RAPID: Studying the Impacts of Refugee Pastoralists on the Logone Floodplain

Summary: This research project will examine the impact of the humanitarian crisis in Northeast Nigeria on the pastoral system in the neighboring country of Cameroon. In the last two years, thousands of pastoralists have fled the insecurity caused by Boko Haram in Nigeria and moved with their livestock to the Logone Floodplain in the Far North Region of Cameroon. The question is how the influx of refugee pastoralists is affecting the management of common-pool grazing resources in the floodplain. In a prior research projected we have shown that mobile pastoralists were sustainably managing these grazing resources in a situation of open access. We explained that management works as a complex adaptive system in which individual decision-making results in an ideal free distribution of grazing pressure over the available grazing resources. While pastoralists previously emphatically argued that access is open for all, regardless of ethnicity, nationality, seniority, or socioeconomic status, it remains to be seen how strong the ethos of open access is when the number of newcomers increases a hundred-fold. In other words, the big question is how resilient the pastoral system is. We will examine the resilience of the pastoral system in a number of ways. First, we will examine whether there is still an ideal free distribution of pastoralists over the available grazing resources. Second, we will examine whether and how the influx of refugee pastoralists strains the ethos and practice of open access. Third, we will investigate other ways in which the refugee crisis is straining the pastoral system. The urgency of this project is that at this particular moment the pastoral system is under the greatest stress and this allows us to study in real time whether and how the systems adapts or collapses.

Intellectual Merit: Our prior research project has shown that mobile pastoralists can sustainably manage common-pool grazing resources in a situation of open access and that this management works as a complex adaptive system. Studying the impact of refugee pastoralists on the Logone Floodplain allows us to examine the resilience of this self-organizing system, as it unfolds in real time. We will able to study the process of adaptation or collapse. Our research project will investigate the impact at the individual and the system level, interviewing Cameroonian and Nigerian pastoralists about how they have changed their movement strategies to the increase in livestock populations.

Broader Impacts: There are two potential broader impacts. First, it is critical to know how resilient the self-organizing system is in the face of a massive influx of refugee pastoralists. I expect that we may learn much about the vulnerabilities and adaptive capacities of the system now that it is under considerable strain. This is critical knowledge for the governance of common-pool grazing resources in pastoral systems. Second, while pastoralists have the advantage that they can move with their livelihood to safer areas, the disadvantage is that pastoralist refugees are ‘invisible’ to aid organizations, unless they have lost their livestock and settle in refugee camps. Instead refugee pastoralists become part of the pastoral population of the host country with which they often already have connections through kinship and other networks. Studying refugee pastoralists will allow us to better understand the vulnerabilities and adaptive capacities of these ‘invisible refugees’.

RAPID: Studying the Impacts of Refugee Pastoralists on the Logone Floodplain

This research project will examine the impact of the humanitarian crisis in Northeast Nigeria on the pastoral system in the neighboring country of Cameroon. In the last two years, thousands of pastoralists have fled the insecurity caused by Boko Haram in Nigeria and moved with their livestock to the Logone Floodplain in the Far North Region of Cameroon. The question is how the influx of refugee pastoralists is affecting the management of common-pool grazing resources in the floodplain. In a prior research projected we have shown that mobile pastoralists were sustainably managing these grazing resources in a situation of open access (Moritz, Hamilton, Chen, et al. 2014; Moritz, Scholte, et al. 2013). We explained that management works as a complex adaptive system in which individual decision-making results in an ideal free distribution of grazing pressure over the available grazing resources. While pastoralists previously emphatically argued that access is open for all, regardless of ethnicity, nationality, seniority, or socioeconomic status (Moritz, Scholte, et al. 2013), it remains to be seen how strong the ethos of open access is when the number of newcomers increases many-fold. In other words, the big question is how resilient the pastoral system is. We will examine the resilience of the pastoral system in a number of ways. First, we will examine whether there is still an ideal free distribution of pastoralists over the available grazing resources. Second, we will examine whether and how the influx of refugee pastoralists strains the ethos and practice of open access. Third, we will investigate other ways in which the refugee crisis is straining the pastoral system. The urgency of this project is that at this particular moment the pastoral system is under the greatest stress and this allows us to study in real time whether and how the systems adapts or collapses.

RESULTS FROM PRIOR NSF SUPPORT

The proposed research builds on several interdisciplinary research projects, including a number that examine the dynamics of pastoral systems in the Far North Region of Cameroon.

CAREER Pastoral Management of Open Access: The Emergence of a Complex Adaptive System, (BCS-0748594, 2008-2013, $530,738), Mark Moritz (PI). Intellectual Merit: This project described and explained how mobile pastoralists in the Logone Floodplain, Cameroon sustainably manage common-pool grazing resources in a situation of open access. Broader Impact: The project contributed to the training of 13 undergraduate students from anthropology, geography, mathematics, and ecology and evolutionary biology. They have conducted ethnographic research in Cameroon, analyzed spatial data using ArcGIS, and modeled pastoral systems using NetLogo. In addition, we have communicated our findings and recommendations to policy makers in Cameroon and international fora (Kari 2015; Moritz, Catherine, et al. 2013), for example, by contributing to a background paper for the FAO and the World Bank (Behnke and Roger Blench 2014). This interdisciplinary study resulted in 12 publications (Moritz, Catherine, et al. 2013; Moritz et al. 2012; Moritz, Hamilton, Chen, et al. 2014; Moritz, Hamilton, Scholte, et al. 2014; Moritz, Hamilton, et al. 2015; Moritz, Handa, et al. 2015; Moritz, Ritchey, and Kari 2011; Moritz and Scholte 2011; Moritz, Scholte, et al. 2013; Moritz et al. 2010) and one agent-based model (Moritz, Hamilton, Yoak, et al. 2014).

EEID: Livestock Movements and Disease Epidemiology in the Chad Basin: Modeling Risks for Animals and Humans, (DEB-1015908, 2010-2015, $2,370,821), Rebecca Garabed (PI), Song Liang, Mark Moritz, and Ningchuan Xiao. Intellectual Merit: This project seeks to understand the epidemiology of infectious diseases in the ecological context of networks of host movements. A specific goal is to understand transmission and maintenance of Foot and Mouth Disease Viruses (FMDV) in networks of livestock movements in the Far North Region of Cameroon. Broader Impact: Graduate and undergraduate students from OSU and Universities of Maroua and Ngaoundére in Cameroon have been trained in the interdisciplinary study and modeling of the ecology of infectious diseases. The project has resulted in 11 publications (Healy Profitós, Moritz, and Garabed 2013; Healy Profitós et al. 2014; Moritz 2013; Moritz, Ewing, and Garabed 2013; Pomeroy, Bjørnstad, et al. 2015; Vougat et al. 2015; Xiao et al. 2015; Ludi et al. 2014; Pomeroy, Bansal, et al. 2015; Djaouda et al. 2014).

CNH: Exploring social, ecological, and hydrological regime shifts in the Logone Floodplain, Cameroon, (BCS-1211986, 2012-2016, $1,475,000) Mark Moritz (PI), Michael Durand, Ian Hamilton, Bryan Mark, and Ningchuan Xiao. Intellectual Merit: This interdisciplinary research project will focus on the impact of human activities and climate change on African floodplains. The goal is to develop an integrated computer model that simulates the dynamic couplings among social, ecological and hydrological systems of the Logone floodplain in Cameroon. Broader Impact: The goal of the project is to contribute to the sustainable management of African floodplains by using our integrated model to assist stakeholders in sustainable management of the Logone Floodplain by evaluating the impact of different human activities and climate change scenarios. We have presented several papers at national and international conferences and have papers published and in the pipeline (Fynn et al. 2015; Moritz et al. Under review).

EAGER: Modeling Coupled Herd and Household Dynamics in Pastoral Systems (BCS-1546061, 2015-2016, $37,756), Mark Moritz (PI), Ian Hamilton and Rebecca Garabed. Intellectual Merit: This project examines whether and how demographic dynamics at the herd and household level constrain the growth of livestock populations in pastoral societies. We are using multi-agent simulations to examine the impact of the domestic cycle of households on the demography of family herds and ultimately on regional livestock populations. Broader Impact: This project contributes to the training of undergraduate and graduate students in agent-based modeling and systems thinking. No papers or models have been published yet.

STUDY AREA AND POPULATION

The Logone Floodplain is flooded by the Logone River and its branches from September until November. After the water recedes in December, thousands of Arab and FulBe pastoralists from Cameroon, Nigeria and Niger move with more than 200,000 cattle into the floodplain making it one of the most important dry season grazing lands in the Lake Chad Basin (Seignobos and Iyébi-Mandjek 2000). Many remain there until the start of the rainy season in June, while others move to other seasonal grazing areas. Pastoralists find nutritious regrowth and surface water in the floodplain far into the dry season, when surrounding pastures have dried up. At the start of the rainy season, pastoralists return to Diamaré plains or their respective countries.

Our study area, called *Yaayre* in Fulfulde, is an approximately 800-km^2 section of the Logone Floodplain with well-defined boundaries of the Waza National Park in the west, the Logone River in the east, the irrigated rice fields of SEMRY in the south, and the village of Zina in the north (see Figure 1). The research site overlaps with the pilot zone of the Waza Logone Project (1990-2003), which started reflooding of the pilot zone by opening an old waterway in the embankment along the Logone River in 1994 (Scholte 2005; Scholte et al. 2006; Loth 2004).

The study population consists of all mobile pastoralists who use the Logone Floodplain at some point during the year. Many of them use the floodplain during the cold dry season in November and December when the water retreats and then either leave for the floodplain further north (*Yaayre Woylare*) or the lakeshore pastures of Lake Maga in the south (*Ndiyam Shinwa*). Before the influx of pastoralist refugees from Nigeria the population consists of approximately 1,000 households divided over approximately 130 camps and includes Suwa Arabs and FulBe, which are sub-divided in Jamaare, Mare, Alijam, Adanko, and Anagamba groups. These different FulBe groups are endogamous and have their own dialect, cattle breed, houses, and marriage system. There are reports that after the rise of Boko Haram in Northern Nigeria, more than thousand pastoralists, mostly Suwa Arabs, have moved to the Far North Region. If this were true, it would be a doubling of the pastoral population in the floodplain.

RESEARCH PLAN

Documenting the Distribution of Grazing Pressure over Grazing Resources

To document the distribution of mobile pastoralists and assess whether the distribution of grazing pressure matches that of grazing resources in the Logone Floodplain we will use a data collection and data analysis protocol that we have used successfully in prior studies (Moritz, Hamilton, Chen, et al. 2014; Moritz, Hamilton, Scholte, et al. 2014).

First we will use GPS/GIS technology to map the locations of all pastoralists' camps in our study area in the floodplain at three different times during the year (November, February, May). During these visits, we will identify all the households in the camp, the number of herds, the name of the campsite, and whether or not the pastoralists are refugees from Nigeria, and how long they have been in Cameroon.

To estimate the distribution of the available resources in the floodplain we will use remote sensing data, in particular the Normalized Difference Vegetation Index (NDVI), which is an indicator of the quality and quantity of forage. NDVI is one of the most common remote sensed vegetation indices for measuring the plant growth and vegetation cover (Anyamba and Tucker 2005), including in the assessment of pastoral ecosystems (Coughenour et al. 2008; Butt 2010). We will use MODIS MOD13A2 satellite data, which are collected every 16 days at 1-kilometer resolution, to calculate the NDVI values for our study area. While NDVI is not a reliable index for absolute measurements of vegetation, it is very useful as a relative measure of green biomass in the same area at the same time (Anyamba and Tucker 2005).

Using ArcGIS software, we will divide up our study area in a grid with 1-km^2 cells and calculate the NDVI value for all 1-km^2 cells in the study areas for the month of February. We will use pastoralists' camp zones as our habitats. To calculate the NDVI for

the camp zones we will create buffers with a 1.5-km radius around each campsite (using the GPS coordinates from our surveys). We will combine the buffers that overlap and shared toponyms into one larger buffer (e.g., all the buffers from the Cubuna campsites will be combined into one Cubuna buffer).

We will use a combination of statistical analyses to examine whether there is still an IFD of mobile pastoralists in the Logone floodplain (using GraphPad InStat (version 3.0a) and SPSS (version 19) for Macintosh). First, we will use descriptive statistics, t-tests, and analysis of variance (ANOVA) to describe and compare the NDVI values for the study area, as well as the occupied and unoccupied cells in the different years. Second, we will use descriptive statistics to describe the population of mobile pastoralists before the refugee crisis (2008-2012) and after the influx of refugees (2015-2016). Third, we will use correlations and multiple regressions to examine whether there is a correlation between the NDVI and the number of cattle for the camp zones in each year. We will also calculate for each camp zone the percentage of the NDVI and of cattle (as a percentage of all the camp zones combined for each year) to examine whether there is under-use or over-use of habitats and whether there is a correlation between the properties of each camp zone (e.g., NDVI, number of cattle) and under- or over-use.

Documenting Changes in Transhumance Movements

To document whether and how transhumance movements of Cameroonian and Nigerian pastoralists have changed as a result of the refugee crisis we will use existing instruments that we have used successfully in prior research projects to collect and analyze data on transhumance orbits (Xiao et al. 2015). We will document the annual transhumance of mobile pastoralists using transhumance surveys in which we census the whole population, i.e., all mobile pastoralists that use our study area in Logone Floodplain at some point during the year. In the survey we ask pastoralists the names of all the sites they had stayed in the previous year as well as how long they stayed in each site. By comparing the transhumance orbits before the refugee crisis (2008-2012) with the orbits after the crisis (2014-2016) we will able to determine whether and how transhumance orbits have changed. We will use a set of existing data analysis protocols in ArcGIS to describe the changes in orbits (Xiao et al. 2015; Kim et al. 2015).

Interviews with Nigerian and Cameroonian pastoralists

The semi-structured interviews with Nigerian and Cameroonian pastoralists serve several purposes. First, we aim to understand how Cameroonian and Nigerian pastoralists have changed their movement strategies to the increase in livestock populations. We are particularly interested in whether and how they changed their decision-making strategies. Second, we want to assess how strong the ethos of open access is now the number of newcomers has increased many-fold, for example, are Cameroonian pastoralists now more likely to engage in territorial behavior because there is increasing competition for grazing resources. Third, we seek to better understand the adaptive capacities of refugee pastoralists. In particular, we are interested how Nigerian pastoralists have used their social network and scouting strategies as they migrate to unknown areas. Finally, we also want to documents the hardships of the migration of Nigerian pastoralists and assess their

vulnerability. The semi-structured interviews will be conducted by Mouazamou Ahmadou, a visual anthropologist at the University of Maroua, with whom I have worked on several other research projects (Ahmadou and Drent 2015; Ahmadou 2010).

CONTRIBUTIONS

The main contribution of the project will be an assessment of the resilience of the pastoral system in the Far North Region of Cameroon when it is under considerable strain. I envision publishing two related papers. The first paper will examine whether there is a still an ideal free distribution of mobile pastoralists in the Logone Floodplain, after the influx of thousands of Nigerian pastoralists, using similar methods as in our earlier papers (Moritz, Hamilton, Chen, et al. 2014; Moritz, Hamilton, Scholte, et al. 2014). The second paper will focus on the plight of refugee pastoralists and examine their migration from Nigeria to Cameroon. Derrick Stenning has described three forms of pastoral mobility: transhumance, migratory drift, and migration (1957), in which transhumance is the regular seasonal movement; migratory drift the gradual displacement of the transhumance orbit; and migration a sudden and dramatic displacement of the transhumance orbit to an entirely new area. While the processes of transhumance and migratory drift have been well described (Bassett 1986; Bassett and Turner 2007), this is not the case for the process of migration. The paper will examine the hardships of the migration as well as the resources that refugee pastoralists draw upon as they move to unknown areas.

Intellectual Merit

Our prior research project has shown that mobile pastoralists can sustainably manage common-pool grazing resources in a situation of open access and that this management works as a complex adaptive system. Studying the impact of refugee pastoralists on the Logone Floodplain allows us to examine the resilience of this self-organizing system, as it unfolds in real time. We will able to study the process of adaptation or collapse. Our research project will investigate the impact at the individual and the system level, interviewing Cameroonian and Nigerian pastoralists about how they have adapted and changed their movement strategies in response to the increase in livestock populations.

Broader Impacts

There are two potential broader impacts. First, it is critical to know how resilient this self-organizing system is in the face of a massive influx of refugee pastoralists. I expect that we may learn much about the vulnerabilities and adaptive capacities of the system now that it is under considerable strain. This is critical knowledge for the governance of common-pool grazing resources in pastoral systems. Second, while pastoralists have the advantage that they can move with their livelihood to safer areas, the disadvantage is that pastoralist refugees are ‘invisible’ to aid organizations, unless they have lost their livestock and settle in refugee camps. Instead refugee pastoralists become part of the pastoral population of the host country with which they often already have network connections through kinship and other ties. Studying refugee pastoralists will allow us to better understand the vulnerabilities and adaptive capacities of these ‘invisible refugees’.

REFERENCES CITED

Ahmadou, Mouazamou. 2010. Nomads under Pressure. Maroua, Cameroon: Available at VIMEO.

Ahmadou, Mouazamou, and Albert Drent. 2015. One Year, Two Plains. Columbus, Ohio: Knowledge Bank, The Ohio State University.

Anyamba, A., and C. J. Tucker. 2005. Analysis of Sahelian vegetation dynamics using NOAA-AVHRR NDVI data from 1981–2003. *Journal of Arid Environments* 63 (3):596-614.

Bassett, Thomas J. 1986. Fulani herd movements. *Geographical review* 76 (3):234-248.

Bassett, Thomas J., and Matthew D. Turner. 2007. Sudden shift or migratory drift? Fulbe herd movements to the Sudano-Guinean region of West Africa. *Human Ecology* 35 (1):33-49.

Behnke, Roy, and Hamath Amadou Dia Roger Blench, Katherine Homewood, Alexandre Ickowicz, Carol Kerven, Peter Little, John McPeak, Mark Moritz, Michael Mortimore, John Morton, Ibra Touré, Abdrahmane Wane. 2014. Background Paper "Human, Social, Political Dimensions of Resilience" to inform the Flagship Report on "Economics of Resilience in the Drylands of Sub-Saharan Africa". FAO, IFPRI, World Bank.

Butt, Bilal. 2010. Pastoral resource access and utilization: quantifying the spatial and temporal relationships between livestock mobility, density and biomass availability in southern Kenya. *Land degradation and development* 21 (6):520-539.

Coughenour, Michael, Roy Behnke, John Lomas, and Kevin Price. 2008. Forage distributions, range condition, and the importance of pastoral movement in Central Asia - a remote sensing study. In *NATO Science for Peace and Security Series* edited by R. Behnke. Dordrecht (Netherlands): Springer.

Djaouda, Moussa, Thomas Njiné, Song Liang, Daniel Ebang Menye, Bouba Gaké, SergeHubert Zébazé Togouet, and Moïse Nola. 2014. Bacteriological Quality of Well Waters in Garoua, North Cameroon. *Water Quality, Exposure and Health* 6 (4):161-176.

Fynn, R. W. S., M. Murray-Hudson, M. Dhliwayo, and P. Scholte. 2015. African wetlands and their seasonal use by wild and domestic herbivores. *Wetlands Ecology and Management* x (x):xx-xxx.

Healy Profitós, Jessica, Mark Moritz, and Rebecca B. Garabed. 2013. What to do with chronically sick animals? Pastoralists' management strategies in the Far North Region of Cameroon. *Pastoralism: Research, Policy and Practice* 3 (8):11.

Healy Profitós, Jessica, Arabi Mouhaman, Seungjun Lee, Rebecca Garabed, Mark Moritz, Barbara Piperata, Joe Tien, Michael Bisesi, and Jiyoung Lee. 2014. Muddying the Waters: A New Area of Concern for Drinking Water Contamination in Cameroon. *International Journal of Environmental Research and Public Health* 11 (12):12454-12472.

Kari, Saïdou. 2015. l'Insécurité: Une menace pour le Pastoralisme. In *Atelier de concertation des acteurs sur la Préservation des Aires Protégées et la gestion de l'élevage dans la Région de l'Extrême-Nord*
. Maroua, Cameroon.

Kim, Hyeyoung, Ningchuan Xiao, Rebecca Garabed, and Mark Moritz. 2015. Describing and Explaining Patterns in Transhumance Orbits: Pastoral Mobility in the Far North Region of Cameroon. In *Manuscript in preparation*.

Loth, Paul, ed. 2004. *The return of the water*. Gland (Switzerland): IUCN.

Ludi, A., Z. Ahmed, L. W. Pomeroy, S. J. Pauszek, G. R. Smoliga, M. Moritz, S. Dickmu, S. Abdoulkadiri, J. Arzt, R. Garabed, and L. L. Rodriguez. 2014. Serotype Diversity of Foot-and-Mouth-Disease Virus in Livestock without History of Vaccination in the Far North Region of Cameroon. *Transboundary and Emerging Diseases*:n/a-n/a.

Moritz, Mark 2013. Livestock Transfers, Risk Management, and Human Careers in a West African Pastoral System. *Human Ecology* 41 (2):205-219.

Moritz, Mark, Larissa Bebisse Catherine, Albert K. Drent, Saïdou Kari, Arabi Mouhaman, and Paul Scholte. 2013. Rangeland Governance in an Open System: Protecting Transhumance Corridors in the Far North Region of Cameroon. *Pastoralism: Research, Policy and Practice* 3 (1):26.

Moritz, Mark, Daniel Ewing, and Rebecca B. Garabed. 2013. On Not Knowing Zoonotic Diseases: Pastoralists' Ethnoveterinary Knowledge in the Far North Region of Cameroon. *Human Organization* 72 (1):1-11.

Moritz, Mark, Zachary Galehouse, Qian Hao, and Rebecca Garabed. 2012. Can One Animal Represent an Entire Herd? Modeling Pastoral Mobility using GPS/GIS Technology. *Human Ecology* 40 (4):623-630.

Moritz, Mark, Ian M. Hamilton, Yu-Jen Chen, and Paul Scholte. 2014. Mobile pastoralists in the Logone Floodplain distribute themselves in an Ideal Free Distribution. *Current Anthropology* 55 (1):115-122.

Moritz, Mark, Ian M. Hamilton, Paul Scholte, and Yu-Jen Chen. 2014. Ideal Free Distributions of Mobile Pastoralists within Multiple Seasonal Grazing Areas. *Rangeland Ecology & Management* 67 (6):641-649.

NetLogo Model of Ideal Free Distribution of Mobile Pastoralists in the Logone Floodplain, Cameroon 3.0, Columbus (Ohio).

Moritz, Mark, Ian M. Hamilton, Andrew Yoak, Paul Scholte, Jeff Cronley, Paul Maddock, and Hongyang Pi. 2015. Simple Movement Rules result in Ideal Free Distribution of Mobile Pastoralists. *Ecological Modelling* 305 (10 June 2015):54-63.

Moritz, Mark, Sara Handa, Yu-Jen Chen, and Ningchuan Xiao. 2015. Herding Contracts and Pastoral Mobility in the Far North Region of Cameroon. *Human Ecology* 43 (1):141-151.

Moritz, Mark, Sarah Laborde, Sui Chian Phang, Mouazamou Ahmadou, Michael Durand, Alfonso Fernandez, Ian M. Hamilton, Saïdou Kari, Bryan Mark, Paul Scholte, Ningchuan Xiao, and Roland Ziebe. Under review. Studying the Logone Floodplain as a Coupled Human and Natural System. *African Journal of Aquatic Sciences*.

Moritz, Mark, Kristen K. Ritchey, and Saïdou Kari. 2011. The Social Context of Herding Contracts in the Far North Region of Cameroon *Journal of Modern African Studies* 49 (2):263-285.

Moritz, Mark, and Paul Scholte. 2011. Ethical predicaments: Advocating security for mobile pastoralists in weak states. *Anthropology Today* 27 (3):12-17.

Moritz, Mark, Paul Scholte, Ian M. Hamilton, and Saïdou Kari. 2013. Open Access, Open Systems: Pastoral Management of Common-Pool Resources in the Chad Basin. *Human Ecology* 41 (3):351–365.

Moritz, Mark, Eric Soma, Paul Scholte, Todd Juran, Leah Taylor, Saïdou Kari, and Ningchuan Xiao. 2010. An Integrated Approach to Modeling Grazing Pressure in Pastoral Systems: The Case of the Logone Floodplain (Cameroon). *Human Ecology* 38 (6):775-789.

Pomeroy, Laura W., Shweta Bansal, Michael Tildesley, Karla I. Moreno Torres, Mark Moritz, Ningchuan Xiao, Tim E. Capenter, and Rebecca B. Garabed. 2015. Data driven models of foot and mouth disease dynamics: a review. *Transboundary and Emerging Diseases* x (x):xx-xxx.

Pomeroy, Laura W., Ottar N. Bjørnstad, Hyeyoung Kim, Simon Dickmu Jumbo, Souley Abdoulkadiri, and Rebecca Garabed. 2015. Serotype-Specific Transmission and Waning Immunity of Endemic Foot-and-Mouth Disease Virus in Cameroon. *PLoS ONE* 10 (9):e0136642.

Scholte, Paul. 2005. Floodplain rehabilitation and the future of conservation and development: Adaptive management of success in Waza-Logone, Cameroon, Centre for Environmental Studies, Leiden University, Leiden (Netherlands).

Scholte, Paul, Saïdou Kari, Mark Moritz, and Herbert Prins. 2006. Pastoralist Responses to Floodplain Rehabilitation in Northern Cameroon. *Human Ecology* 34 (1):27-51.

Seignobos, Christian, and Olivier Iyébi-Mandjek, eds. 2000. *Atlas de la Province Extrême-Nord Cameroun*. Paris: IRD & MINREST.

Stenning, Derrick J. 1957. Transhumance, migratory drift, migration; patterns of pastoral Fulani nomadism. *The Journal of the Royal Anthropological Institute of Great Britain and Ireland* 87:57-73.

Vougat, Ronald Romuald Bebey Ngom, Harquin Simplice Foyet, Rebecca B. Garabed, Rol, and Ziebe. 2015. Antioxidant activity and phytochemical constituent of two plants used to manage foot and mouth disease in the Far North Region of Cameroon. *Journal of Intercultural of Ethnopharmacology* 4 (1):7.

Xiao, Ningchuan, Shanshan Cai, Mark Moritz, Rebecca Garabed, and Laura W. Pomeroy. 2015. Spatial and Temporal Characteristics of Pastoral Mobility in the Far North Region, Cameroon: Data Analysis and Modeling. *PLoS ONE* 10 (7):e0131697.