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How is science making its way into national climate change adaptation policy? Insights from Burkina Faso

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ABSTRACT

Burkina Faso is highly vulnerable to the increasing impacts of climate change and currently has large adaptation deficits. To improve adaptation planning at the national level, policies must, among other things, be informed by the current observed state of the environment as well as the best available projections of future climate change impacts. Scientific information has gradually been making its way into policies since 2007 but barriers still hinder the climate science-adaptation policy interface. A systematic policy document analysis, semi-structured interviews and participant observations were undertaken to explore how scientific information makes its way into national adaptation policy documents from its production to its inclusion into policies. The results suggest that overall, national adaptation policies are only to a limited extent informed by scientific information, due to insufficient availability of information, limited human and technical capacity and lack of finance. This highlights the need to build up national technical capacities to produce the required scientific information, by inter alia prioritizing it within ministerial budgets, reducing the dependency on international technical and financial partners. Further policy recommendations include capacity building and continuous formal collaboration protocols between producers and users, to ensure that usable scientific information is structurally integrated into policy-making processes..

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Climate change; adaptation; science-policy interface; Burkina Faso; policy formulation

1. Introduction

West Africa is considered to be one of the most vulnerable regions in the world in terms of climate change and variability (Cobban et al., 2016), due to its high exposure to climate stress and low adaptive capacity (Niang et al., 2014). With ongoing global warming, the region will be exposed to temperature increases above the global average (Weber et al., 2018). Droughts will increase and a high number of people will be vulnerable to increased desertification and yield decline (IPCC, 2019). Moreover, extreme rainfall events are projected to increase (Taylor et al., 2017) and sea-level rise will further exacerbate coastal erosion. Adaptation to climate change is and will continue to be of crucial importance for all sectors of West African countries' economies, as well as for the well-being of their populations.

Most countries are well aware of this and have formulated national and more local level climate change adaptation strategies and policies (Climate Analytics, 2019). Scientific information is one of a number of important contributors to effective policy. It can set or inform certain baselines, targets and indicators, and enables monitoring and (re)evaluation of these over time and under different policies and practices. Its absence can hence lead to an incomplete overview of policy options and in turn misguided or partial policies. This paper therefore focuses on the science-policy interface in the field of climate change adaptation in Burkina Faso, namely on the production and use of scientific information and its uptake in national policy formulation processes. The term of 'scientific information' is used to describe the physical measurements and projections of climatic, ecological and socio-economic parameters (alternatively conditions) which were traced during this study.

For science to make its way into policies, a number of factors have to be in place. As a first step, adequate scientific information at the right temporal and spatial scales has to be produced (Webber & Donner, 2017). Secondly, a common understanding of the available scientific information and approaches (e.g. in terms of climate and impact models and possibilities for downscaling or aggregating information) on the one hand and policy and governance processes, jurisdictions and timelines on the other hand needs to be in place. Finally, there has to be ownership of this principle, namely the creation of usable science, by actors from both the science and policy spheres (Prokopy et al., 2017). The usability of science depends on the production process but also on the context of potential use (ibid). Daly and Dilling (2019) describe this as a process of "co-production" where both "producers" and "users", namely the science and policy spheres, iteratively interact to mutually influence and strengthen each other.

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However, a gap between the scientific information produced and action taken by decision-makers still persists (Kristjanson et al., 2009). Despite the progress that has been made in mainstreaming adaptation into sectoral policies in West Africa (Nkiaka & Lovett, 2018), numerous barriers still hinder the science-policy interface and Sub-Saharan countries are failing to incorporate medium to long-term scientific information into core national development processes (Jones et al., 2015). The main challenge for the production of scientific information on the African climate is the low capacity for climate modelling, both for data generation and the assessment of these data (Jones et al., 2014; Nkiaka & Lovett, 2018). Scientific information is difficult to obtain due to their limited physical availability (e.g. weather stations are sparsely distributed) and limited sharing between institutions (Dike et al., 2018). Most African universities have inadequate research facilities and insufficient funding for earth systems science (Dike et al., 2018; Koch, 2018). This results in insufficient (processing of) scientific information, especially at regional and local levels (Nkiaka & Lovett, 2018). Regarding adaptation planning in general, some have argued that there are often low levels of ownership from national governments due to high reliance on donor assistance (Eguavoen & Wahren, 2015).

Burkina Faso formulated its National Adaptation Plan (NAP) in 2015 and its implementation is well underway. The country therefore offers a unique and rich setting to explore how, which, and when scientific information is making its way into adaptation and development policies. The institutions, people and processes involved were analysed and the science base of climate adaptation policies, plans and strategies screened. Scientific information on climate impacts and adaptation was empirically traced from its 'source', or production stage, to its appearance, or reference, in policy documents, to answer the following questions: (1) was scientific information used?; (2) if yes, what scientific information?; (3) how was this scientific information produced and communicated?; and finally (4) who was involved and in what capacity?

The next section gives a brief overview of climate change impacts and national policy response efforts in Burkina Faso to date. Then, the data collected and the methodology used is presented. The results section describes the scientific basis of adaptation relevant national policy documents in Burkina Faso and the various processes of scientific information integration encountered. The results are then compared with the theory presented above in the discussion section, before concluding and offering a number of recommendations.

2. Setting the scene

2.1. Climate variability and change in Burkina Faso

In recent years, West Africa has observed a spatially variable, but gradual warming reaching 0.5°C per decade (Sylla et al., 2016). Regarding precipitation, the Sahel has recovered from the drought episodes in the 1970s and the 1980s (Panthou et al., 2018; Sylla et al., 2016) but the number of precipitation events has not returned to the level of the pre-drought period (Sylla et al., 2016). Average intensity of rainfall events has hence increased since the droughts and have in recent years frequently surpassed the intensity of rainfall events that occurred in the 1950s (Panthou et al., 2014) with the number of extreme rainfall events over the Sahel tripling over the course of the last 30 years (Taylor et al., 2017). Floods are the most frequent disaster being experienced by Burkina Faso, approximately three flood events per year for the period 1986–2016 (Tazen et al., 2019). In the 2000s, this number increased to five per year (ibid).

At regional scales in sub-Saharan Africa, temperature increases are projected to be higher than the global mean temperature increase (Weber et al., 2018). Projections show that West Africa will be exposed to particularly large increases in the number of hot days, both at 1.5°C and 2°C of global warming (Hoegh-Guldberg et al., 2018). For a global warming scenario of 2.5°C by 2100 (RCP4.5), Burkina Faso's yearly average temperature is projected to reach 30°C by 2040, compared to 28°C in 1960 (Climate Analytics, 2020). In the region and particularly in the Sahel, projected changes in total precipitation remain uncertain (Hoegh-Guldberg et al., 2018). However, most models project that the Western Sahel will experience drying, with a significant increase in the maximum length of dry spells (Diedhiou et al., 2018), potentially leading to serious food security issues (Hoegh-Guldberg et al., 2018).

2.2. Policy context

Burkina Faso first signed the United Nations Framework Convention on Climate Change in 1993 and the Kyoto Protocol in 2005. The National Strategy for the Implementation of the Convention on Climate Change was published in 2001 before Burkina Faso adopted the National Programme of Action for Adaptation to Climate Variability and Change (NAPA) in 2007. To be able to, inter alia, benefit from international climate funding, the NAPA was complemented by a NAP in 2015. Burkina Faso was the first country in the world to formulate its NAP which was done by an interdisciplinary group of experts in the fields of agriculture, animal production, environment and natural resources, meteorology, energy, health, infrastructure and housing, women's associations and civil society organizations. This global NAP is the culmination of 6 sectoral NAPs, previously published in 2013 for agriculture, livestock production, energy, environment and natural resources, health, infrastructure and habitat and incorporates the cross-cutting issues of water security, women's associations and civil society organizations. In addition to the NAPs, other policy documents touch upon climate change adaptation such as the National Economic and Social Development Plan 2016–2020 (PNDES) (2013a), the National Sustainable Development Policy in Burkina Faso (PNDD) (2013b) and the National Programme of the Rural Sector (PNSR) (2011).

The Ministry of Environment, Green Economy and Climate Change (MEEVCC) is in charge of the implementation and coordination of environmental policies on the basis of the policy guidelines and options defined by the Government. The National Council for Sustainable Development (CNDD), placed under the MEEVCC, is responsible for the adequate consideration of environmental issues in the elaboration of policies, programmes, plans and projects in the fields of decentralization, economic reforms, education, poverty and sustainable development. It is composed of three bodies, namely the

Conference, the Permanent Secretariat (SP-CNDD) and the Specialized Commissions. The SP-CNDD contributes to the general objectives of the MEEVCC: preserve the environment, ensure sustainable management of natural resources and develop and/or strengthen international partnerships to enhance funding opportunities. The SP-CNDD is also the government body responsible for Burkina Faso's compliance under the UNFCCC and hence the formulation and implementation of related policies such as the NAPA, the NAP and the Nationally Determined Contributions (NDCs). To efficiently mainstream adaptation into national development efforts, all key sectors must be involved (Basson et al., 2020). Ministerial technical units are therefore responsible for the integration of the NAP into their operational plans, requiring cross-ministerial collaboration. All ministries also depend on the national budget allocated to them, as well as external funds. For the elaboration of the NAP for example, the MEEVCC received technical and financial support from the United Nations Development Programme, the Kingdom of Denmark, the Global Environment Facility and Japan.

Civil society organizations are involved in policy development through validation and accountability processes (e.g. by monitoring policy implementation). They support ministerial technical units and take on a coordination role by effectively organizing stakeholder feedback and information exchange processes. The provisional Implementation Report of the National Adaptation Plan to Climate Change in Burkina Faso from the SP-CNDD states that the NAP aims to increase the participation of civil society organizations to ensure good governance, sustainability of projects implemented and inclusion of the wider public.

3. Data and methodology

The integration of scientific information in national policy documents was analysed by tracing back the entire process from the production of information to its use in the formulation of policies and the identification of feasible adaptation options. A two-stage approach combined a systematic document analysis with a series of in-depth semi-structured interviews with key actors involved in the formulation and implementation processes of these documents. These two deliberate data collection methods were supplemented by participant observation by one of the authors. The following aspects were the focus of this study: the policy context around NAP implementation; the roles and responsibilities of the different stakeholders; interactions between stakeholders; and finally, the role and importance given to scientific information and external influences. This approach allowed to identify barriers and opportunities to further bridge the spheres of science and policy in this area.

3.1. Document analysis

A systematic in-depth qualitative analysis of adaptation related national policy documents published after 2007, the publication date of the NAPA, was conducted. This was the first programme explicitly devoted to climate change adaptation in Burkina Faso, marking the beginning of an increased national commitment in this field. The first documents to be included in this analysis were the global and three sectoral NAPs. The three sectoral NAPs on energy, agricultural and the environment were selected and provided by the SP-CNDD, as they are the three most elaborate NAPs produced to date. Secondly, the existing national documents related to adaptation were identified and analysed. Based on this initial analysis, further sectoral development documents, referenced in the NAPs, as well as national policy documents for the water resources, agriculture, environment and economy sectors were selected. The selection of sectors was made jointly with the staff of the SP-CNDD, who considered these sectors as priorities for Burkina Faso's adaptation approach and gave us access to a number of documents. All the other documents were accessed online, through the relevant ministerial websites. The final selection of 15 documents was subdivided into three categories (Supplementary material, Annex A).

The documents were systematically reviewed, using a questionnaire divided into four parts (Supplementary material, Annex B). Firstly, general metadata on the type of document, title, authors, institutional affiliation and year of publication were recorded for each document. Secondly, any climate change consideration made in these documents was tracked. Particular attention was paid to how climate change was described in general, how the specific aspects of climate change were being addressed, how climate change impacts were presented, how vulnerable populations and sectors were identified and how this identification was justified, and finally what priorities and projects were mentioned or suggested for climate change adaptation. The third part of the questionnaire dealt with scientific information, focusing on physical measurements and projections of climatic, ecological and socio-economic parameters/conditions. The different types scientific information mentioned, their sources and how they were used, and the types of analyses conducted were recorded. In the final part, the references to scientific information for adaptation priorities and projects and the rationale behind potential additional data collection were traced. The answers to these questions were recorded in an Excel table and subsequently analysed to identify potential patterns and trends, and more in general facilitate analysis.

3.2. In-depth interviews

To complement the information captured in the document analysis, a number of pilot discussions were held with key informants in May 2018. Subsequently, a more structural series of individual and focus group interviews were organized in July 2018 with relevant staff members from ministerial technical units, national research agencies, public universities, civil society organizations and technical and financial partners, involved in national policy development, formulation and implementation processes for adaptation and/or relevant sectors. The selection of the interviewees was informed by and triangulated though a combination of (online) author tracing of the policy documents, analysis of national expert networks and a mapping exercise conducted with senior SP-CNDD staff in May 2018. A total of 14 pilot meetings and 14 in-depth individual or focus group interviews were held with altogether

63 people (9 women and 54 men), working in 22 different institutions at the national level (Supplementary material, Annex C). 6 institutions and 4 individuals were met twice.

Similarly to the document review, the semi-structured interviews conducted in July 2018 were split into four stages. In the first stage, the interviewees were asked about the general role of the institution they belonged to, as well as their own specific role. During the second stage, they were asked to identify existing national climate change or adaptation documents they had been or were involved with. In the third stage, they were questioned asked about the level and processes of acquisition of scientific information on climate change impacts (typically) included in the policy documents the interviewee had been involved in. In the fourth and last stage focuses on the process of integrating (this) scientific information into the policy documents. The interview guide was sent beforehand via e-mail to all the interviewees to inform them about the questions that would be asked (Supplementary material, Annex D).

All the interviews were conducted in French and lasted between 45 and 75 min. For each institution interviewed, between one and eight people participated in the interviews with an average of three participants. Detailed notes were taken by hand during all the interviews. In addition, 7 out of the 14 interviews were audio recorded and subsequently fully transcribed. For the analysis of results, all interviews were coded according to the different predefined sections of the interview guide in the 'NVivo qualitative data analysis software'. A validation workshop held in July 2018 was attended by 16 interviewees from 8 institutions giving them the opportunity to provide feedback on the initial findings. The feedback was recorded and considered during the analysis of results.

3.3. Participant observation during workshops

The document analysis and interviews were complemented by participant observation of both policy and science sphere actors during a series of 6 technical workshops held in Ouagadougou, Burkina Faso between May 2018 and November 2019. These actors were for the major part the same as the interviewees with whom we conducted in-depth interviews: staff members from ministerial technical units, national research agencies, public universities, civil society organizations and technical and financial partners, involved in national policy development, formulation and implementation processes for adaptation and/or relevant sectors. One of the authors was present during all workshops, and took notes of the discussions taking place between the different participants of these workshops, specifically around data availability and production, data sharing and the level of knowledge exchange between different institutions. The notes were analysed using Nvivo.

3.4. Limitations & positionality

The data collection for this research was associated to one of the activities of a climate change and development project funded by the German ministry for Environment (BMU). The Projet d'Appui Scientifique pour les processus des Plans Nationaux d'Adaptation (PAS-PNA), implemented by the German development cooperation (GIZ) and Climate Analytics, an independent research institute, focused on science support for national adaptation plan formulation and implementation processes in francophone West-Africa. Even though the authors strived to observe academic practices and standards for data collection, participant identification and interviewing, their affiliation with the above-named project potentially influenced parts of the data and outcomes of the research in the field, most notably the data collected during the interviews and workshops. Indeed, partiality, positionality and accountability must be considered when conducting critical research (Leavy, 2014). Finally, (focus) group interviews or discussions, in contrast to individual interviews, can also lead to potential heterogeneity in answers provided, as they do not collect information on individual narratives and personal experiences (Hennink, 2014). In case parallel views were expressed during the group interviews, they were noted down and treated separately.

4. Results

4.1. The science base of adaptation related policy documents

4.1.1. Representation of climate change, its impacts and priorities for intervention

When tracking the references made to climate change, it is found that all the documents analysed mention it, from the NAPs to the sectoral and national development documents. The sectoral NAPs provide the most detailed descriptions and portray Burkina Faso as a country suffering from the adverse effects of climate change, undergoing profound changes (Energy NAP, 2013a; Agriculture NAP, 2013). In three out of the seven national documents on adaptation to climate change, climate change is presented as a barrier to the country's development and one document describes adaptation as an unavoidable necessity. The sectoral and national development documents more vaguely present climate change as a present risk. The three sectoral and the global NAPs describe the same increasing temperatures and the Environment NAP (2013b) states that since 1975, there has been a temperature increase of 0.6°C, namely 0.15°C per decade. Regarding precipitation, after a decrease between 1950 and 1980, the amount of rainfall has more or less stabilized in the last 20 years (Environment NAP, 2013b). All four documents mention an observed high spatial and temporal variability of rainfall (alternation between droughts and exceptional heavy rains) projected to persist in the future.

Throughout the documents, the most pressing climate change impact identified is environmental degradation. The Agriculture NAP (2013) cites crop damage and poor agricultural productivity, the Environment NAP (2013b) highlights reduced vegetation cover, reduced biomass production and loss of biological diversity. Three of the six national development documents state how vulnerable Burkina Faso's economy is to the impacts of climate change. For example, the PNSR (2011) states that the economy is particularly vulnerable to the fluctuating prices of cotton and the effect of climate variability on agricultural yields.

The term 'vulnerability' is omnipresent in the policy documents and various vulnerabilities are identified, depending on the focus sector of the respective document. All the sectors covered (energy, environment and natural resources, agriculture, water, economy) are considered vulnerable to the impacts of climate change, but umbrella adaptation documents such as the NAPA (2007) and the global NAP (2015) identify agriculture and water resources as the most vulnerable ones. Rural populations, women, youth and small agricultural producers are considered to be the most vulnerable to climate change. Studies conducted as part of the NAPA (2007) and NAP (2015) are the main scientific bases to justify these statuses of vulnerability.

Sectoral NAPs and national documents on adaptation all state their main priorities for climate change adaptation and the projects required to achieve these priorities. For example, the Agriculture NAP plans to sustainably increase agricultural production in the context of climate change and to strengthen the resilience of stakeholders through adequate techniques, technologies and early warning systems. Mobilizing freshwater resources to secure agricultural production is also mentioned as a priority. The global NAP has broad aims such as protecting economic growth, ensuring food security and preserving water resources. National development documents also outline priorities which are not solely focused on adaptation due to their wider scope but adaptation is always mentioned as part of their priorities. Because these are national level documents, they do not outline projects on the ground and the actions listed remain generic.

4.1.2. Use of scientific information referring to climate change and its effects

The Agriculture NAP (2013) contains the highest number of distinct scientific references (fourteen) and the most precise information on the methods used to obtain scientific information and the models used to process them (e.g. crop models). From the document analysis, it is clear that coordinated efforts purposefully producing scientific information for policy documents in the field of adaptation occurred during the drafting of the NAPA (2007) and the sectoral NAPs respectively. Very few scientific references in the national and sectoral development policy documents were found.

Each of the three sectoral NAPs refer to scientific information, such as economic data, agricultural productivity and current levels of flora and fauna. Conversely, some of the more practically oriented documents such as the draft Implementation Report of NAPs (2017a) and the draft Investment Plan of NAPs (2017b) do not. Perhaps surprisingly, the SNACC (2017c) does not contain scientific references either. Nevertheless, the NAPA (2007), the global NAP (2015), the Second National Communication (2014), the PNDD (2013) and the PNSR (2011) are to some extent based on scientific data and studies. Most of the scientific references come from national sources (around 3/4 of the references). The IPCC's Fourth Assessment Report (2007) and the Food and Agriculture Organisation's (FAO) are two international sources used for statistics of general contextual data.

The main scientific studies referred to with respect to climate change information are the national studies conducted under the NAPA (the vulnerability studies among others) and the studies conducted by the LAMI laboratory (2012), as a basis for the elaboration of the NAP. The NAPA (2007) studies focus on the manifestations of climate change on the most vulnerable sectors and groups, the impacts of climate change and the adaptation measures that must result from it. Vulnerability studies were conducted in three different agro-climatic zones, the MAGICC/SCENGEN model was used for climate variable projections with time horizons up to 2025 and 2050 and the DSSAT and GR2M were used to assess the impact of these projections on crop production and water resources respectively. Table 1 below summarizes the institutions and the type of information mentioned in the NAPA (2007).

The Materials and Environment Laboratory of the Joseph Ki-ZERBO University of Ouagadougou (LAME studies, 2012) conducted in-depth analyses of climate change scenarios up to 2021, 2050 and 2100 (trends and projections) and vulnerability to climate change of a number of identified priority

Table 1. List of institutions referenced in the NAPA (2007) and the type of scientific information provided.

Institutions	Type of information
National Meteorological Agency (Agence NAtional de la Météorologie, ANAM)	Rainfall (e.g. monthly amount of rainfall for 2006 for three climatic zones, annual amount of rainfall and length of rainfall season between 1961 and 1990 for three climatic zones and evolution of the amount of rainfall in Ouagadougou between 1920 and 2000) and temperature trends (e.g. temperature evolution between 1961 and 2014 in Bobo Dioulasso and Dori)
United Nations Food and Agriculture Organisation (FAO)	Forest cover
Integrated Water Resource Management Department (Gestion Intégrée des Ressources en Eau, GIRE)	Water resources, flood zones and impacts caused by floods
Ministry of Animal Resources (Ministère des Ressources Animales, MRA)	Plant and animal resources (e.g. crop distribution on national territory, forest composition, amount of livestock namely ruminants, pigs and poultry)
National Council for Environmental Management (Conseil NAtional pour la GEStion de l'Environnement, CONAGESE)	
National Institute for Statistics and Demographics (Institut National des Statistiques et de la Démographie, INSD)	Economic data (GDP, economic growth, activities contributing to economic growth)
Ministry of Agriculture, Hydraulics and Fishery Resources (Ministère de l'Agriculture, de l'Hydraulique et des Ressources Halieutiques, MAHRH)	
Ministry of Economy, Finance and Development (Ministère de l'Economie et du Developpement, MED)	
National Council for Emergency Relief and Rehabilitation (Conseil NAtional de Secours d'Urgence et de Réhabilitation, CONASUR)	Damages from droughts
SP-CNDD	Vulnerability studies (climate projections in three different agro-climatic zones for crop production and water resources up to 2025 and 2050)

sectors (agriculture, livestock, environment, energy, environment, infrastructure, health and disasters). This includes scientific information on climate variables and impacts (precipitation, temperatures and agricultural yields). The Threshold 21 Model (from the Millennium Institute) was used as an integrated modelling and socio-economic and environmental planning tool based on system dynamics.

The scientific basis of specific priorities and projects described is difficult to identify in the documents. No quantitative objectives are set and scientific information is generally used to describe the context. However, the NAPA and the NAP go one step further compared to the other documents as they look into sectoral vulnerability to future climate change, information taken into account when developing priorities.

A number of the documents analysed argue for additional collection of scientific information, on the magnitude and damages of climate change impacts for example (Environment NAP, 2013b). The need for more scientific information on the impacts of climate change, disaggregated at the sub-regional level through high-resolution climate models is recognized (NAP, 2015). In addition, monitoring and evaluation was identified as remaining challenging to implement without regular data collection to inform the process (Agriculture NAP, 2013).

4.2. The process of integration of scientific information into policies

The full process of science production and integration into policies in Burkina Faso proceeds as follows according to the interviewees. Ministerial technical units, research agencies and independent academic institutions produce and collect data and conduct analysis. A ministerial technical unit testified: "we produce data ourselves but we also get requests from other structures when they need specific data". Ministerial technical units, research agencies, independent academic institutions and civil society organizations do collaborate on an ad hoc basis, often as part of one-off projects bringing together relevant stakeholders and institutions around a specific topic. Interviewees knew of no continuous formal collaboration protocols or institutional ties in place. Protocols exist in the context of national adaptation policies, as relevant sectoral ministries such as the ministries of agriculture and environment were asked to contribute data, knowledge and expertise to the NAPA and the NAP formulation processes and underlying studies. It is unclear where data is subsequently stored.

4.2.1 Barriers for the production and communication of scientific information

In reality, the process faces some challenges. Lack of financial resources, insufficient human and technical capacity and lack of (long time series of) observational scientific information were identified as major obstacles for the production of scientific information. Interviewees from the ministerial technical units expressed that "there are not enough resources to finance data collection, to be able to calculate certain indicators" and that data availability varies across sectors and levels. For example, the agricultural ministry has detailed data on crop yields down to the provincial level, whereas data at this level of detail is largely unavailable for most indicators (e.g. biodiversity) produced and used by the Ministry of Environment. Insufficient financial resources were also identified as leading to human resources challenges, both in terms of quantity and quality. This also has direct repercussions on the communication of scientific information and the interactions between producers and users needed. An interviewee from a ministerial technical unit complained about the insufficient numbers of trained people with technical knowledge, particularly engineers, in public administration. At the time of the interview, this interviewee expressed fears that the few senior technical experts working in his ministry would leave as soon as a better job was on offer elsewhere.

Stakeholders working for civil society organizations and ministerial technical units alike stated that gaps in the existing data also hinder the production and communication of scientific information. These gaps were in some cases ad hoc but also extend over several years. Several stakeholders in the water sector testified that data collection systems and networks required urgent extension and modernization, especially for groundwater measurements. Interviewees from ministerial technical units and research agencies pointed out that scientific information was mainly produced during one-off field campaigns for specific projects or programmes, often financed by (international) technical and financial partners.

Barriers to access scientific information, especially sub-national and communal data, were highlighted on numerous occasions by interviewees from universities, research agencies and ministerial technical units. In particular universities and independent academics find it challenging to get access to data from research agencies. Sub-regional data was said to often be used as an alternative but was found to not produce sufficiently reliable and accurate results. Even if, in some cases, data was shared between institutions, both state and non-state interviewees highlighted that it was often necessary to recruit the 'right' consultant to actually be able to access scientific information, especially more sensitive data. Taking stock of scientific information production and databases within institutions has equally been identified as a challenge.

4.2.2. Barriers in the process of integration of scientific information into policies

From the interviews and participant observations, it transpired that subjects from research agencies and civil society organizations judge policy documents to have a weak scientific basis. Interviewees from ministerial technical units and civil society organizations feel that policy-makers neglect data collection and production and do not consider scientific information as fundamental for the formulation of policies. The production of relevant scientific information is found not to be prioritized in the ministries' budgets. Nevertheless, financial and technical partners do conduct projects which result in scientific information but the involvement of national stakeholders remains inadequate. An example of this was noted during the technical workshops as none of the national stakeholders mentioned an ongoing World Bank led project specifically focused on collecting existing information on ground water resources in Burkina Faso, at the time of the research. During the interviews, it

was also noted that answers were sometimes guided by plans and projects recently discussed with technical and financial partners, instead of providing a more neutral view or meta-reflection of current problems being faced.

Most interviewees were of the opinion that policy documents should provide a science-based vision with indicators enabling monitoring. They emphasized the importance of considering scientific information from the initial phase of policy formulation. However, a conflicting example of a policy in the field of sustainable development and food security was mentioned by an interviewee from a ministerial technical unit: "we have not set our objectives based on existing problems". The objective was to allocate 30% of land to women but results showed that 36% of the land already belonged to women, even before the policy was formulated. This example highlights an arbitrary choice of policy objectives. Several stakeholders identify a need for scientific capacity building at the decision-making level to effectively translate climate change into the policies and projects.

The absence of collaboration protocols at the national level between different research agencies, universities and ministries also hinders the science-policy interface. An interviewee from a research agency described that when a national communication is being written up for example, "90% of researchers are from our structures, and it is their individual expertise that is valued (…) but it is necessary to contractualise these actions from the institutional point of view". Scientists are recruited as consultants and are only mobilized for specific ad hoc projects. This results in difficulties in ensuring continuous monitoring of the production of scientific information on a national level and does not allow research agencies to plan data collection and analyses within reasonable timeframes. Nevertheless, one stakeholder from another research agency reported that consultation frameworks with ministries did exist for some sectors. These served to share available and existing scientific information and to understand the constraints encountered in the field during policy formulation.

5. Discussion

Although Burkina Faso led the way on a global level as being the first country developing its NAP, the scientific basis of this plan and other national adaptation policy documents remains patchy. However, stakeholders responsible for the production of scientific information on adaptation and policy formulation clearly acknowledge the negative impacts of climate change and the necessity to base adaptation planning on science.

In the broader policy context, the policies centrally steered from the Ministry of Environment, namely the SP-CNDD, are strongly influenced by the conferences, conventions and negotiations happening on an international level in the field of climate change. In addition, the numerous technical and financial partners active in Burkina Faso shape to a certain extent the national political context and thus the science-policy interface. This study shows that, on one hand, funding and projects are often temporary and do not always adequately involve national stakeholders, resulting in lack of ownership and knowledge communication. However, on the other hand, they are often the only opportunities to produce and analyse data and formulate plans like the NAP. Basson et al. (2020) argue that continuous capacity building is needed to ensure that all stakeholders are up to date on climate change issues which would ease the process of mainstreaming climate change into ministerial operational plans.

From the science side, the findings confirm that there are numerous barriers hindering the ability to adapt to climate change in Africa such as the lack of funding and measuring equipment available (Dike et al., 2018). As supported by literature, it was also observed that there is a pressing need to build technical capacities and ensure adequate resourcing of scientific institutions and climate scientists (Jones et al., 2015). Jones et al. (2014) mention that there is a low capacity when it comes to climate modelling, for both the production and analysis of data. The study shows that this is a barrier also being faced by independent academics and research agencies in Burkina Faso.

The study also finds that there is a need to formally link research agencies to technical ministerial units to ensure successful and transparent collaboration and improve access to scientific information, a point highlighted by research agencies and civil society organizations. The National Meteorological Agency has for example received increased technical capacity and infrastructure over time, mainly driven by project-based funding, but lack of clarity remains when it comes to their mandate for the delivery of scientific information and long-term finance (Harvey & Singh, 2017). Currently, scientific information mainly accumulates at the individual level instead of being structurally incorporated into institutional memory. Civil society organizations have been found to be well positioned to support closer interlinkages, communicate complex scientific information and ensure the needs from end users are taken into account (Harvey et al., 2019), a role that could be further established in the context of Burkina Faso. Local knowledge produced through indigenous knowledge systems also has a role to play here, as it has proven to reduce vulnerability to climate variability and change (Nyong et al., 2007). Climate change adaptation strategies would largely benefit from the uptake of this knowledge in formal adaptation strategies, strengthening links to the local context and people (ibid).

6. Conclusions and policy recommendations

For climate change adaptation, it is of utmost importance to base policies on an accurate picture of the observed state of the environment along with future scenarios likely under increasing climate change. This kind of scientific information is required to set realistic medium to long-term objectives to decrease risks and vulnerabilities in the future. This study shows that the national adaptation planning and implementation process in Burkina Faso is non-linear and involves multiple actors, characterizing the science-policy interface in this domain as a dynamic space for iterative co-production. Overall, actors in Burkina Faso explain the country's weak science basis of policy documents by insufficient data, lack of finance and limited human and technical capacity. To overcome these barriers, the production of scientific information should

be prioritized on a national level and within ministerial budgets to reduce the dependency on technical and financial partners. Further policy recommendations include capacity building of stakeholders working both in the science and policy spheres to facilitate the production of usable scientific information and ease communication. The need for continuous formal collaboration processes between research agencies, ministerial technical units and further organizations from civil society for example was expressed by interviewees, to inter alia build solid databases of relevant scientific information. Further research on the translation of national policy documents into sub-national planning and implementation could reveal how adequate these documents are in tackling realities on the ground.

Disclosure statement

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