economic security, political security, food security, environmental security and health security.

security and livelihoods requires an approach within comprehensive development policies and the 'climate proofing' of strategies.

This paper synthesises the analyses carried-out and draws key policy considerations for policy makers in terms of policy responses, dialogue and future work. Chapter 2, based on the analysis of the UK Met Office Hadley Centre presents the key characteristics of the Sahel climate, climate 'hotspots' based on an analysis of the ten worst droughts of the period 1970 – 2007 and climate change projections and its uncertainties. Chapter 3, summarises results from the security analysis. Chapter 4, highlights aspect of food security and livelihoods in the Sahel that determine vulnerability and the need for integrating human security impacts of climate change in development policies. Chapter 5, provides a range of policy responses that emerge from the analyses.

2 The climate of the Sahel

The analysis of the Sahelian climate, long term trends, key characteristics and processes driving the climate and model projections presents two key results[4]. First, the main characteristic of Sahel climate is the extreme seasonal and decadal variability of rainfall and second, significant disagreement between climate model projections for the Sahel (particularly for precipitation), with some predicting a greener Sahel and others a drier one. Three climate hotspots are identified which are particularly sensitive in terms of exposure to rainfall variability.

2.1 Climate variability: the key feature of Sahelian climate

Few other places share the same climate variability that characterises this region, even when compared on very different time-scales. In the last century the Sahel experienced a slight increase in precipitation around the middle of the century which was followed by an unprecedented and severe long-lasting drought from the late 1960s to the late 1980s. In more recent years there has been a partial recovery. Despite the large effort put into establishing the cause of observed trends, a full consensus on the origin of the drought period has not been reached in the scientific community. Sahel rainfall variability is likely to be driven by complex interactions between several processes and no process in isolation appears able to explain all the observed variability.

Whilst there is no evidence green-house gasses played a role in causing or exacerbating the drought period[5], some research[6] supports the idea that a significant part of the recent drying over the region can be attributed to the differential in aerosol loading[7] between northern and southern hemisphere.

Modelling studies have stressed the important role of sea surface temperature (SST) in regulating precipitation in the Sahel. More than a third of the observed rainfall variability can be explained by the variability in the ocean surface's temperature. Rainfall in Sahel appears to be negatively correlated with the Tropical Indo-Pacific SST and positively correlated with the Atlantic meridian SST gradient.

Such a correlation can be used to provide skilful seasonal and decadal climate predictions, although whether or not the same physical processes will be controlling the rainfall variability over a longer time-scale is still debated. Some authors believe that coupled processes driving the inter-annual rainfall variability are unable to provide a useful guide on centennial changes suggesting that another mechanism may be operating on those time-scales.[8] At least two other processes are likely to influence the rainfall variability in the regions: land surface feedback and aerosol.

4 This section is based on UK Met Office Hadley Centre, 2010: "Sahelian climate: past, current, projections"; study carried out with the framework of the SICCS project.
5 Christensen, et al 2007, IPCC, Contribution of working group I to the Fourth Assessment Report.
6 Baines and Folland, 2007,
7 Aerosol loading refers to the presence of small particles (liquid or solid) in the air. A feature dominated by human emissions.
8 Biasutti, M. and Giannini, A. 2006

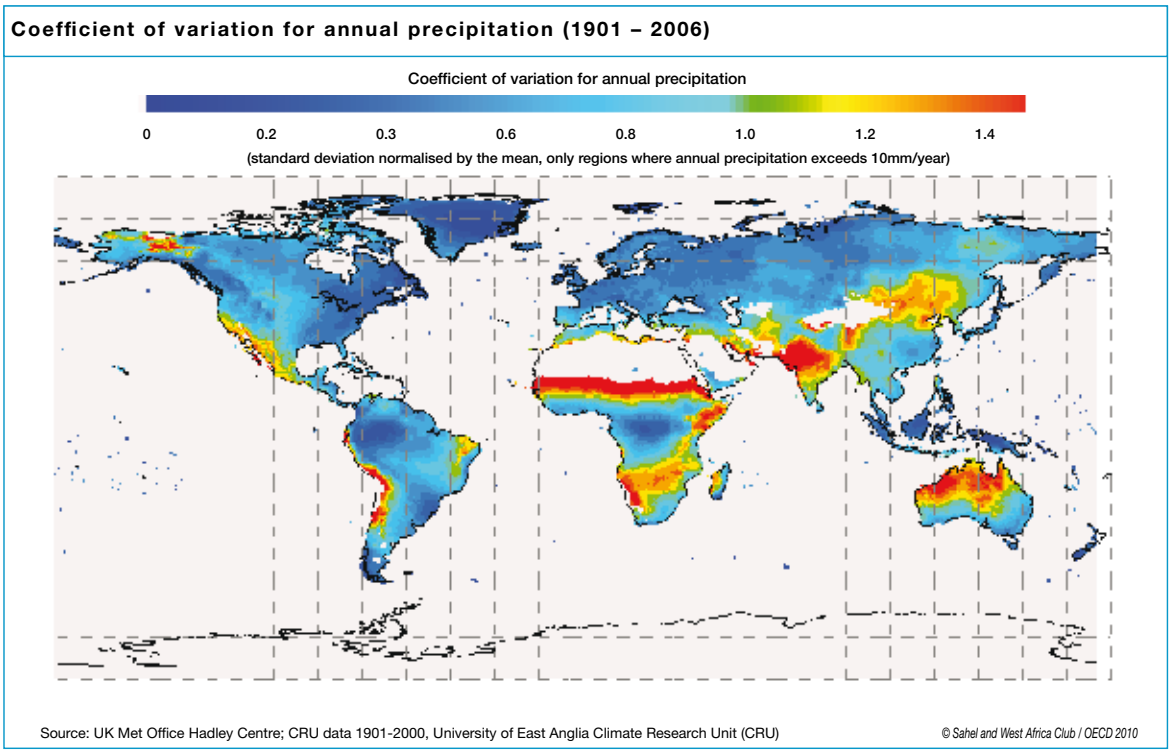


Figure 2

Coefficient of variation for annual precipitation (1901 – 2006)

2.2 No agreement among climate model projections

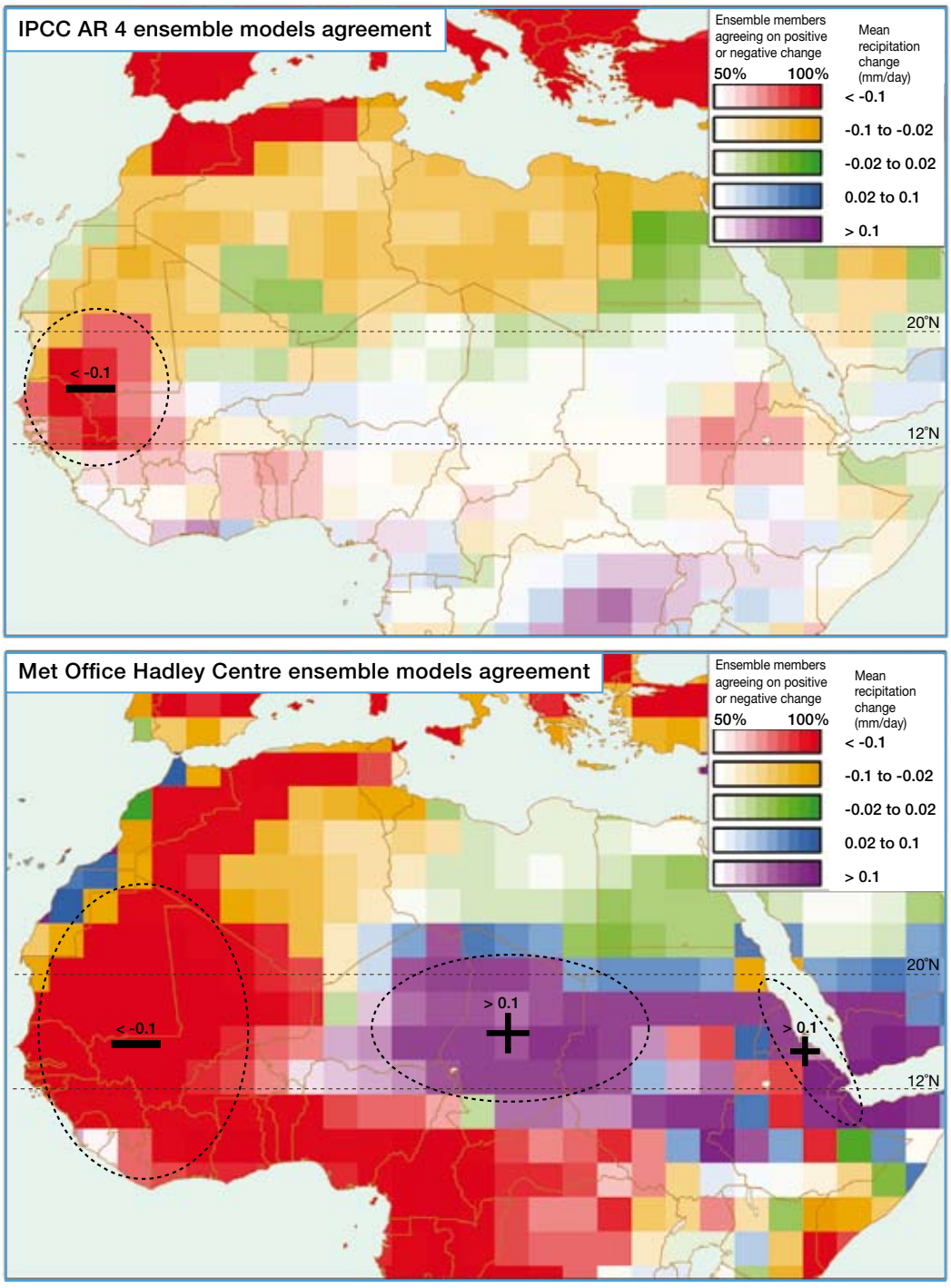
Climate projections over the Sahel are particularly challenging for two reasons. On the one hand, the large climate variability observed over the 20th century makes it difficult to identify a sign that can be attributed to climate change. On the other hand, climate model projections are in significant disagreement over this region. This is particularly true for precipitation where models disagree even on the direction of change (greening vs. drying, Figure 3). Also, there is no consensus between models on whether extremely dry or extremely wet seasons are likely to become more common. However, the thermodynamic argument suggests a general increase in the intensity of high-rainfall events.

Projections for temperature tend to be more uniform among climate models and suggest a noticeable increase, especially for summer (June, July, August, September). This warming is likely to be higher than the global average, with temperature increasing between 3 and 4 degrees by the end of the century compared with the last twenty years of the 20th century. In geographical terms, the greatest warming (~4 degrees) occurs over land and in particular in the western side of the Sahel. Over the coast and close to the southern edge of the region the increases are expected to be smaller but still substantial (~3 degrees). In addition, extremely hot seasons are likely to become more frequent in the future.

Figure 3 illustrates the agreement between IPCC AR4 climate model projections for summer precipitation (June, July, August). This shows that the coastal countries of West Sahel are likely to see a reduction in precipitation, while the Ethiopian highlands are likely to receive more rain. However, no clear signal can be detected over a large area of the Sahel. The UK Met Office ensemble depicts a similar picture over West Africa while predicting an increase in precipitation in both the central and eastern-most Sahel region, even during the summer months.

Climate model projection 2041– 2070: agreement vs. disagreement

These maps illustrate agreement of model projections (more than 50% of models in ensemble) for difference (mm/day) in summer (JJA) precipitation between 2041–2070 and 1960–1990 across IPCC Assessement Report 4 and Met Office Hadley Centre ensembles. The colour indicates the strength of the signal (variation in precipitation), while the colour-intensity indicates the consistency across the ensemble (agreement). For example, deep red colours indicated where close to 100% of models agree on a precipitation reduction of more than 0.1 mm/day, dark green indicates where nearly 100% of models agree on no change. White colours indicate areas where models disagree on the direction of change (50% of models indicate increase in precepitation and 50% decrease).



Source: UK Met Office Hadley Centre, 2010

Figure 3

Climate model projections 2041 – 2070: agreement vs. disagreement

2.3 Climate hotspots

A sensitivity analysis based on historical observations has been carried out to identify regions where in the past droughts have caused the largest difference in precipitation between drought and normal years. Here the average precipitation for the month of August over the period 1901 – 2000 can be compared with the same field during drought periods.

The results (Figure 4) suggest the presence of at least three particularly sensitive regions. One lies along the western-most part of the region (Senegal and Mauritania), the second stretches between Mali and Niger and the third sits along the eastern fringe of Ethiopia and extends northward up to Sudan. For some of these areas, such as eastern Sudan/Eritrea, the average reduction of rainfall during the 10 most severe droughts of the 20th century has reached almost 100%. Of the 10 worst droughts since 1970, five occurred simultaneously in eastern and western Sahel (arbitrarily separated at 20 E).[9]

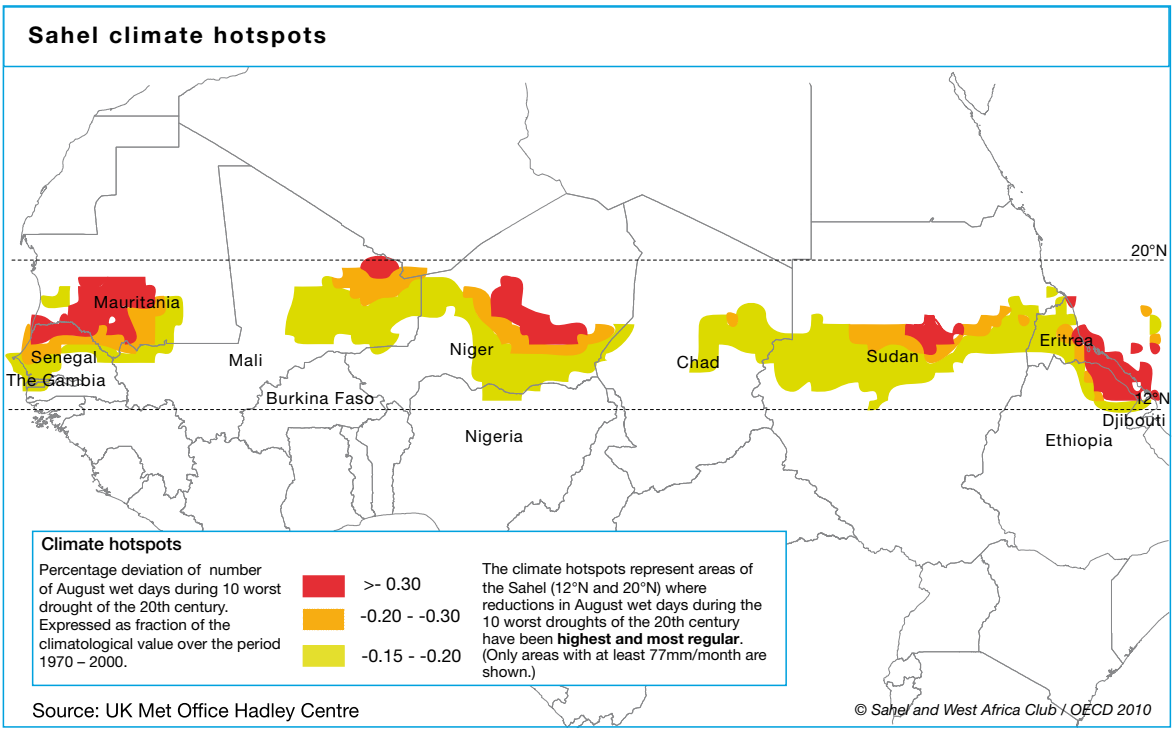


Figure 4

Sahel climate hotspots

9 1984, 1972, 1986, 1990, 1976. The sensitivity analysis has been conducted for the two sub-regions separately and rejoined at a later stage.

3 Understanding the link between security and climate change in the Sahel

"Security and environmental variables: The debate and an analysis of links in the Sahel". The study looked at the evolution of the security concept from a purely military interpretation towards the human security concept integrating aspects such as environmental variables influenced by climate change. It then carried out a review of the environmental security literature and tried to examine the historical analysis ("A review of past security events in the Sahel 1967 – 2007") and case studies in this framework to analysis the link between security and climate change

3.1 Linking security and climate change: the political approach

The scale of the attention on the 'security – climate change debate' in recent years is visible in various policy reports – national and international alike. These reports have brought climate change to the realm of international policymaking by placing it as a key threat to state and global stability.

A widely cited example in the European context is the 2008 'Solana report'[10]. This report identifies and discusses seven climate change-related threats[11] to state and global security, with the proviso that they may not necessarily degenerate into armed conflict. Solana defines climate change as a threat multiplier which "…exacerbates existing trends, tensions and instabilities" (Solana 2008, p2.). These threats and "forms of conflict" cover all countries, however Africa is identified as "… one of the continents most vulnerable to climate change because of multiple stresses and low adaptive capacity," and is therefore likely to cause growing international insecurity that "...directly affects European interest." The mechanisms proposed in various studies[12] to explain the impact of climate change on security involve three parameters: rising sea-level, higher temperatures and more frequent and intense extreme events (e.g. droughts, floods, storms). In many cases, environmental variables that depend on climate change, such as desertification and dwindling water reserves, are also cited as factors influencing threats. However, the Solana report, and indeed many other policy papers[13], do not present or refer to theoretical and/or empirical studies used as evidence for the expressed relationship between climate change and security. The proposed relations between identified threats and security are debatable, albeit presenting preoccupations of governments that need to be taken into account.

10 Solana, Javier, 2008, "Climate Change and International Security" document prepared by the High Representative and the European Commission for the European Council.

11 Conflict over resources; economic damage and risk to coastal cities and critical infrastructure; loss of territory and border disputes; environmentally-induced migration; situations of fragility and radicalisation; tensions over enegry supply; pressure on international governance.

12 Buhaug Halvard, Gleditsch Nils Petter, Theisen Ole Magnus, 2008, "Implication of climate change for armed conflict", The Social Development Department, the World Bank Group

13 EU, 2003, "A Secure Europe in a better world – The European Security Strategy"; UN Economic Commission for Africa and African Union Commission, 2010, "Climate change and development in Africa"; UN Security Council Meeting 5663, April 2007, "Impact of climate change on peace and security".

3.2 The missing impact: theory and evidence

It is easy to lose one's way in the raft of studies positing links between climate change and security. The variety of both their approaches and the chains of causation hypothesised easily illustrate just how difficult and ambiguous the exercise is.

Most theorists argue that climate change may increase the risk of violent conflict only under certain conditions and in interaction with several socio-political factors14. The complex dynamics involved in climate change and security and the nature of their relations – causal, linked, general, dynamic, etc. – render projections and scenarios very complicated. In addition, the threat to security from climate change depends strongly on the specificities of each country and other contextual factors. The specific relations among those variables create as many potential crisis catalysts as there are different climate and sociopolitical environments.

As previously mentioned, we defined security to include all aspects that impact global and state stability. This enabled the analysis to look beyond solely violent conflict and state security, and consider 'human security'[15] issues such as food crises and low-scale localised tensions, rather than state security. Using the concept of human security is both more instructive and constructive for the following reasons: first, it covers a more relevant range of potential security implications of climate change and second, it recentres the policy debate on developmental, environmental and economic aspects.

To date there is no robust empirical evidence for a general relationship between climate change and security. Most existing case studies[16] highlight the predominant role played by non-climate variables like weak governance, social fragmentation and economic instability on insecurity. This type of relationship is confirmed by the results of the econometric analysis carried out in this project, showing a stronger role of socio-economic variables in explaining the triggering of conflicts in the Sahel[17]. However, econometric and statistical attempts to detect a significant relation between climate variables and conflict have failed so far and/or have been criticised for not capturing complex processes and poor quality of data[18].

In sum, a review of climate change conflict literature and case studies of past security events in the Sahel highlights the[19]:

- Complexity of variables intervening in the relationship between climate change and security (environmental, political and economic variables; feedback-loops of relations; dominant influence of political, historical and economic variables on security and particularly on conflict).
- Difficulty of qualifying and measuring the impact of climate change on security (causality, robustness, generaliseable). Therefore, it appears more warranted to consider the link without a deterministic qualification (i.e. relation vs. impact);

Based on these observations our analysis of past security events in the Sahel (1967 – 2007) looked at the role played by environmental factors[20] in insecurity processes in the Sahel. Environmental variables such as scarcities and soil degradation are directly affected

14 The most commonly cited ones are: political instability, economic instability, food insecurity and migration.

15 Human security is an emerging paradigm for understanding global vulnerabilities. The traditional notion of national security is challenged by arguing that the proper referent for security should be the individual rather than the state. Human security includes aspects like; economic security, political security, food security, environmental security and health security.

16 Peluso and Watts, 2001; Gleditsch, N.P., 1998; Benjaminson, T.A., 2008; Buhaug, H., 2010; Tacoli, C. ,2010; Salliot, E., 2010.

17 Hissler, Sebastien, 2009, "Econometric study on the impact of rainfall variability on security in the Sahel"; Sahel and West Africa Club Secretariat / OECD.

18 For a good discussion of the statistical literature see Buhaug Halvard, Gleditsch Nils Petter, Theisen Ole Magnus, 2008, "Implication of climate change for armed conflict", The Social Development Department, the World Bank Group; Theisen, Ole Magnus, 2008, "Blood and Soil? Resource Scarcity and Internal Armed Conflict revisited"; Journal of Peace Research 45 (6); Hissler, S. 2009, "Econometric study on the impact of rainfall variability on security in the Sahel"; Sahel and West Africa Club Secretariat / OECD.

19 "Security and environmental variables: The debate and an analysis of interactions in the Sahel" 2010, Sahel and West Africa Club Secretariat / OECD.

20 Here we use environmental factors to mean only those dependent on climate.

by climate change and climate variables. In the Sahel, characterised by strong climate variability, the analysis of past climate meant focusing on this aspect rather than on the effects of an emerging climate change signal. However, we also looked at the more gradual climate trends in addition to climate variability.

Our analysis of the Sahel confirms the absence of a generaliseable and direct impact of climate change on security. For the majority of security events, no deterministic relation has been indentified between environment and security dynamics. Environmental variables are of secondary importance at best compared to political, historical and economic variables. These variables for which a consensus on the direct causal link with conflict exists are: level of economic development, history of conflict, existence of either ethnic dominance or polarisation, geographical proximity, non-democratic regimes and relative power.[21]

The endemic nature of tensions in the Sahel is often highlighted. Although a decline in armed conflict in recent years can be observed, many tension "hotspots" experiencing recurrent crises remain: ethnic and religious oppositions, tensions between farmers and herders, illegal trafficking, resource access (notably land), and weak governance. These tensions are the result of a combination of factors and where these persist, conflict may recur. Resource access-based conflicts resemble rather 'traditional' military conflicts, like the Libyan occupation of the Aozou Strip in 197322. In other events, environmental variables combine with a host of socio-political variables such as: land use, resources, ethnicity, governance, etc. in conflict dynamics. This suggests that the environmental variable is not distinct from other dependent variables and requires an adapted and integrated strategy.

Although our analyses did not provide any evidence for environmental variables impacting deterministically on security in the Sahel, given the lack of sufficient empirical and local case analyses the existence of general linkages between security and climate change can not be rejected. Further research is needed, particularly focusing on regional spaces and localised areas. Also, there is need to clarify definitions and concepts of the debate. Climate change, climate variability and environment all refer to distinct features. Also, 'security' can be interpreted differently, depending on contexts and involved parties (states, researchers and the public, etc.). Undifferentiated use of concepts and ignorance of uncertainties can favour misunderstandings, or worse lead to inadequate policy design.

21 Buckland, B., 2007, "A Climate of War? Stopping the Securitisation of Global Climate Change", International Peace Bureau, Geneva.
22 Salliot, E. 2010.

4 Livelihoods and food security: concrete policies

Based on the analyses and conclusions of the Dakar workshop livelihoods and food security appear to be the most prominent transmission mechanisms between climate variables and human security. First, the impact of climate and climate variability (in particular rainfall) on livelihoods and food security is direct and second, both are sensitive to sudden events.

Table 1

Socio-economic indicators

	Total population (in million)	Rural population (% of total)	Agricultural population* (in % of total)	Population density (people per km²)	Population density (agr. pop. per arable land** km²)	Agricultural value added (% of GDP)
Nigeria	151.21	52	26	166	110	32.7
Ethiopia	80.71	83	78	81	442	46.3
Sudan	41.35	57	53	17	114	28.3
Burkina Faso	15.23	80	92	56	261	33.3 [1]
Niger	14.70	83	84	12	81	40.0 [2]
Mali	12.71	68	76	10	197	36.5
Senegal	12.21	58	71	63	284	13.4
Chad	10.91	73	68	9	170	12.5
Eritrea	4.93	79	74	49	559	24.3
Mauritania	3.22	59	51	3	355	12.5
Gambia, The	1.66	44	77	166	357	28.7

* Agricultural population is defined as all persons depending for their livelihood on agriculture, hunting, fishing and forestry. It comprises all persons economically active in agriculture as well as their non-working dependent, not exclusively rural population. / ** Arable land includes land defined by the FAO as land under temporary crops, temporary meadows for mowing or for pasture, land under market or kitchen gardens, and land temporarily fallow. / [1] 2006 / [2] 2003 / Source: FAO; World Bank

Sahelian production systems are heavily dependent on rainfall: food crop production is mostly rainfed and livestock rearing transhumant[23], explaining the direct impact of climate variability on food security and livelihoods (Figure 5). This dependence is further heightened by the fact that livelihoods in the Sahel are dominated by agricultural activities. Around two thirds of the population depends on agriculture for its livelihood with little or no diversification of other revenue sources.

The suddenness and unpredictability of an impact determines the population's coping and adaption capacity. Extreme events such as droughts and floods can lead to an immediate

23 Also referred to as nomadic pastoralism or nomadic transhumance which is characterised by seasonal livestock movements is search of pastures.

loss of livelihoods and/or food insecurity and decrease the population's adaptive capacity. The effects can be particularly severe – as in the case of famines – and long lasting. From a human security perspective, sudden events deserve particular attention.[24]

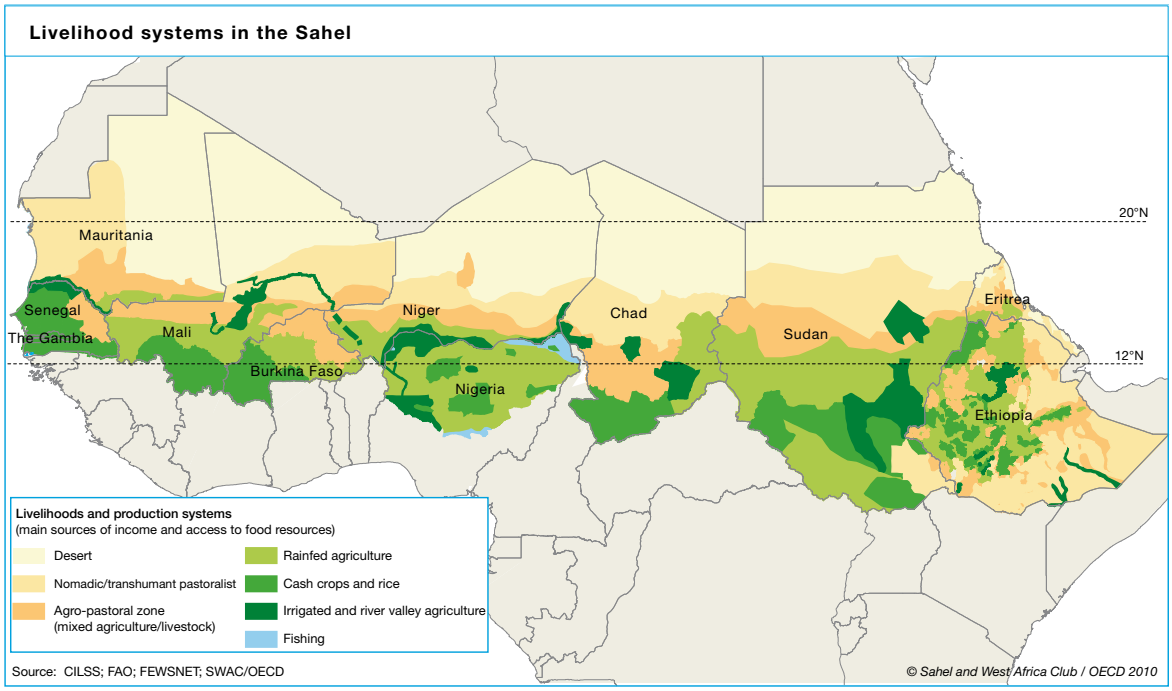


Figure 5

Livelihood systems in the Sahel

In addition to the direct impact of climate variability on both aspects, our analysis of food crises and low-scale localised conflicts, notably agro-pastoral conflicts (between sedentary farmers and nomadic herders) showed a second type of relationship between food security, livelihoods, climate and security.[25] Here, gradual and sudden changes to livelihood systems can combine with economic, social, religious and political variables and lead to tensions. These changes can be caused by climate factors. In the case of agro-pastoral conflict, most often they are changes in livestock migratory patterns in search for pastures, changes in availability of and access to watering holes[26] and issues like land rights and other socio-economic factors. Although socio-economic and political variables have been acknowledged as the determinant factors in explaining the emergence of tensions, it is recognised that these variables can be influenced by climate factors.[27] Similarly, food crises have been shown to have also been caused or aggravated by political factors and bad governance (e.g. 1984 Ethiopian famine, "A review of past security events in the Sahel 1967 – 2007", 2010, SWAC/OECD). The human security concept encloses food security as a threat to well-being.

24 Numerous studies show that anticipated gradual impacts of climate change on environmental factors, like reduced agricultural yields and water scarcity, are not likely to result in conflict: Hendrix, C.S. and Glaser, S.M., 2007, "Trends and Triggers: Climate Change and Civil Conflict in Sub-Saharan Africa", Political Geography no. 6; Raleigh, C. and Urdal, H., 2007, "Climate Change, Environmental Degradation and Armed Conflict", Political Geography no. 6.

25 Case studies: "Agro-pastoral conflict in southwest Burkina Faso"; "Senegal-Mauritania conflict: Settlement dynamics and competition over land and resources"; "The Afar rebellion: geopolitical motivations and control over land and resources" 2010, SICCS, Sahel and West Africa Club Secretariat / OECD.

26 Livestock migratory patterns and access to watering holes can also be influenced by non-climate factors like land rights, emergence of agricultural production, legislation, etc.

27 For instance in the CEWARN cluster reports on pastoral conflict the 'environmental pressure' variable does not explain the occurrence of violent incidents.

4.1 Livelihoods

The great vulnerability of the Sahelian population to climate change is linked to its high dependence on agricultural activities and absence of alternative income earning activities. Although populations have over centuries developed coping strategies and adapted livelihoods to the region's climate constraints, like nomadic pastoralism, development processes are accompanied by changes to ways of life.

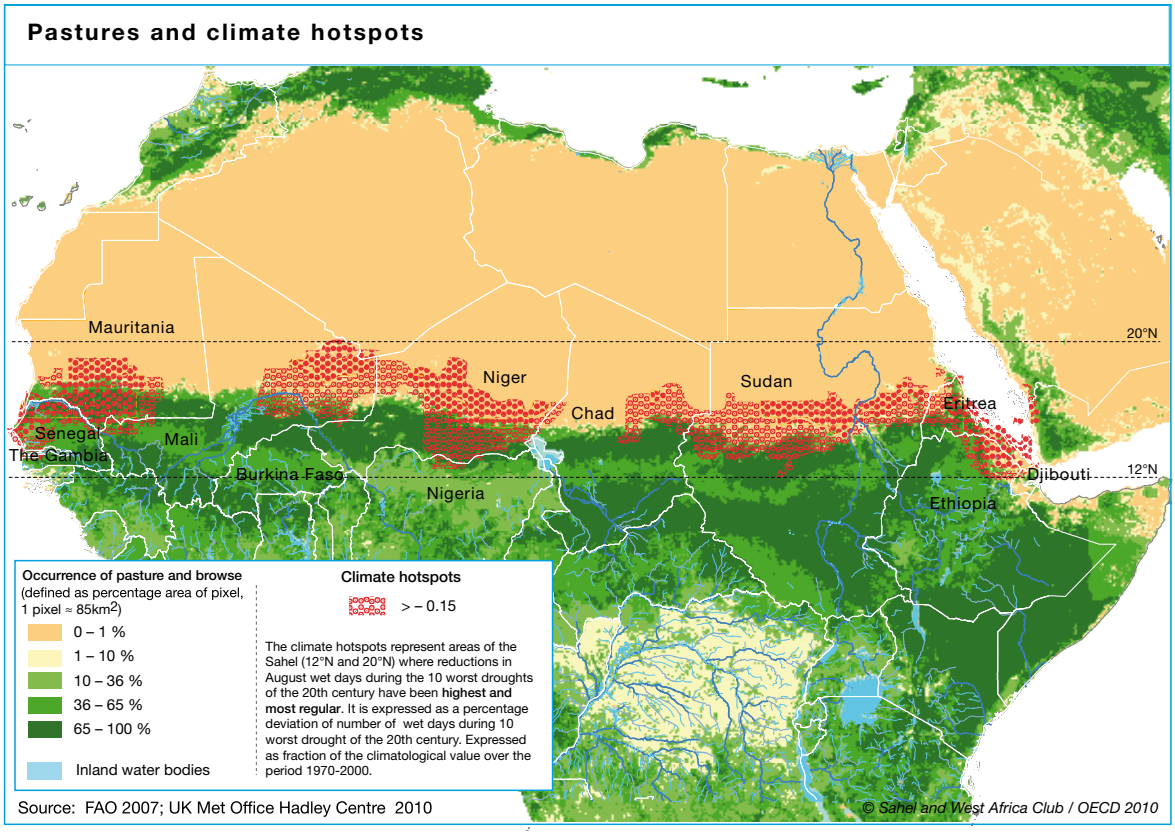


Figure 6

Pastures and climate hotspots

Livelihoods and livelihood changes are influenced by myriad complex processes, gradual or sudden, positive or negative. Climate variables, among others, can influence and/or accelerate such changes[28]. Examples from the case studies include the sedentarisation of nomadic pastoralist communities, intensification of agricultural activities and loss of income sources from alternative activities

Governments should aim to reduce vulnerabilities, smooth transitions and promote the emergence and adoption of new sources of livelihoods. A successful strategy will require taking a broad approach across various policy domains, ranging from agricultural development, social protection, land planning to migration and governance. Strategy formulation needs to integrate the impact of climate variables on these processes. In addition, the involvement of all stakeholders in policy processes will provide additional understanding of concerns as well as facilitate implementation of proposed policies.

28 The droughts in the 70's and 80's led to accelerations in urbanisation growth rates with many rural households fleeing to cities.

However, further research is needed to improve understanding of dynamics as well as strategies of actors. This is particularly important given the complex and constantly evolving dynamics. In the short term, systematic and close monitoring of livelihoods should facilitate the development of emergency responses and insurance mechanisms to prevent problems from reaching critical levels.

Pastoral communities, occupying mostly the northern band of the Sahel, appear particularly vulnerable in terms of exposure to climate variables, coping capacity, instability of livelihood, and insecurity and violence (Figure 6). However, in many cases it is impossible to isolate and localise impacts given the complex relations between the climatic, socio-political, economic, security variables and livelihoods. Impacts in one particular area or on a certain population can have consequences that extend beyond the original location and/or group of people.

4.2 Food security

Food security dynamics in the Sahel have evolved greatly over the last decades. Today, rainfall is only one of several factors in determining food insecurity. Food production, i.e. food availability (highly dependent on rainfall characteristics), combines with other factors such as malnutrition, access to food, and market and trade mechanisms in determining food insecurity. Widespread malnutrition, particularly of children, increases vulnerability and the health impact of food shortages. Access to food depends on physical criteria like infrastructure but also on financial, such as prices for marketed food-products. In addition, market mechanisms can amplify the fluctuations of production[29] through price levels and trading strategies. However, rainfall characteristics remain a key determinant of food security for subsistence farmers and non-diversified livelihoods, like most pastoralist communities, due to the fact that a majority of rural households still auto-consume a large share of production.

Agricultural production and food security are particularly sensitive to climate variability. Climate change impacts are expected to further increase vulnerability. Governments need to develop strategies and techniques 'climate proofing'[30] agricultural production. Given the currently low level of investment in agricultural production in the Sahel the potential of adapting cost-effective techniques increasing yields and resilience to climate variability is high (soil techniques, irrigation systems, water and feedstock provision for cattle, etc. Figure 7, 8, 9). In most cases benefits in terms of increased yields and production exceed costs.[31] Hence, investments in agricultural production are essential development priorities overriding uncertainties in climate change projections.

29 See SWAC/OECD, 2006, "Food security and cross-border trade in the Kano-Katsina-Maradi corridor", WABI/DT/30/06, for a description of food-security dynamics in one part of the Sahel.

30 Climate proofing refers to measures that increase resilience to climate change and climate variability impacts.

31 Economics of Climate Adaptation Working Group, "Shaping climate-resilient development: a framework for decision-making", 2009.

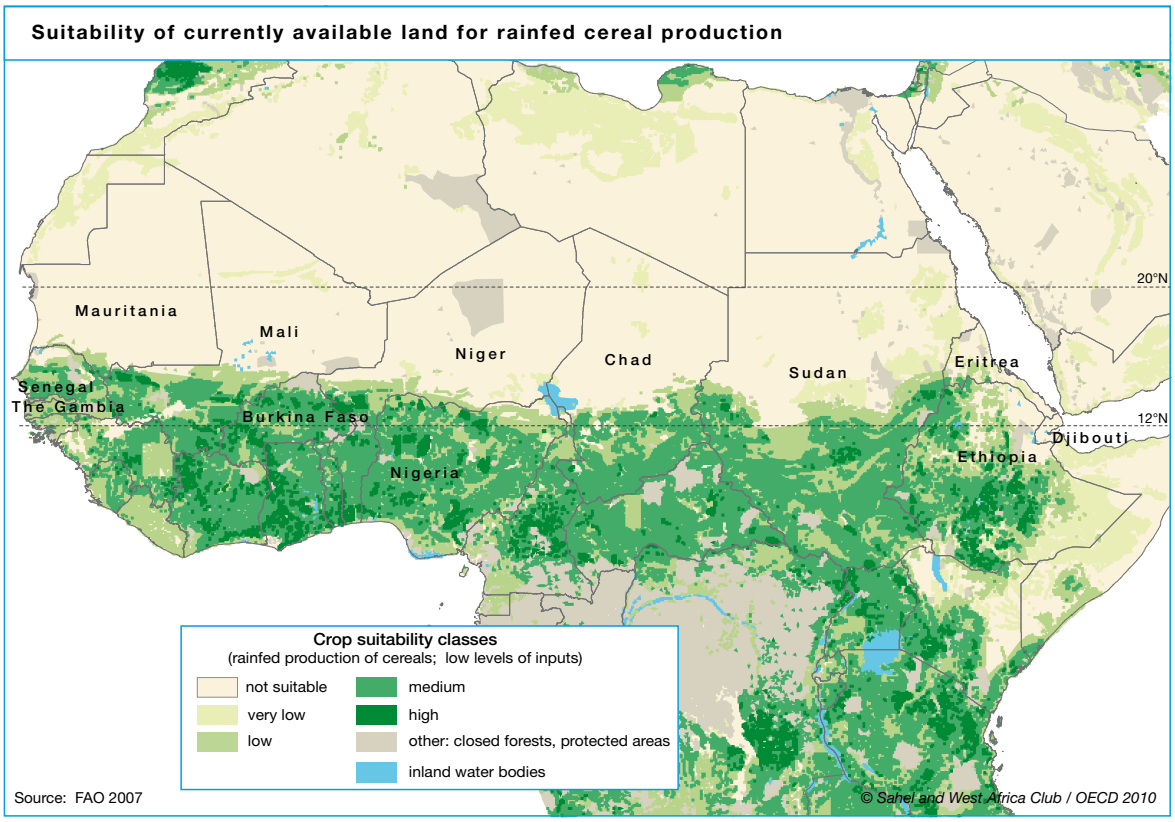


Figure 7

Suitability of currently available land for rainfed cereal production

For instance, an unchallenged component of agricultural and food security policies is improved water management. The Sahel is one of the least irrigated areas of the world, although most countries in the region have a large and almost untapped irrigation potential (Figure 8)[32]. Large and small scale irrigation and water conservation techniques (e.g. traditional systems like Zai cultivation[33], modern drip irrigation, solar pumps, open wells) can be adopted depending on local contexts. Opportunities to develop portfolios of climate resilient measures at different costs and time scales are ample.

32 Out of the 12 countries covered by this study, only Sudan consumes more than 20% of its total annual renewable water resources (63%).
33 Zai is a traditional form of planting crops in circular pits perpendicular to the slope of the land to capture and retain water.

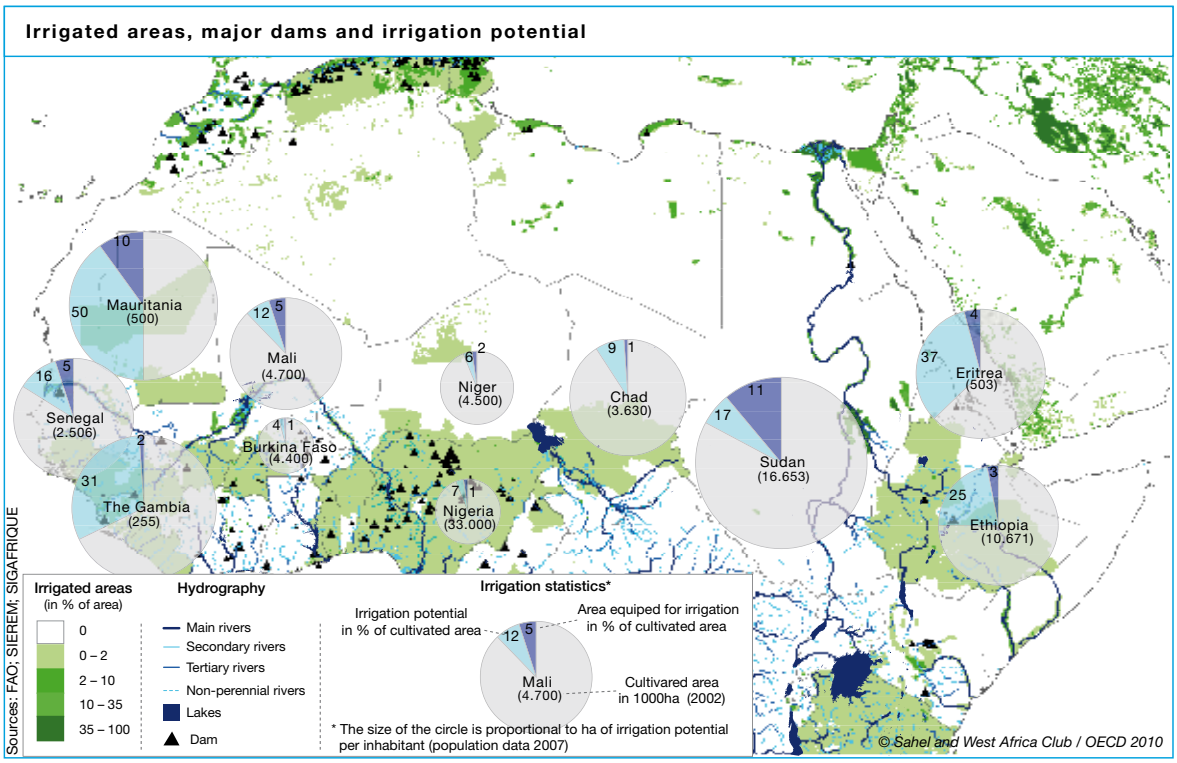


Figure 8

Irrigated areas, major dams and irrigation potential

However, in the Sahel national and international famine early warning mechanisms will remain a crucial tool for preventing and managing food crises. The region disposes of well developed mechanisms that are constantly evolving to integrate ever more factors and improve forecasting. Developing better seasonal weather forecasting and facilitating wider dissemination of produced information will also help to further improve famine early warning mechanisms and management of food insecurity.

Addressing the impact of climate change on livelihoods and food security require long-term and integrated development policies. Development policy design needs to include climate change impacts and long-term changes and its interaction with other dynamics of change.

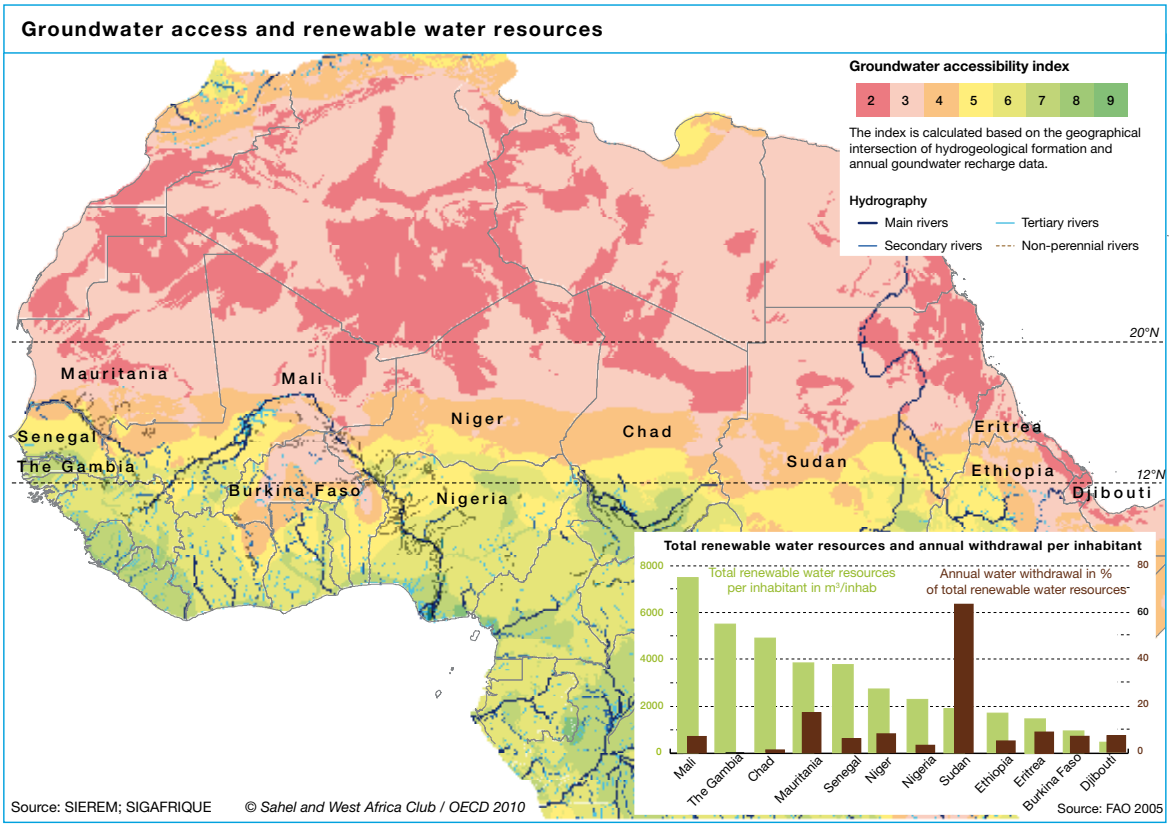


Figure 9

Groundwater access and renewable water resources

5 Conclusions: Policy responses

Given the nature of the project's subject, the aim was not to present conclusions that provide definite answers. It was rather to provide a neutral assessment of the scientific evidence and current debate and propose a constructive argument to help policymakers develop concrete responses. Also, areas where future research will need to improve our understanding and inform policy making are presented.

5.1 Manage uncertainty

Over the centuries, people have adapted their livelihoods to deal with the climate variability that characterises this area. However, over the last decades, Sahelian ways of life have changed fundamentally. Rainfall variability is now affecting Sahelian economies through various channels. During extreme events like droughts and floods, and in the absence of insurance mechanisms, livelihoods are threatened with particularly strong and lasting consequences.

In terms of policies addressing climate variability and climate change the need to manage uncertainty clearly emerges. Uncertainty in terms of: inter-seasonal variability and extreme weather events and climate change in terms of absence of a defined trend of precipitation. Policy makers in the Sahel need to develop strategies that allow for better management of and lessen the impact of climate variability on livelihoods and agricultural production. The absence of robust projections in terms of climate change impacts and therefore well-defined threats or opportunities further underlines the importance of policies geared towards reducing vulnerability. The possible options range from reducing certain forms of uncertainties (improved seasonal and long-term forecasting) to smoothing impacts (improved water management, more efficient management of food insecurity).

Improve intra-seasonal forecasting

Intra-seasonal forecasting of precipitation allows populations and governments to better manage activities dependant on rainfall and resulting impacts. Operational climate prediction centres[34] and well-developed models exist in Sahelian countries. However, there is a strong need to improve current capacities as well as access to and dissemination of produced information. In particular:

- Improve current seasonal forecasting capacities of existing regional and national climate and meteorological centres. Improvements should include further enhancing models and resolution (importance of reliable and good observational data, see below), co-operation between national and regional centres (south-south co-operation), access to internationally available data and observational capacity.
- Improve access and dissemination of information. Many of the people whose livelihood depend directly on such information live in vast and, in many cases, isolated areas. Extending and developing mechanisms that can be used to reach these populations and allow for timely consideration of climate information is of crucial importance. Pastoral livestock communities should receive particular attention as parts of their activities are located in the identified climate hotspots. In addition, information should also be used by policy makers and international partners in preparing for eventual crisis situations, like food shortages.

34 Regional meteorological centres in the countries covered by this study are: CILSS Regional Centre AGRHYMET, the African Centre for Meteorological Application and Development (ACMAD) and the IGAD Centre for Climate Prediction and Application (ICPAC).

Reinforce observation and long-term forecasting capacities

The improvement of long-term climate change forecasting is dependent on the availability and quality of observational data. Increasing the availability of observational data is crucial to improving understanding of climate processes, developing new regional models and driving forward long-term climate simulations. The World Meteorological Organisation has recently highlighted that Africa has only 744 weather stations of which only 300 are operational compared to an estimated optimal coverage of 10 000. In the Sahel, the coverage is between one and four stations per 10 000 km^2 although higher climate variability requires a higher density of stations to provide localised forecasting. In addition, also seasonal weather forecasting requires higher observational capacity.

5.2 Promote open and constructive dialogue

Towards a coordinated multilateral approach – based on national concerns

Although climate change awareness is international, the mechanisms for addressing climate issues are still primarily national given the lack of multilateral regulatory mechanisms and environmental laws. The absence of multilateral mechanisms not only reduces the scope for effective long-term action but also adds an element of uncertainty into the international system, prompting states to monitor environmental concerns unilaterally. This is particularly the case in terms of security impacts. Security has naturally a strong national dimension. Hence, it is important to bear in mind that "the subjective nature of a state's judgment of attacks on its national security leaves matters open to interpretation"[35] and that "each state's perceptions of environmental pressure are also highly subjective, but figure in political choices and thus in national development strategies"[36]. Taking into account national concerns, like interpretation of security issues (military versus human; national, regional or international dimensions) and policy choices – including those in the Sahel – is key to developing effective multilateralism. In this sense it seems that the primary concerns of Sahelian states regarding the links between climate change and security are more oriented towards defining climate change adaptation strategies in the context of broader development objectives than 'fear of instability'.

Aspects of human security like well-being and food security are at the heart of states' national development strategies. As the analysis have shown, effective policy responses on climate change-security issues requires comprehensive development strategies and coordination of various national policies domains extending beyond solely security responses.

A stronger role for African regional institutions

Promoting dialogue at the level of regional African institutions like the African Union, ECOWAS or IGAD should also figure among priorities. Identifying regional preoccupations and strategies ensures better coordination and effectiveness of activities. International partners should support efforts towards the formulation of regional agendas and climate change policy responses and base dialogue on identified priorities. This process should examine how to integrate issues related to climate and its links to regional instability into regional strategies.

35 Buhaug et al. 2008.
36 Frederick, M. 1993.

Integrate environmental variables in conflict early warning mechanisms

Conflict early warning mechanisms are an important tool for conflict prevention. A variety of early warning and monitoring mechanisms exist in Africa, often integrated in regional or continental intergovernmental authorities. Most of these mechanisms are conceived and designed on a purely military basis[37]. As the analyses have shown, integrating environmental variables into the monitoring and analysis of early warning mechanisms would extend the range of insecurity signals covered. Some data on seasonal climate forecasts and food security dynamics are already available at regional level. In particular, this could improve the detection of low-scale localised tensions. Bearing in mind that climate variables do not play a distinguished role in conflict dynamics compared to economic or political variables.

A first step could be to bring together climate science centres, conflict early warning mechanisms and partner institutions and launch a dialogue process on defining methodology, variables to be included, data sources and exchange of data and experience, notably intra-African. European partners could contribute by facilitating dialogue, providing additional data, technical assistance and funding where necessary. First informal discussions with involved stakeholders in Africa and partners in OECD countries has confirmed an interest in this proposal.

5.3 Integrate climate change in development strategy

Driven by the urgency and severity of projected impacts, climate change adaptation has become a new priority for the development community. There is no doubt that 'good' climate change adaptation is good development, notably for identifying vulnerabilities and integrating long-term planning in policy design. However, this new sense of urgency also bears risks. The need to be 'doing something' about anthropogenic climate change should not override other key development priorities.

In the Sahelian context climate change impacts are a development concern and investment in development is the best instrument for promoting peace and security. This interpretation is also reflected in the 'human security' concept that integrates concerns like well-being, food security and environmental security.

Integrating the long-term features of climate change in national and regional development strategies requires the analysis of the effect of all vectors of change in Sahel and how they interact with climate change. Population dynamics, migration, trade and economic development are some of the key vectors of change. These long-term dynamics will be crucial in understanding and dealing sustainably with vulnerability to climate change.

Until climate change impacts can be defined with more confidence, adaptation policies need to reduce vulnerability of populations to climate variability, a key characteristic of Sahelian climate. Vulnerability towards climate variability, notably rainfall, is particularly high in the context of large rain-dependent agricultural sector. Agricultural development and food security is a priority development domain in the Sahel. Policies aiming at increasing production and resilience to climate variability overlap naturally with climate change adaptation strategies.

37 A successful exception is IGAD's Conflict Early Warning and Response Mechanism (CEWARN) which is monitoring cross-border agro-pastoral conflicts in eastern Africa. CEWARN integrates an 'environmental pressure' variable in its regular reports.

Le Seine Saint-Germain
12 bd des Iles
F–92130 Issy-les-Moulineaux

Contact philipp.heinrigs@oecd.org

Mailing Address 2 rue André Pascal
F–75775 Paris
Cedex 16

Phone +33 (0)1 45 24 89 87

Fax +33 (0)1 45 24 90 31

E-mail swac.contact@oecd.org

www.oecd.org/swac