David Ambrosetti, Jean-Renaud Boisserie,
Deresse Ayenachew & Thomas Guindeuil, eds.

Climatic and Environmental Challenges

Learning from the Horn of Africa

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Corne de l'Afrique contemporaine | 5
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Climatic and Environmental Challenges: Learning from the Horn of Africa

David Ambrosetti, Jean-Renaud Boisserie, Deresse Ayenachew and Thomas Guindeuil (dir.)

Publisher: Centre français des études éthiopiennes
Place of publication: Addis-Abeba
Year of publication: 2016
Published on OpenEdition Books: 28 juillet 2016
Serie: Corne de l'Afrique contemporaine
Electronic ISBN: 9782821873001

http://books.openedition.org

Electronic reference
AMBROSETTI, David (ed.) ; et al. *Climatic and Environmental Challenges: Learning from the Horn of Africa.* New edition [online]. Addis-Abeba: Centre français des études éthiopiennes, 2016 (generated 05 October 2016). Available on the Internet: <http://books.openedition.org/cfee/101>. ISBN: 9782821873001. DOI: 10.4000/books.cfee.101.

In the prospect of the COP21 held in Paris in December 2015, the French Centre for Ethiopian Studies (CFEE) organised a scientific conference on environmental and climatic changes in the horn of Africa, with a decisive financial support of the *Institut français* (Fonds d'Alembert), Paris. The conference was part of a larger event, called "the Road to Paris" and organised by the French Embassy to Ethiopia and the Horn of Africa Regional Environment Centre and Network (HoA-REC&N), Addis Ababa University, in HoA-REC&N headquarters at Gullele Botanic Gardens, Addis Ababa, from 7 to 9 April 2015.

In this event, our first purpose was to set aside from the pressure of short-term and policy-oriented concerns raised by the international bureaucracies and bilateral donors, as to try to explore diverse, cross-disciplinary dimensions related to environmental change in the region in a wider way, wider in time and also wider in the elements observed. In a way, the Road to Paris event has also showed, with the various stakeholders and speakers it has gathered, that the issue of climate change has "solidified" automatic discourses, supporting wishful intentions and thinking, and clearly embedded in the building of professional opportunities and international careers. These discourses, indeed, are everything but close to the reality observed on the ground.

In this new, competitive, social field, priority may not be easily given to scientific exploration that is not directly policy-oriented and that requires a longer time to produce strong data than what the political and bureaucratic agendas allow. One could not state, though, that interest for science is totally absent in these arenas on climate change. But, invariably, public expectations appear to be much too high in scope and in time, compared to what intellectual curiosity and scientific processes and protocols can produce on a day-to-day basis. Improving awareness on environmental changes should start here: to give a better understanding on the complexity and multiplicity of factors involved in the relation between human evolution, societal choices and developments, and natural environments. The French Centre for Ethiopian Studies (CFEE) in Addis Ababa was quite well equipped to initiate, with its partners, such a cross-disciplinary exploration.

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TABLE OF CONTENTS

EDITOR'S NOTE

This publication has been supported by the French Embassy to Ethiopia and the *Institut français* (Fonds d'Alembert).

Introduction

David Ambrosetti, Jean-Renaud Boisserie and Thomas Guindeuil

1 In the prospect of the COP21 held in Paris in December 2015, the French Centre for Ethiopian Studies (CFEE) organised a scientific conference on environmental and climatic changes in the horn of Africa, with a decisive financial support of the *Institut français* (Fonds d'Alembert), Paris. The conference was part of a larger event, called "the Road to Paris" and organised by the French Embassy to Ethiopia and the Horn of Africa Regional Environment Centre and Network (HoA-REC&N), Addis Ababa University, in HoA-REC&N headquarters at Gullele Botanic Gardens, Addis Ababa, from 7 to 9 April 2015.

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4 The French Centre for Ethiopian Studies (CFEE) in Addis Ababa was quite well equipped to initiate, with its partners, such a cross-disciplinary exploration. In its 25-year long

history (not mentioning here its own "prehistory" bringing back to the permanent presence of French archaeologists in Ethiopia from the 1950s till 1974), it has been leading and supporting research in the Horn of Africa in various topics of direct or indirect interest for the matter of environmental changes, notably:

5 - the "deep past" of the humankind and its environments, thanks to the paleo-anthropological mission Jean-Renaud Boisserie has been leading on the Shungura Formation (Southern Omo) since 2006, in direct collaboration with the Authority for Research and Conservation of Cultural Heritage (ARCCH) of the Federal Democratic Republic of Ethiopia;

6 - the medieval and modern history of Ethiopia, thanks to our long-lasting collaboration with Deresse Ayenachew and the department of history and management of cultural heritage he is leading at Debre Berhan University, also with Margaux Herman through her historical investigation on women and gender in the Ethiopian history;

7 - as well as more contemporary and socio-political issues, such as the administration of land and the effects of the current constitution of the cadastre on the management of the Ethiopian natural parks, studied by Mehdi Labzae, the making of the Ethiopian heritage as a tool of national conscience awareness supported by foreign experts, explored here by Thomas Guindeuil, or the intervention of international organisations and their relations with the states in the region, studied by David Ambrosetti.

8 The conference has also allowed expanding CFEE's network to new researches on environmental changes with meaningful implications for the region. Wilfran Moufouma-Okia has shared with us his experience, as both a scientific and a practitioner, on the organisation of the COP21 and the way the African states engage today with the scientific debates on climate changes. Pierre Sepulchre reveals the rich lessons specialists of paleoclimatology have raised on the relations between climate change and biodiversity and the factors that may favour the conservation of biodiversity. Maxi Domke and Jürgen Pretzsch's paper raises more policy-oriented questions about the social structures involved in the local diffusion of relevant information on environmental challenges in rural areas. Were these locally-specific social structures to be neglected in any government-driven program, results would inescapably be suboptimal, at best, or even counter-productive. Julia Blocher explores the promises and limits of the forest governance through a review of the United Nations collaborative initiative on Reducing Emissions from Deforestation and forest Degradation in developing countries (UN-REDD). She particularly notes some weaknesses of the program, in terms of sensitivity to the local contexts and accountability to local institutions. And Joachim G. Persoon suggests that the religious cosmologies in Ethiopia, and particularly within the Ethiopian Orthodox Tewahedo Church, may provide with useful tools as to promote an ecological ethics and subsequent behavioural changes. He offers, in so doing, an original, and quite personal, insight on these cosmologies.

9 At the end, the conference has brought to some general conclusions that seem important to keep in mind in every debate and scientific enterprise related to environmental and climatic change:

10 - The long history of life, including humankind and its societies, represents a fantastic reserve of experience and lessons for who observes carefully, and locally, the diverse combinations adopted in reaction to environmental and climatic changes. The fossil record offers a better understanding of what are mass extinctions of biodiversity (an

ecological situation that human actions are probably now creating), what strategies of adaptation were deployed successfully or not, with certain species clearly grasping better opportunities than other and thus modifying the structure of the biosphere. Another example is given by the accounts inherited from explorers in Ethiopia, who have depicted the ecological situation of the country: we clearly see that indicators of environmental crises are social constructions, deeply rooted in cultural features, specific historical contexts and personal trajectories. The very processes of indicator construction are part of the scientific analysis of the overall phenomenon.

11 - It is nonsense to set climate apart from environment. Climate is one component of the environmental dynamics, and current human ways of life heavily impact other components as well (e.g., biodiversity). Considering climate alone narrows the spectre of the dimensions to be considered, the current situation being much better depicted as a "global environmental crisis" than as just a "climate change." The view on the sole climate seems to support the view that "the planet" needs to be saved, whereas a more systematic view on interdependent environments brings to the conclusion that the real issue at stake is the survival of human societies as we know them today, or, in the worst-case scenario, the interrelations between biodiversity and the survival of humankind as such.

12 - Nature conservation, built in direct relation with the realm of culture conservation, is an inescapable political process, mingling local competitions for resources, national impetus aimed at building territories and nations, and geopolitical affiliations framing international epistemic communities. One example is provided by the current framing of environmental issues in terms of gender policy.

13 - And for the states, the ability to hold a firm position on the scientific debates about climate change depends on multiple "technical" factors lying in the negotiation process itself. If indicators of environmental crises are socially determined and constructed, the same must be said about the construction of measurable objectives.

14 All in all, social, political, economic and professional interests have largely seized and covered the contemporary debates on the issue, so one can have doubt about the chances to see these debates trigger out deep transformations. This social world turning around the environmental issues (i.e., including climate) has added a new layer of interest and complexity one has to consider in order to look for positive reforms and social transformations for tomorrow in this regard. We hope that the texts that follow will contribute to inspire promising questioning and guidance for change.

15 The CFEE organisers would like to thank the partners of the conference, the French Embassy to Ethiopia, the *Institut français*, and HoA-REC&N, as well as the following colleagues who have accepted to participate to this event: Zewdu Eshete, Doris Barboni, Berhane Asfaw, Edwin Kumfa, Dong Gill-Kim, Facil Tesfaye, Tesfaye Tafesse, Fesseha Berhe, Guillaume Blanc and Peggy Frey, as well as the Climate Science Centre of Addis Ababa University, and, last but not least, the CFEE team in charge of the editorial work: Orin Gensler and Alexandre Girard-Muscagorry.

16 **To learn more about research engaged by the CFEE's teams in the various fields of environmental and social sciences in Ethiopia and the Horn of Africa, please visit our website (http://cfee.cnrs.fr) and our research blog (http://cfee.hypotheses.org).**

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African States, Climate Change and the COP21

Interview with Dr. Wilfran Moufouma-Okia

David Ambrosetti

Translation : Chloé Darmon

1 Dr. Wilfran Moufouma-Okia is a climate science expert at the African Climate Policy Centre (ACPC), an integral part of the Climate for Development in Africa (ClimDev-Africa) programme – which is a joint initiative of the United Nations Economic Commission for Africa (UNECA), the African Union Commission (AUC), and the African Development Bank (AfDB). ClimDev-Africa aims at addressing the need for greatly improved climate information for Africa and strengthening the use of such information for decision making, by improving analytical capacity, knowledge management and dissemination activities. It has been mandated at regional meetings of African Heads of State and Government, as well as by Africa's Ministers of Finance, Ministers of Planning and Ministers of Environment. The ACPC serves Regional Economic Communities, governments and communities across Africa and takes guidance from a number of on-going processes and activities including the African Union Conference of African Heads of State and Government on Climate Change (CAHOSCC) and climate change negotiators, United Nations Framework Convention on Climate Change (UNFCCC) and related instruments, African Ministerial Conference on the Environment (AMCEN), African Development Forum, Global Climate Observation System (GCOS), High level Advisory Group on Climate Change financing (AGF), and African Ministerial Conference on Water (AMCOW).

2 Wilfran Moufouma-Okia completed his PhD at the Grenoble Institute of Technology (*Laboratoire d'étude des Transferts en Hydrologie et Environnement*) and then became a senior regional climate modelling scientist at the U.K. Met Office Hadley Centre in Exeter. From the Ethiopian capital city of Addis Ababa, he actively contributed to the preparation of the COP21 with African governments, led number of debates which took place within the

Africa Pavilion, and worked towards raising awareness of the African authorities invited in Paris about the issues at stake during this meeting.

3 This interview was conducted on the 12th of March 2016 in Addis Ababa, as Wilfran Moufouma-Okia is about to leave the ACPC to join the Intergovernmental Panel on Climate Change (IPCC) as the director of sciences of IPCC Working Group I (within the Technical Support Unit based in Saclay) in charge of the analysis of the causes of climate change[1]. He reviews the lessons learned from the most important meeting on climate since Kyoto (1992) concerning the current role of the African continent in diplomatic and scientific discussions related to climate challenges.

What were the most important scientific issues at stake for African governments during the COP21?

The main issue is the threshold at which current global warming, which is undoubtedly partly caused by human activity, puts humans and societies at risk in different parts of the globe. Limiting warming to no more than two degrees has become the de facto target for global climate policy. This is in broad alignment with Article 2 of the objectives of the United Nations Framework Convention on Climate Change (UNFCCC 1992), i.e. 'stabilization of greenhouse gas (GHG) concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system'. But there are serious questions about whether policymakers can keep temperature rise below the two-degree limit, and what happens if they don't, particularly for Africa?

The need to limit global surface temperature rise below two degree above pre-industrial levels was first brought in by the European council of environment minister in 1996 with little scientific basis. But, it offered a simple focal point for discussions. Since then, three political challenges have emerged. First, the goal is effectively unachievable; owing to continued failures to mitigate emissions globally. Second, the 2 °C goal is impractical since it is only related probabilistically to emissions and policies, so it does not tell particular governments and people what to do. Third, more than half of the world's nations represented under the UN's Framework Convention on Climate Change are in favor of a tougher 1.5° C target. These include the least developed and most vulnerable countries, such as the small island states that are already losing farmland to rising sea levels. One of the major talking points during the negotiations at COP21 in Paris has been whether the international community should aim to limit global temperature rise to the internationally accepted 2° C above pre-industrial levels, or a more stringent target of 1.5° C.

The French Presidency of the COP21 first wanted States Parties to be able to assess whether they would collectively exceed the(se) dangerous threshold(s) by 2030. Each government was thus requested to voluntarily present how it would contribute to limit global warming by evaluating its amount of greenhouse gas emission in the coming fifteen years. Given the voluntary nature of these contributions (amounting a total of 55 gigatons of greenhouse gas emissions), participants acknowledged that the expected warming would considerably exceed 2 °C (which roughly corresponds to 40 gigatons of greenhouse gas emissions). In this respect, the emissions from African States are marginal, compared to those from big industrialized polluters.

In light with the above mentioned, a key science-policy challenge is the ability to assess the regional scale impact of a 1.5 °C global warming, particularly in countries 'of the

South'. Consequently, the COP21 invited the Intergovernmental Panel on Climate Change to provide a detailed and science-based report in 2018 on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathway. We will see whether this request will be echoed positively during the IPCC 43rd session scheduled to take place in Nairobi from the 11th to the 13th of April 2016[2]. In order to conduct such a spatially detailed assessment, it is however necessary to improve our understanding of the potential effects of climate warming, which cannot all be documented thoroughly. Each government around the globe will thus independently suggest its priority for a detailed report to be conducted by the IPCC. For instance, the effect of warming on coastal cities or melting of ice could be among subjects to be discussed. I will be directly involved in these discussions as part of my new position within the IPCC Working Group I.

When it comes to the African continent, the conclusion is straightforward: the available monitoring tools for basic research generally remain insufficient to meet the above-mentioned need for evaluation. For many, the reports of the IPCC are the only available source of information that can be used in debates. During discussions while preparing for the COP21, I have myself taught representatives of African governments that the scientific data currently employed did not take African specificities into account in any way, and that the role of the African continent in terms of greenhouse gases emission as well as climate change-related consequences was not clearly established.

Yet, these are the evidences all the following debates will be based on when we will have to make negotiated decisions to collectively deal with the challenges related to climate change and global warming, or when we will elaborate detailed financial demands on the major polluters of our Planet...

Why does Africa lack visibility?

The Intergovernmental Panel on Climate Change (IPCC) is the leading international body for the assessment of climate change. It was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) in 1988 to provide the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts. In the same year, the UN General Assembly endorsed the action by WMO and UNEP in jointly establishing the IPCC.

The IPCC reviews and assesses the most recent scientific, technical and socio-economic information produced worldwide relevant to the understanding of climate change. It does not conduct any research nor does it monitor climate related data or parameters. As an intergovernmental body, membership of the IPCC is open to all member countries of the United Nations (UN) and WMO. Currently 195 countries are members of the IPCC. Governments participate in the review process and the plenary Sessions, where main decisions about the IPCC work programme are taken and reports are accepted, adopted and approved. However, the IPCC recent review cycles have suffered from limited contribution of African scientists and research institutions.

But despite the fact that scientific capacities need to be reinforced, African political authorities did submit voluntary contributions.

Yes, the majority of African States submitted their contribution.

But each government followed its own method, including or excluding key economic sectors depending on the priorities it has set in order to promote the country's economic development. These voluntary contributions thus do not result from the use of a predetermined standardized methodology, or from a centralized auditing procedure systematically applied to each State Party.

Did African States Parties have the necessary knowledge to provide such data?

They benefited from outside support for this purpose, but once again, in an isolated fashion, depending on the existing relationships with given industrialized country or a given international development partner.

It always brings us back to the issue of the existence of scientific infrastructures specialized in this field in Africa. For now, there is real scope for improvement. The available scientific capacities are not sufficient for this. But, for the first time, these scientific shortcomings as well as the necessity of further data for future negotiations have at least been acknowledged by governments of the continent.

Within the IPCC, the need to establish a survey of the various methods employed by African States to assess their national contribution is becoming evident.

And, generally speaking, the scientific community is thinking of providing requesting States with 'climate services' in order to standardize and accelerate the available measures to deal with the challenges of climate change in business sectors that are widespread in several countries (such as fishing, for example), in partnership with universities, meteorological services, and so on. One should understand that major infrastructure projects, such as the PIDA program of the African Development Bank, do not have access to any systematic study regarding the effects of climate change yet. And you can imagine what may happen to a dam, on which a lot of money was spent, if important hydrometric variations are not taken into account! The need for basic research in this field is critical. In Europe, research dug deep into this issue. It has to be done for Africa.

Will States be able to modify the national contributions submitted on a voluntary basis in 2015 in the future?

Yes indeed. It gives us a chance to make data production more systematic. But the business sectors that each State chose to list in its contribution is also at stake. From this viewpoint, once a specific business sector has been submitted to the COP21, it is no longer possible to withdraw it from the list which will be considered in discussions to come. The only option is to keep (or update) the figures of greenhouse gas emission of this sector.

Did these contributions go hand in hand with binding commitments regarding the actual carbon emission rates reached by 2030? If so, the importance of the accuracy of the data submitted during the COP21 (and consequently the methods employed to establish them) would be even greater...

This issue has been debated and finally rejected. It was too difficult to apply from a technical viewpoint and it could have jeopardized the chances of reaching an agreement.

We have presented the main scientific stakes of the COP21, but who were the institutional representatives chosen by Africans to present and discuss these scientific arguments?

First of all, there is the African Group of Negotiators on climate change. It is made of personalities renowned for their knowledge of this topic, due to previous experience in other COPs for instance.

Initially close to the G77 at the UN, this Group is however not directly endorsed by all the African States. Nevertheless, it is recognized by the African Ministerial Conference on the Environment (AMCE), an internal body of the AU. The African Negotiators thus convey the decisions made at the COP to African governments through this AU internal body.

Each African State Party then has one vote within the COP. States Parties may have the feeling that they are not well represented by the stances of the African Group of Negotiators. This can of course generate difficulties and inconsistencies in announced stances.

It is important to keep in mind that this Group of Negotiators lacks resources. They are only five (as against the twenty members of the United Kingdom delegation, for example), and must deal with very different technical issues related to science, law, etc. Fortunately, the Group has received external assistance, notably from the African Union and thus from us, the IPCC, for the past five or six years. In line with this, I have been put in charge of assisting African States in elaborating the main scientific issues at stake to prepare for the COP21.

It is hence possible to say that the Group was far better prepared for this meeting than for previous ones. Its interventions were more precise and sharper. Members were clearly speaking with confidence rather than only listening and standing by.

But this did not prevent African States from presenting divergent opinions. Some, for instance, did not integrate issues related to the forest and deforestation, even though deforestation is an important factor in climate warming (given the role forests play in storing carbon gas). This was against the stances of the African Group of Negotiators, who very much counted on the positive role played by forests in this respect. Now, we thus need to concentrate our efforts on the representativeness and legitimacy of the Negotiators' stances to the eyes of all the African governments. Behind this lies a grievance regularly mentioned by African States: the feeling that the willingness of the international community to reduce the carbon gas produced by others (the most industrialized States) may, all things being equal, prevent them from reaching an identical level of industrialization and economic development.

More precisely, to which extent would African States agree to modify their current strategies for economic development in order to minimize their carbon gas emission?

This debate ultimately leads us to the demand for financial and technical means of supporting the efforts made to adapt to the situation and minimize carbon gas emissions. We are talking about money, but also about technology transfers. Countries who have been asked to contribute keep on mentioning the current economic conditions, which are tough for public finances, as well as the tremendous amount of resources that needs to be mobilized. Let us not forget the Global Climate Fund, which had launched the challenge of raising 100 billion dollars per year after the Copenhagen Conference.

Now, this is not only about money strictly speaking. Technical skills are a very important issue as well. Let us consider the market for the right to pollute adopted during the Kyoto Conference. Who is capable of building the highly technical cases required to have a chance at accessing the funds transfers organized by this market? Not all African States for sure. This market is not trivial for them; it remains addressed to industrialized countries because it is too expensive to access.

In efforts to address these weaknesses, the director of the IPCC, Ms. Fatima Denton, is insisting on the necessity to take into account the new opportunities opening up to adapt quickly to current changes, rather than only considering the negative effects that should be financially compensated. This is the case of renewable energies, for instance. There are economic opportunities that could be of interest to specialized companies in industrialized countries in the long run. But, before getting there, we need to believe in a number of promising sectors for the future and give them priorities in terms of scientific investment.

What about the role played by Ethiopia during the COP21?

Ethiopia has been held up as an example among African States. First of all, Ethiopian authorities quickly saw that Africa as such, with its needs, its opportunities, and its specific challenges, did not appear in the reports of the IPCC. A couple of years ago, the country thus decided to create an entirely Ethiopian micro-IPCC relying on the national scientific community, the Ethiopian Panel on Climate Change (EPCC). In each Ministry concerned, experts have been identified in order to collectively gather information useful to the country's authorities about the detailed consequences of climate changes. In the last two reports of the IPCC, a part is hence entirely dedicated to Ethiopia. Thanks to this, Ethiopia went to the COP21 with a truly national perspective. It no longer needed to constantly refer to the reports of the IPCC. The EPCC published its own report a few months before the Paris Conference. The scientific positions advocated were, of course, very much in line with the country's political vision, and especially with its five-year plans for economic development (the Growth and Transformation Plans). The fact that, in the margins of the Conference, the IPCC poached Ethiopian meteorological experts who got noticed in the course of the last months while preparing for the meeting is also quite revealing. Besides being a mark of recognition of the Ethiopian scientific and political voluntariness, it may indicate that the IPCC is not willing to let this kind of totally independent initiative spread. Indeed, such an example could be replicated and affect the principles of consensus and scientific unity of the IPCC. Ethiopia is actually the only country who dared to do this! If we take a look at other African powers, we see that they use a quite different strategy. Southern Africa is trying to ensure the presence of its scientists and elites in bodies of the IPCC (Working Group II on the effects of climate change is thus directed by a South African). Consequently, the African response has consisted in applauding Ethiopia, not –only– for its good results, but in support of its willpower for creating its own institution to specifically deal with national matters regarding climate change. Elsewhere, the scientific quality of the Ethiopian work has been questioned with more or less good faith. If this kind of initiative was replicated, in the island States for instance, it is the legitimacy of the IPCC that could be damaged.

Generally speaking, given the various tensions and disagreements mentioned above, it is hard to understand what kind of diplomatic alliances led African States to finally accept the agreement prepared during the COP21…

Globally, African States did come individually to the COP21, without proper coordination, despite the fact that there is an African Group of Negotiators. And even regions who share very strong common issues, such as the IGAD regarding droughts for instance, did not manage to turn these common issues into common stances during negotiations –at least I did not perceive them as such. No, if an agreement was reached, it is largely thanks to the substantive work carried out by French Negotiators to rally their diplomatic partners (including their African friends) in order to overcome the risks of blockage. I think that it is possible to say that the COP negotiations would have been very different if they had taken place in another country. Peru or Denmark clearly did not have the same diplomatic network as France did, especially on the African continent.

Yet, on the African continent, we hear that some are unhappy with this agreement, saying that it did not go far enough, etc.

Yes, the fact that the agreement does not include any binding commitment disappointed some countries. What will happen when we will realize that there are gaps between the numbers announced in 2015 and the actual amounts of gas emitted by 2030 (which is likely)? At this point it is important to consider were we started from: it was a very long shot.

NOTES

1. Working Group II and III are in charge, respectively, of the effects of climate change, and of the available means of minimizing the negative effects of global warming.

2. During this 43rd session held in Nairobi, IPCC has finally accepted the request to deliver a special report on the effect of a global warming of 1.5 °C.

INDEX

Mots-clés: COP21, climat, relations internationales, développement
Keywords: climate, international relations, development

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Environmental Changes and Their Impacts on Life: A Paleontological Approach

Jean-Renaud Boisserie

The “Fossil Earth”

1 We – meaning the whole living humankind – are facing a fast climatic change that is a harbinger of forthcoming dismal days (IPCC, 2014). Yet, we have a hard time at agreeing on what should be done to limit the effects of this change, as reflected by the resounding failure of the 2009 Copenhagen summit on climate change. Over the years, climatologists have refined their prospective scenarios based on ever more elaborate virtual climatic modellings, and they have convinced most of the scientific community. However, the conclusions of the IPCC report continue to trigger disinterest, suspicion, or even hostility from many policy makers, economic stakeholders, media and ordinary people, unwilling to change their present way of life and society.

2 To overcome this resistance, the wonderful science fiction author Terry Pratchett offered a solution. In *The Long Earth*, Pratchett & Baxter (2012) imagined that our Earth is only one iteration within an apparently infinite succession of parallel earths displaying slight climatic differences between each other, and that a small side step would be enough to travel from one iteration to another. By studying these parallel earths, scientists could work on life-size earth models, dropping most of the built-in uncertainties of their virtual models. Even better, “climate change skeptics” could see for themselves the effects of climate variations and finally understand what on-going changes mean for the whole humankind, themselves included[1].

3 Frivolous fancy? Yet I believe that, given the magnitude of our growing problems, we need all our assets, and the ability to envision the impossible is certainly not the least of them. Besides, I have good news: the Long Earth actually exists, and we can explore it!

4 Of course, it is not exactly the horizontal quantum continuum described by Pratchett & Baxter (2012); instead our long earth is formed by another type of parallel realities, vertically stacked within a temporal continuum of *ca.* 4.54 billion years, which could be called the "Fossil Earth." Indeed, the deep past of our planet[2] is a continuous sequence of extinct worlds that differ in their climatic conditions. Given their antiquity, the fossil witnesses of these worlds are unavoidably fragmentary and distorted. Yet, thanks to them and to hard work, we can study the main features and events of Fossil Earth worlds.

5 We can consider them as many "*in vivo* experiments" performed at global scale during thousands, hundred thousands, and millions of years. These experiments have an educational dimension demonstrating the effects of ancient events that can be compared with today's on-going changes, as well as a practical dimension: past data allows us to reach a deeper understanding of what is going on. This understanding is of course based on observing the incipient effects of on-going changes; but in the best cases, these observations started only a few decades ago, i.e. a ridiculously brief period of time considering the antiquity, complexity, and size of Earth. This results in a strong degree of uncertainty in extrapolating future consequences from recent observations. The time depth of Fossil Earth helps us to reduce this uncertainty and to refine predictive scenarios.

6 In this contribution, I propose to cruise some of Fossil Earth's worlds. Sepulchre (2015, this volume) conducted a similar exploration following a paleoclimatological approach. Doing this, he showed the connections between physical earth, climate, and biodiversity. This is important, because now at the beginning of the 21th Century, we are not merely facing a climate change. Rather, we are facing a multifactorial and global environmental crisis. There is a strong level of international commitment on the particular issue of climate change because it has been showcased by climatologists with energy and soundness, but in this crisis climate is only one component among others.

7 Within our observable part of the universe, Earth's biosphere is unique. As with climate, the biosphere constantly evolved through time, responding to physicochemical factors (abiotic parameters, including climate) as well as to its own action (biotic interactions). Biotic interactions are a key aspect of the on-going crisis. Exhaustion of marine resources by overfishing, land salinization by intensive irrigation, damage and pathologies brought by invasive species, decline in abundance of pollinating insects, and deforestation are examples of the major issues directly linked to biotic interactions – primarily interactions between our species and the rest of the planet. The impacts of these actions can be reinforced by climate warming, but they can also intensify the speed and harmful consequences of the latter[3].

8 Our planet has already gone through many large-scale environmental crises. The five most dreadful, called mass extinctions, resulted in the collapse of whole ecosystems at global scale and the extinction of most existing species within a relatively short time, generally less than two million years. Barnosky et al. (2011) asked the following question: are we now facing the sixth mass extinction in the history of our planet? They estimated that, given current trends, 75 % of living species should disappear in less than 11,330 years in the best-case scenario, and in less than 250 years at worst! Ceballos et al. (2015) suggested that the current extinction rates are eight to 100 times faster than the usual "background rates." So, these studies clearly lend support to the concept of "sixth mass extinction."

9 This paleontological exploration of the Fossil Earth first examines some of the previous mass extinctions. This should help in grasping their general traits which could also characterize the on-going biodiversity breakdown. The second half of my contribution deals with the tiny portion of Fossil Earth (0.15%) inhabited by humankind. Humankind has never before experienced a mass extinction, but the available fossil records and methodologies make it possible to observe our ancestors' responses to past environmental changes. The work currently being carried out in the Lower Omo Valley in Ethiopia illustrates this. In addition, even if major aspects of our evolution are still poorly understood, it is possible to learn some lessons from the travel of humankind through the Fossil Earth.

Serial apocalypses

10 The five greatest biotic crises[4] have all resulted in the loss of at least 75% of existing species. These events lasted from more than 20 million years to less than 100,000 years, if not (in one case) in less than a year! They were all triggered by more or less well understood combinations of factors, which all seem to differ from each other in details. Following are depictions of three of these events, starting with the biotic crisis that occurred during the Late Devonian, around 372 Ma (the Mega-annum, or Ma, is the international system unit used for dates in million years).

The Frasnian-Famennian crisis

11 Barring the quite unlikely release of a "Spielbergian" *Devonian Park*, the Devonian (419 Ma – 359 Ma) will remain a period largely unknown to the general public. Yet, it was a turning point in life history. During the Devonian, terrestrial ecosystems gained momentum, notably with the establishment of the earliest forests (e.g., Meyer-Berthaud & Decombeix, 2012)[5] and the appearance of the two most important groups of terrestrial animals: the insects (Glenner et al., 2006) and the tetrapods (Clément & Letenneur, 2009). Today, the former group has the greatest land diversity and the heaviest land biomass, and plays a vital role in ecosystem life (notably by pollinating flowering plants). The earliest known insects were Devonian terrestrial forms.

12 The latter group included the ancestors of all extant land-based vertebrates, including *Homo sapiens*. Unlike fishes, the first Devonian tetrapods, all aquatic, displayed two pairs of limbs with digits, which later allowed their descendants to invade land[6]. The Devonian tetrapods were relatively discreet, and the dominant vertebrates and the true rulers of the Devonian seas were the placoderms, a major group of armored fish and also the earliest jawed vertebrates, including the spectacular *Dunkleosteus*[7].

13 This distant Devonian world lost *ca.* 75% of its species before 359 Ma. The tropical marine environments were by far the most severely impacted. The rich coral and sponge reefs were destroyed and the placoderms met their end. On the continents, many plants disappeared, while freshwater tetrapods became so few that they literally vanished from the fossil record until much later.

14 The duration and complexity of this event distinguish it from other mass extinctions. It happened in several waves spread over more than 20 million years. The main peak, centered on the transition between the Frasnian and Famennian ages (372 Ma), lasted for

about 1.5 million years. The proposed causes are diverse, including a succession of meteorite or comet collisions with Earth. However, the most likely direct causes were a climate cooling, perhaps involving a glaciation, and a dramatic decline of marine water oxygen – or anoxia (McGhee in Briggs & Crowther, 2001: 223).

15 These immediate causes, however, could have had a single source: the Devonian forests (Algeo & Scheckler, 1998). The rapid expansion of the earliest forests and the root penetration of their trees led to the formation of thick soils. These soils contributed to substantially modifying the patterns of land erosion, triggering a massive input of nutriments into continental and marine waters. Resulting massive algal blooms probably caused the observed global marine anoxia. In addition, Devonian forests pumped out a lot of the atmospheric CO_2, sequestering it in soils[8]. This decrease of atmospheric CO_2 may have led to global cooling[9]. After the Devonian, the establishment of an atmospheric cycle integrating the plant sequestration of CO_2 restored the balance.

The Great Dying

16 Contemporaneous with the onset of the supercontinent named Pangea[10], the end of the Paleozoic era (541 Ma – 252 Ma) was defined by the greatest mass extinction of all times: the final Permian event, when about 96% of species went extinct. Groups that had populated the seas for almost 300 million years vanished. This is the case of the trilobites [11], already weakened by the Late Devonian crisis, and of various large, sessile organisms[12] of the sea floors. On land, the main herbivorous and carnivorous species of reptiles[13] and amphibians were killed, as well as the main forest tree species. And this was the only time that insects were strongly impacted by a biotic crisis (Wignall in Briggs & Crowther, 2001: 226).

17 Once again, the direct causes of this event were probably multiple (Lane, 2007), including a dramatic decrease in atmospheric and marine oxygen content, an increase of greenhouse gases (CO_2 and probably methane), and local abundances of sulfur gases in seas. Global temperatures rose by 6 °C, terrestrial and marine biotas suffocated or were even poisoned by sulfurs and acid rains, while the acidification of the seas compromised the development of hard tissues by marine organisms. The primary culprit of these cataclysmic conditions is most likely immense volcanic activity, knocking out environments relatively weakened by rather low oxygen concentrations and a relatively dry climate. For about one million years, a series of eruptions released 3,000,000 km^3 of basalts forming the Siberian "traps"[14] and a huge quantity of greenhouse gases and atmospheric acids, also possibly altering the ozone layer.

18 A particularly striking aspect of the terminal Permian event is the rhythm of ecosystem recovery. The redevelopment of stable and complex sea floor ecosystems took about nine million years (Chen & Benton, 2012). In the aftermath of the killing, the sea floors were mainly covered by microbial crusting. Later, opportunistic organisms (notably bivalve seashells) gained ground, forming extremely monotonous faunal assemblages attesting to low biodiversity levels[15]. This situation lasted for several million years.

19 This extinction largely shaped the post-Permian Fossil Earth. Indeed, the surviving organisms were those able to live despite low oxygenation. Sea floors became dominated by burrowing or wandering mollusks (bivalves and gastropods) and decapod crustaceans (crabs, shrimps, etc.), a structuring which still prevails today. The decimation of Paleozoic land tetrapods favored the emergence of new major groups that became the rulers of the

succeeding eras: marine reptiles, archosaurs[16], and mammals. The greatest mass extinction of all times hence triggered the evolution of more complex, further diversified, and more efficient organisms.

The K/T crisis

20 The K/T[17] boundary separates the Cretaceous (145 Ma – 66 Ma) from the Cenozoic era (66 Ma – present). During the Mesozoic era (252 Ma – 66 Ma), the seas were dominated by ammonites and marine reptiles, while archosaurs ruled on land and in the air.

21 The ammonites[18] were part of the same biological group as octopuses and squids (the cephalopods), but they differed from these in having a chambered spiral shell allowing precise control of vertical motion, like the use of ballast in submarines. These animals, living in the depths as well as near the shores, occupied an intermediate, particularly rich level of the oceanic food chain. Various marine reptiles[19] crowned this food chain, such as ichthyosaurs[20], which were fully adapted to aquatic life in the same way living cetaceans are. At the bottom were planktonic and coralline organisms, extremely abundant in Mesozoic epicontinental seas, as indicated by the thick calcareous and chalky rocks they formed.

22 Archosaurs had quickly diversified during the early Mesozoic. Among them, the famous dinosaurs[21], including the largest land animals ever, proliferated during the Jurassic (201 Ma – 145 Ma) and the Cretaceous. Despite popular imagery, we now know that these animals were not archaic and stupid, but in fact formed complex ecological communities and could display elaborated behavior such as gregariousness and parental care. Another major success of the Mesozoic archosaurs was the conquest of the air. This was performed by the pterosaurs (or flying reptiles)[22] and by a group of dinosaurs, the Maniraptora, from which the birds emerged[23].

23 This Mesozoic World, densely populated and well-structured, was overturned by the most famous of all mass extinction events (rate of species extinction: 76%). Among other groups, the dinosaurs died out at this time. Again, this event was probably caused by a combination of catastrophes. Around 66 Ma, a new sequence of volcanic eruptions build the Deccan traps in India, piling basalts over more than 2 km in some places. Although less massive than the final Permian traps in Siberia, the Deccan traps formed in a shorter time, and some of these eruptions may have released huge quantities of sulfur gases into the air within years or decades (Archibald et al., 2010; Courtillot & Fluteau, 2010; Keller et al., 2010). Ecosystems were probably already quite weakened by this volcanic pollution when they received the *coup de grace*: a 10-km-diameter asteroid fell near the northern tip of the Yucatán Peninsula in Mexico, creating the Chicxulub crater with a diameter of *ca.* 180 km.

24 This impact generated a global shock wave with giant fires, and above all sent into the atmosphere hundreds of millions of tons of dust and no less than one hundred billion tons of sulfur gases, occulting sunlight for a long duration (Schulte et al., 2010). The resulting “winter” was probably uninterrupted for several years. Plankton, corals and land vegetal cover were largely destroyed. Land masses were for a time covered by fungi, then by ferns. All the dominant groups described above were exterminated, except the avian branch of the dinosaurs.

25 Again, this mass extinction event helped outsiders to replace the former rulers, mammals being a very good example. Mammals appeared during the Mesozoic at *ca.* 225 Ma, i.e. only a few million years after the dinosaurs. Although important phases of their phylogenetic and ecological diversification took place during this era, they remained discreet and largely overshadowed by archosaurs in the ecosystems. After the K/T crisis, however, the surviving mammals went through an impressive diversification and came to replace the missing archosaurs and marine reptiles. This trend culminates today with the grip of humankind on the entire planet.

Exegesis of biosphere serial apocalypses

26 This quick survey of three great biotic crises indicates that if some crises had external primary causes (e.g., volcanism and meteorites), others had internal causes: in other words life destroyed life. This is likely the case with the rapid expansion of late Devonian forest ecosystems, the primary source of a crisis that terminated 75 % of living species. I would like to mention another, much more ancient example. From *ca.* 3,800 Ma onward, unicellular photosynthetic organisms started to release massive quantities of oxygen (O_2) in the Precambrian environments. Today vital for most living beings, oxygen was then toxic to most organisms which had an anaerobic metabolism. At first all this oxygen was captured in the process of oxidizing oceanic iron. By 2,400 Ma, this process was largely complete, and the oxygen could now be released as free oxygen into the seas and the primitive atmosphere. This triggered an ecological crisis during which opportunist aerobic life forms (using O_2 in their metabolism) put an end to 1.5 billion years of dominance by anaerobic organisms. Therefore, life has been able to deeply and lastingly modify the physicochemical and biotic conditions prevailing on Earth's surface.

27 Whatever tremendous biotic crises occurred, life always recovered and even more. After each sinking of a Fossil Earth world, the emerging world was more complex, lusher, and more sparkling. Yet, this was far from being an easy process: for every single major environmental crisis, the planet remained tarnished for a long time, and the emergence of bright new worlds always took millions of years (possibly about 10 after the Permian, and at least five after the K/T crisis).

28 These recovery phases did not benefit the pre-crisis dominant organisms, however complex and efficient they may have been. On the contrary, these organisms were generally the most severely affected. The extinction of non-avian dinosaurs is a typical case: despite their dominant position, they appeared more sensitive to abrupt changes than relatively more discreet groups, such as mammals.

29 It is tempting to explain the favorable fate of mammals and birds at the K/T boundary because they seemed more gifted than dinosaurs: they were small-sized, warm-blooded, smart, and occupied peculiar ecological niches (burrowing, arboreal, or flying). However, this explanation does not hold up to scrutiny. Indeed, many species of mammals and birds perished during the K/T crisis, while other groups lacking these alleged advantages did survive, such as crocodilians. In addition, we now know that small size, efficient thermoregulation as well as complex behaviors and ecologies also characterized various dinosaurs and pterosaurs.

30 Instead, I would like to suggest that the very dominance of dinosaurs, ammonites and marine reptiles could have been their main weakness as well. Thanks to their

morphological and physiological innovations evolved during the early part of the Mesozoic, these animals gained privileged access to the most abundant and the highest quality of primary resources. Because of this preemption, Mesozoic ecosystem structures were influenced by the ecological characteristics of these dominating groups. A high level of competition within these groups was supported by high levels of biomass consumption, favoring lush evolution and long-term ecological dominance. But it is possible that such important energy needs made them eminently sensitive to extreme scarcity situation. With the K/T apocalypse, the collapse of most primary producers led to the downfall of the primary and secondary consumers that had been best integrated within the Jurassic-Cretaceous ecosystems. By contrast, the most marginal fringes of these ecosystems, more often exposed to resource scarcity or to low quality resources, were probably more efficient in responding to a catastrophic change. This was notably the case of fungi, ferns, some mammals, some birds, some crocodilians, etc.

31 Finally, one can note that during the ~135-million-year rule of non-avian dinosaurs, no other group superseded them. If Mesozoic conditions had remained more or less stable, it is quite likely that this ecological balance would have lasted another 66 million years. Consequently, Earth would be currently dominated by further evolved, non-flying dinosaurs, and mammals would have never experienced the evolutionary radiation that led to horses, elephants, cetaceans, and chimpanzees. In other words, we are the children of the K/T event...

Humankind[24] facing environmental changes in the Fossil Earth

32 All fossil witnesses of humankind older than 1.8 Ma have been discovered in Africa. This is true in particular for the most archaic such remains, dated to between 7 Ma and 4.4 Ma and characterized by frequent bipedalism and relatively small-sized canines (Senut et al., 2001; Brunet et al., 2002; Haile-Selassie et al., 2004; White et al., 2009). Later on, most of the main events in our evolution also took place in Africa, including the emergence of our own species at *ca.* 200 ka[25] (Day, 1969; White et al., 2003; and for a summary, Boisserie, 2011). "Fossil Africa" is therefore a key part of the Fossil Earth for observing the long-term impact of environmental changes on humankind.

33 For a long time, scientists have looked for correlations between environmental events and the main phases of human history. Two hypotheses gave assigned central role to abiotic factors of regional or global scale. The first one, nicknamed "East Side Story," aimed at explaining the origin of bipedalism (e.g., Coppens, 1994). In this scenario, the formation of the Arabo-African rift system[26] drove the drying out of eastern Africa. The resulting opening up of landscapes selected eastern African hominoid primates more able to move efficiently outside forests, i.e. those that developed bipedalism and that h the earliest representatives of humankind. Some aspects of this hypothesis have since been validated, notably the climatic impact of the rift formation (Sepulchre et al., 2006). However, the discovery of fossil humans in central Africa, older than the eastern African ones (Brunet et al., 2002), as well as the reconstruction of wooded habitats for ancient human species in eastern Africa (WoldeGabriel et al., 2001; White et al., 2009), disagree with a simple causal relation between the tectonics-climate coupling and bipedalism.

34 The second hypothesis correlates the emergence of genus *Homo* and the ability to make stone tools with a global climatic cooling that led to further aridity and thus an even greater opening up of African landscapes (Coppens, 1975). At a more general level, this hypothesis links the evolution of African fauna (including humans) to global climatic changes (e.g., deMenocal, 1995; Behrensmeyer, 2006; deMenocal, 2011). In its various versions, it puts forward single events (Vrba, 1995), climate variability (Potts, 1996), or cyclical phenomena (Trauth et al., 2005) as the main drivers.

35 All these hypotheses face a difficulty in establishing strong enough correlations between the record of environmental evolution and that of biotic evolution (e.g., White, 1995). This requires particularly precise records, but also the examination of multiple factors, inasmuch as a good correlation does not necessarily warrant a causal relationship. In addition, human remains are particularly scarce, even in the giant fossil accumulator constituted by the eastern African rift. If, after decades of research, this record still suffers from many gaps, we nonetheless do have good assets for improving the situation. I propose to describe one example of these assets: the Shungura Formation in the Lower Omo Valley, southwestern Ethiopia.

A natural laboratory for testing the human-environment interactions in the past

36 At *ca.* 2.8 Ma, our evolution experienced a major twist: the emergence within humankind of two major parallel branches. On the one hand, robust australopithecines were displaying particularly strong jaws and molars compared to other humans[27]; on the other hand, the forerunners of genus *Homo*, to which we belong, had slender jaws and a supposedly more developed brain. Roughly at the same time, the cycle of northern hemisphere glaciations was beginning and the global climate became more unstable and cooler, possibly with more marked seasons, all this resulting in more open landscapes. Many scientists see a causal relationship between this climatic change and the concurrent evolution of robust australopithecines and forerunners of *Homo*.

37 The Shungura Formation provides an excellent record of these events. Most other contemporaneous deposits in Africa are limited, characterized by a reduced spatial extension and/or gaps in the record. To the contrary, the deposits of the Shungura Formation crop out over an area of on *ca.* 160 km² and constitute a particularly well-dated, thick and continuous sequence dated to between 3.6 Ma and 1 Ma (Heinzelin, 1983; Feibel et al., 1989). This sequence is rich in remains of the past: about 49,000 fossils of vertebrates were discovered during the 1960s-1970s, including many ancient human remains as well as stone tool series which are among the oldest known tools (*ca.* 2.3 Ma). Given its extension, its temporal depth, its continuity, its richness and the nature of its fossil record (Coppens et al., 1976; Boisserie et al., 2008), the Shungura Formation can be seen as a real "natural laboratory" where evolutionary dynamics, their causes and their impacts can be observed within the "Fossil Omo Valley."

38 Whereas existing museum collections are often used to establish correlations between global climatic changes and faunal changes (e.g., Bobe & Eck, 2001), new fieldwork we have performed at Shungura since 2006 (Boisserie et al., 2008; Boisserie et al., 2010) has been much more narrowly focused, specifically targeting the impact of local scale factors on the Omo Valley ecosystem. This includes the human populations as well as the biotic and behavioral responses of these populations to the evolution of local factors.

39 For this, our team first had to expand the available data on human evolution in the Omo. Its work has resulted thus far in the discovery of 35 human fossils, including isolated teeth, jaws, and limb bones. The study of these fossils should help clarify the diversity of our ancestors, in particular the identity of the forerunners of genus *Homo* at *ca.* 2.5 Ma. At the same time, new research on the stone tool industry produced by these populations helps to understand their behaviors and cultures (Delagnes et al., 2011; Maurin et al., 2014).

40 Another goal of our work is to characterize as accurately as possible the local ecosystem and its evolution from 3.6 Ma to 1 Ma. This involves first the examination of sedimentary deposit features for reconstructing the environmental conditions that resulted in their formation (e.g., meandering rivers, deltas, or deep lakes). This also includes larger scale dynamics that, through time, shifted these environmental conditions across the landscapes.

41 The past biodiversity of the Omo Valley is another critical corpus of data. The analyses of this biodiversity, reinserted into its geographic, temporal and environmental context, focus primarily on key vertebrates, such as antelopes, pigs, hippos, fish, monkeys, and of course humans. Not only do our analyses contribute to documenting faunal changes at ecosystem scale, but they also target the evolutionary history of each individual group, exploring different modes and factors of evolution.

42 Finally, the reconstruction of the Omo Valley past environments involves reconstructing the vegetal cover. This can done partly by using direct evidence, such as fossil wood, pollens, silica particles formed in vegetal tissues (phytoliths), and the biogeochemical compounds preserved in fossil soils (for an example combining these methods, see Barboni, 2014). Indirect evidence can be also used: the diet of past herbivorous animals can be estimated by quantifying the biogeochemical compounds found in their tooth enamel, as well as the microscopic wear marks on teeth which vary from one type of food to another. Finally, past seasonal cycles can be observed thanks to the markers of water evaporation, also preserved in the dental enamel of animals that drank or lived in this water.

Observed human responses to past environmental changes

43 The Omo Valley presents us with a record of several disruptions in its ecological history. The first one is witnessed by a dietary change in several species around 2.8 Ma (Bibi et al., 2013), likely indicating a change in vegetal cover. This event occurred just before the appearance of robust australopithecines in the valley and, possibly, of the forerunners of genus *Homo*.

44 The second disruption is a major faunal turnover[28] at *ca.* 2.4 Ma, preceding by 100,000 years the sudden appearance of stone tools in the valley. These tools, made from quartz pebbles that were carefully selected, immediately became abundant in the landscape (Delagnes et al., 2011). At the same time, robust australopithecines further specialized, their cheek teeth becoming even larger and their incisors and canines even more reduced[29].

45 The third disruption seems to correspond to a biogeographic isolation of the valley from 2 Ma onward, suggested by a peculiar endemic fauna (Boisserie, 2013). At the onset of this isolation, the Lake Turkana waters drowned the Omo Valley, then receded. Stone tool

making was mostly or totally stopped after 2 Ma, although robust australopithecines and *Homo* inhabited the valley continuously until 1.4 Ma. At this date, robust australopithecines vanished, *Homo* remaining alone in the valley.

46 This sequence of events is an opportunity for testing the mechanisms and factors controlling ecological changes, biological evolution, as well as the acquisition and loss of technological activities in this valley. In fact, the Shungura evolutionary record illustrates the various categories of human responses to the environmental challenges that occurred throughout its deep history.

47 A first category of human response is the adaption to environmental changes through innovations. Innovations have been morphological, physiological and ecological: e.g., when habitats opened up and dried out, the strong teeth and jaws of robust australopithecines made it possible to feed on hard and/or abrasive foods at least occasionally (Ungar, 2011). The slender body acquired by some representatives of *Homo* by 1.8 Ma (e.g., Lordkipanidze et al., 2007) is another example of adaptive innovation: in the context of a retreating or vanished forest cover, it probably made it easier to travel long distances under the sun and the eyes of predators. To the contrary, the stocky body of the Neanderthals (known from *ca.* 400 ka to *ca.* 40 ka from western Europe to central Asia) was well-adapted to cold climate (Weaver, 2009). Innovations were also behavioral (e.g., Foley & Gamble, 2009), including notably the early development of stone industries (Semaw et al., 2003; Harmand et al., 2015) and the successive stages of their diversity and complexity.

48 Other human responses seem more like reversals than innovations. Morphologically speaking, the most striking case could be that of *Homo floresiensis*[30]. This species, discovered in 2003 on Flores Island in Indonesia and dated to *ca.* 14 ka for the youngest remains, came as a surprise by virtue of the small size of its braincase and its body, size-wise more similar to human species known in Africa *ca.* 2 Ma than to recent ones (Brown et al., 2004). What happened to the humans who settled on Flores at *ca.* 1 Ma (Morwood et al., 1998)? In an insular context, typified by geographic isolation and limited resources, many species have experienced a dramatic decrease in their body size (Sondaar, 1977), and in some cases in brain size (e.g., Weston & Lister, 2009). The Flores humans possibly went through such insular evolution, leading to a pygmy species that, on the brink of our modern world, had an encephalization quotient[31] not much different from that of an australopithecine.

49 More clear-cut "reversal" cases are known from the techno-cultural record. The case of the Omo quartz industry, i.e. the loss or abandonment on know-how correlated with an environmental change, is not an isolated one. Between *ca.* 40 ka and 12 ka, the material culture that developed during the last glaciation in Western Europe, called the "Upper Paleolithic," produced remarkable art pieces, globally renowned thanks to the cave paintings of the Lascaux Cave and the Chauvet Cave[32]. This culture blossomed within populations that were technically and culturally adapted to the then-cold and dry climate of this region, with an economy principally based on the hunting of steppe mammals. With the quick deglaciation and withdrawal of these animals at *ca.* 12 ka, the western Europeans were thrown into a new world, the Holocene[33]. Undoubtedly puzzled by these new conditions and probably pushed back to the brink of survival, these people drastically reduced their artistic practices, now mostly limited to decorated pebbles[34].

50 Finally, a last type of human response is pure and simple extinction. Humankind has been composed of several contemporaneous species probably for most of its history. Today,

there is only one species, which means that other lineages went extinct. The robust australopithecines, living side by side with *Homo* for more than 1.5 million years, vanished definitively between 1.4 Ma and 1 Ma. Until very recently, three very different groups of humans existed at the same time: Neanderthals, *Homo floresiensis*, and our species. Neanderthals went extinct by 40 ka, the Flores pygmies by 14 ka. In each case, plausible causes were either abiotic changes (such as the intensification of the last glaciation impacting Neanderthal habitats) or biotic changes (notably, the expansion of *Homo sapiens* to Western Europe and Flores). As for biotic crises, a combination of these factors is quite likely, and may well explain the extinction of the robust australopithecines in Africa. In this latter case, it is also possible that their morphological specializations had led them to an evolutionary dead end.

Lessons from extinct worlds

51 This exploration of the Fossil Earth may tend to reassure incurable optimists about on-going changes. After all, life, toughened by the previous mass extinctions, will most probably go on beyond this crisis too. The massive anthropization of our planet, one might argue, is just another step in its transformation by life: bacteria, then land vegetation, have previously dramatically altered the original state of Earth, so why not us? This is a philosophically interesting viewpoint. However, at the risk of disappointing professional lobbyists for skepticism regarding climate change and citizens irritated by authoritarian ecological dogmatism, it does not have much immediate practical use for us.

52 First, the claim of "anthropization as just another step" might well turn against us in a not-so-distant future, on the occasion of Earth's next evolutionary step made, for example, by artificial intelligences[35]. Second, if we consider only the reduction of biodiversity, which gets much less coverage in the mass media than global warming, it not only entails great suffering for wild species, but also for humankind and its commensals. This not only implies the erosion of supposedly renewable resources vital to many people (in particular marine and forest resources), but it also involves the dysfunction of major services provided by natural ecosystems (Cardinale et al., 2012; Johnson et al., 2013): carbon sequestration, soil fertilization, pollination, and limitation of pathogens and pests are threatened processes. In addition, one can note that wildlife has always been a great source of inspiration and innovation for human cultural and technological advances. Some examples are Upper Paleolithic art, mostly portraying non-human species[36], medical research, and various religious myths. are examples among others. So a decline in biodiversity also means the disappearance of some of our cultural foundations and of sources for future innovations.

53 Observations of the past in general and paleontology in particular do not provide ready-made solutions for improving the situation. Yet, on the basis of past natural experiments, paleontologists can provide a more robust scientific basis for anticipating faunal and vegetal responses to environmental changes than extremely short-term observations. Investigation of past life therefore plays an increasing role in the process of decision making for preserving extant biodiversity (Dietl & Flessa, 2011; Blois et al., 2013). There is room for significant improvement in this area, notably thanks to renewed multidisciplinary studies of exceptional sites, in particular in Africa, such as the Lower

Omo Valley. In this regard, heritage management is a key aspect of such future researches [37].

54 Scrutiny of the Fossil Earth finally offers a general framework for thinking, without which what is at stake hardly makes sense for too many of us[38]. I would like to conclude by sketching this framework with some general remarks based on the observation of deep past life.

55 Paleontology reveals the considerable impacts of environmental change on life over the course of its history. We live in a constantly changing world, a fact which is not obvious on the scale of a human life.

56 Compared to the background rate of past changes, the on-going changes are close in their speed and intensity to the most sudden and catastrophic events of all of Earth history (Barnosky et al., 2011; Ceballos et al., 2015; Sepulchre, 2015, this volume). In this and the previous regard, paleontology can play an educational role for understanding and accepting that global environments are currently evolving in a truly impressive way.

57 From its earliest development, life has had a large scale effect on the biosphere and on the physicochemical parameters of Earth's surface. The ecological balance prevailing on our planet is indeed so fragile that, in past times, it was totally overturned by microscopic unicellular organisms and by plants. Our species, densely distributed and endowed with rich cognitive and technological capabilities, is thus able to have a deep, swift and long-lasting effect on this balance. In other words, those who do not believe that humankind or other living organisms could be the cause of a large-scale environmental crisis are plainly wrong.

58 The idea of an opposition between humankind and nature, deeply anchored in our mentality, is overall detrimental in terms of environmental crisis management, whether it serves to justify 1) unrestrained exploitation of natural resources, or the opposite 2) demonization of all or part of humankind (Blanc, 2015). Paleontological data, together with biological data, demonstrate that this nature/humankind opposition is devoid of any historical or ecological foundations. Our ancestors' fossils scattered over the Fossil Earth (and notably "Fossil Africa") deeply root extant humankind within the biosphere history, our species having been born from the same process as all other living beings. In addition, *Homo sapiens* is not the only species to have developed advanced cognitive abilities, as indicated by the astonishing technical and cultural traits of other species such as apes and crows (e.g., Emery & Clayton, 2004; Caron et al., 2011; Roffman et al., 2012). It is therefore imperative to consider the whole biosphere, humankind included, as an integrated system[39].

59 As with all other living beings, the fossil record indicates that past human populations went through declines and/or extinction. The progress of humankind is not irresistible, and the emergence of morphological and behavioral innovations has been related to environmental factors, the very complex cultural behavior of *Homo sapiens* being no exception to the rule (d'Errico & Stringer, 2011). So it must be clear to everyone that the on-going environmental changes could really cause decline, collapse (Diamond, 2005), and even, locally[40], extinction of human populations.

60 Recovery phases of global ecosystems following previous major biotic crises required millions of year. Accordingly, given the temporal scale of a human life (at an average of 70 years), of a human society (some hundred, or even thousand years), or even of our

species (200,000 years), to wait for a natural recovery of these ecosystems, or waiting for their adaptation to human activities, is not an option for us[41].

61 The greatest biotic crises were triggered by a combination of cumulating factors, sometimes amplifying each other. This is what is currently observed, with the concomitance of global warming, of biodiversity decline, and of the explosive increase of global demography. This combination must be taken into account in the actions that should be decided. Following an analogy with the K/T crisis, discussing on climatic issues alone would be like fearing volcanoes while believing meteorites are fairytales. Given the intertwining of the problems, solutions need to be integrative.

62 Finally, one can note that, for a given species, its fate during a biotic crisis depends on the nature of its adaptability. Resilience, i.e. the ability to adapt to environmental pressures so as to preserve abilities and/or adaptive traits insuring a favorable status, is an important aspect of adaptability. Hence, non-avian dinosaurs were remarkably resilient, as they were able to constantly renew their initial adaptive recipe for a successful exploitation of Mesozoic ecosystems for almost 150 million years. By comparison, the adaptability of mammals was clearly less efficient in the same evolutionary context.

63 However, another adaptive quality is to be able to use its initial abilities in a totally new framework. The sudden collapse of the main Mesozoic primary producers led to the collapse of the best integrated components of the trophic networks. To the contrary, some mammals survived through that event and then thrived because they had the potential to free themselves from the framework of Mesozoic ecosystems and to survive in drastically different conditions. Similarly, the only surviving dinosaurs, i.e. birds, were those that followed a very peculiar evolutionary pathway among the group.

64 It is very tempting to draw a parallel between this scenario and the current situation of humankind. Our advanced societies are based on a complex exploitation system of natural resources, which has been developed in the context of the relatively stable environmental conditions that have prevailed for about the last twelve thousand years. These societies went through spectacular changes notably thanks to emulation and competition, and to an exponential growth in their energy consumption. They are therefore in a position recalling that of non-avian dinosaurs, and their strength could potentially be their greatest weakness in case of catastrophe.

65 Mammals in general and humankind in particular display remarkable abilities to adapt, and at least some of us have an acute awareness of the on-going environmental crisis. However, modern societies have grown considering the world as if it was endlessly vast with almost unlimited resources, and transmitted this assumption to the "social genome" of our extant societies. Collectively, humans are bound by relatively rigid cultural and societal constraints. The extinction of the Norse colony settled in Greenland from the 10th century to the 15th century is likely an unfortunate example of combination between social rigidity and inexorable environmental change (Barlow et al., 1997)[42].

66 Our societies are therefore facing the advent of a new world. Should we keep up with most of our past successful recipes, or should we opt for something radically new? For living species, the former solution most generally has ended in extinction when changes were quick and massive. The latter solution requires the ability to divert an adaptive trait from its initial function toward a fundamentally different function – what paleontologists Gould & Vrba (1982) have called "exaptation." In short, we, the offspring of the K/T crisis,

must remember that all will depend on our ability to use the upheaval of our planet as an opportunity to further evolve.

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NOTES

1. More pragmatically, Pratchett & Baxter's multiverse (2012), by providing millions of human-empty worlds alongside our own iteration, would resolve a frightening dilemma of our actual world: according to the ecological footprints computed for the wealthiest countries, the lasting adoption of their ways of life by all ~7.3 billion humans would be possible only by consuming the natural resources of at least four more additional earths (cf. http://www.footprintnetwork.org/en/index.php/GFN/).

2. For a geological time scale, see: http://www.stratigraphy.org/ICSchart/ChronostratChart2015-01.jpg

3. Of course, the on-going climate warming is itself of anthropic origin (IPCC, 2014). And even if it was not, the observed climatic trends would threaten our future all the same, and it would be certainly not less urgent to act against them!

4. Biotic crisis is another frequent name for mass extinction events. The big five were: the final Ordovician event, ending at *ca.* 443 Ma; the Frasnian-Famennian event (Late Devonian), *ca.* 359 Ma; the Permo-Triassic event, *ca.* 252 Ma; the final Triassic event, *ca.* 201 Ma; the K/T event, at 66 Ma. Illustration: https://commons.wikimedia.org/wiki/File:Extinction_Intensity.svg

5. For a reconstruction of a Devonian forest: https://www.youtube.com/watch?v=KJdCytwAigU

6. Illustration: http://evolution.berkeley.edu/evolibrary/images/evograms/tetrapod_evo.jpg

7. Reconstruction (body length *ca.* 10 m): https://upload.wikimedia.org/wikipedia/commons/4/4c/Dunkleosteus_interm1DB.jpg

8. Carbon sequestration is the trapping of carbon in non-atmospheric forms.

9. This process is the reverse of the current global warming linked to increasing atmospheric greenhouse gases.

10. Illustration: http://cpgeosystems.com/240moll.jpg

11. Illustrations: http://static.palaeontologyonline.com/Figure13.jpg and http://www.trilobites.info/triloclass2009.png

12. Reconstruction: http://science.nationalgeographic.com/staticfiles/NGS/Shared/StaticFiles/Science/Images/Content/permian-diorama-umich-img-4260-sw.jpg

13. Reconstruction of some species: http://geologicalman.blogspot.es/cache/media/files/00/736/872/2015/05/1-permian-animals-artwork-mauricio-anton.jpg

14. Traps are successive lava flows that formed stairstep landscapes (from the Scandinavian root "trapp" for stairs). In some cases, the trap volcanic rocks can pile up until forming several-kilometers-thick sequences.

15. Illustration: http://www.nature.com/ngeo/journal/v5/n6/fig_tab/ngeo1475_F3.html

16. Notably crocodilians, flying reptiles (pterosaurs), dinosaurs, and birds.

17. K/T stands for Kreide/Tertiär in German, i.e. Cretaceous/Cenozoic or Cretaceous/Tertiary.
18. Reconstruction: http://www.nationalgeographic.com/seamonsters/images/gallery/ammonites-lw.jpg
19. Illustration: http://eis.bris.ac.uk/~ts0438/images/Marine%20reptiles.bmp
20. Reconstructions of ichthyosaurs: http://www.dinofan.com/dfAnimals/dfAnimalsSitePics/CladImages/Ichthyopterygia.jpg
21. Illustration: https://commons.wikimedia.org/wiki/File:Various_dinosaurs.png
22. Reconstructions: http://img03.deviantart.net/f23e/i/2015/108/5/2/pterosaurs_by_atrox1-d757xt2.jpg
23. Illustration: https://upload.wikimedia.org/wikipedia/commons/9/9d/Archaeopteryx_lithographica_%28Berlin_specimen%29.jpg
24. Comparative anatomy and molecular biology have formally demonstrated that the closest living species to our species are *Pan paniscus* and *Pan troglodytes*, i.e. the bonobos and the chimpanzees, respectively. These species and we share an ancestor more recent than all the other ancestors we share with other living beings. Two evolutionary branches were born from this common ancestor: one is represented today by the genus *Pan*, the other by *Homo sapiens*. In this contribution, all extinct representatives of the latter branch are included within humankind.
25. kilo-annum, for dates in thousands of years.
26. Formed by the rise of a *ca.* 2,000-km-wide bubble of magma under eastern Africa. This created a doming of the earth crust, the formation of the Ethiopian traps, and a collapse of Earth's crust along three main lines: the Red Sea, the Gulf of Aden, and the eastern African rift running from the Afar triangle (Djibouti and Ethiopia) to the coast of Mozambique.
27. For further information and illustrations: http://humanorigins.si.edu/evidence/human-fossils/species/paranthropus-aethiopicus
28. Many species go extinct while many others appear in the fossil record.
29. For further information and illustrations: http://humanorigins.si.edu/evidence/human-fossils/species/paranthropus-boisei
30. Illustration: https://commons.wikimedia.org/wiki/File:Homo_floresiensis.jpg
31. Ratio between brain mass and whole body mass.
32. www.lascaux.culture.fr and http://archeologie.culture.fr/chauvet/fr/
33. The Holocene started at 11.7 ka and continues today. It is a relative stable, interglacial climatic phase during which *Homo sapiens* developed an economy based on controlled production, complexly structured civilizations, and large populations.
34. https://commons.wikimedia.org/wiki/File:Galet_peint_MHNT.PRE.2006.0.93.jpg
35. See, e.g., some serious recommendations and caveats on this topic: http://futureoflife.org/AI/open_letter
36. www.lascaux.culture.fr and http://archeologie.culture.fr/chauvet/fr/
37. For learning about potential threats to the conservation of the Omo Valley sites, see: http://whc.unesco.org/document/127576
38. An example: http://www.debate.org/opinions/do-you-believe-in-global-warming
39. By the way, this reasoning can be extended to oppositions between different human populations, given that our own species was born from a single, extremely recent African population (on the scale of the history of life, 200 ka is like 26 minutes to a year).
40. A complete extinction of *Homo sapiens* would be unlikely to occur soon, given the size of our global population. Yet, in case of global decline, our species would probably become much more vulnerable to adventitious catastrophes (asteroid, nuclear war, pandemic diseases).
41. In my opinion, the motto "Save the Earth" is misleading: our living planet has already gone through the worst and did not need us to survive, thank you very much! A better statement would be "Save yourself, you fool!"
42. For other examples, see Diamond (2007, 2009, 2010).

INDEX

Mots-clés: paléontologie, paléoenvironnements, climat, biodiversité
Keywords: paleontology, paleoenvironments, climate, biodiversity
Geographical index: Omo (vallée)

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Links between Solid Earth, Climate Changes, and Biodiversity through Time: Insights from the Cenozoic

Pierre Sepulchre

1 The Cenozoic is the most clearly defined geological era in terms of climate and life history. Since the late 60's, oxygen isotopic values have been measured on benthic foraminifera shells coming from deep-sea records. These values give insights about the evolution of deep-sea temperatures and continental ice volume during the last 65 million years. More than ten years ago, Zachos et al. (Zachos et al., 2001) compiled over 40 published isotopic records to depict carbon and oxygen isotopic trend through the Cenozoic. This seminal study has been recently updated and is classically used as the paleoclimatic reference in most climate and paleoecological studies. From this record one can divide the Cenozoic into warm periods (Paleocene and Eocene), also called "Greenhouse climates", and cooler periods (Oligocene, Miocene and Pliocene) during which permanent icesheets developed at the poles.

The Paleocene-Eocene Thermal Maximum

2 Temperatures were warm during the Paleocene; polar regions were ice-free and characterized by subtropical flora and fauna. As an example, the late Paleocene flora that grew on the former land bridge connecting Antarctica to South America (Seymour Island fossil records), at latitude 63°S, is described as a "paratropical forest growing in a warm and rainy climate" (Reguero et al., 2002). Atmospheric CO_2 reconstructions are uncertain for this period but suggest pCO_2 higher than 1000 ppmv[1].

3 At ~55.5 Ma, a large isotopic excursion is observed in the $\delta^{18}O$ and $\delta^{13}C$ records from benthic microfossils. This excursion is associated with a 4-6°C deep-sea warming, a 5°C increase in tropical Sea Surface Temperatures (hereafter SST) and an up to 8-10°C increase in high-latitude SST (Zachos et al., 2003). This event has been called the

Paleocene-Eocene Thermal Maximum (PETM) and is now used to define the Paleocene-Eocene boundary, as it is contemporaneous with the Paleocene-Eocene transition observed in the North American Land Mammal Series. The event lasted no more than 20,000 years, and a return to normal values occurred after 170,000 years, making the PETM the most abrupt climate change recorded in Earth history. Hypotheses to explain the mechanisms and the source of the massive input of depleted carbon in the global system, ultimately leading to this carbon isotope excursion and global warming, are still debated. The usual mechanisms driving isotopic excursions (volcanism, weathering) are too slow (with too low values for carbon originating from volcanic activity) to be responsible for the PETM. The consensual hypothesis invokes a massive release of isotopically light carbon (relatively little $\delta^{13}C$) in the ocean system, through methane injection. Where does the methane come from? Some authors invoke volcanic activity in the northeastern Atlantic triggering a massive methane release (Svensen et al., 2004); others suggest that huge amounts of methane hydrates (clathrates) stored at the bottom of the oceans were destabilized 55.5 Ma ago (for a still unknown reason) (Dickens et al., 1997).

4 The PETM is contemporaneous with a major extinction event in the deep ocean. Between 30 and 50% of the benthic foraminifera community were wiped out within less than 10,000 years. The massive input of methane in the water at all depths could have triggered low oxygenation and increased water corrosity, both through methane oxidation. Marine productivity may have been altered as well. However, none of these changes was global; otherwise extinct cosmopolitan species may have survived in refugia and repopulated afterwards. The remaining factor is the global warming that occurred in the ocean; but the mechanism linking it to foraminifera extinction is not yet understood. Recent modeling studies suggest that the extinction was due to multiple environmental changes, all related to perturbation of the carbon cycle (Winguth et al., 2012).

5 On the continents, temperatures increased by ~5°C during the PETM. This warming impacted continental flora which responded with inter- and intra-continental dispersals (Wing et al., 2005) and major compositional turnovers (20 % of US Gulf Coast palynoflora became extinct after the PETM (Harrington & Jaramillo, 2007)). The Paleocene-Eocene transition is also crucial for the fauna, as three major modern orders of mammals, namely Primates, Artiodactyla (e.g. deer, cows, camels) and Perissodactyla (e.g. horses), appear coincidently in the fossil record at that time in Europe, Asia and North America, while some Paleocene taxa (Champsosaurus, Plesiadapis) became extinct. The warming led to a reduction in size of several taxa (herbivorous ungulates, Primates, Artiodactyla), conforming to the famous ecological Bergman's rule, that specifies that species have smaller body size at greater ambient temperatures[2] (Secord et al., 2012). Apparent dwarfing of some mammal taxa was even evidenced at the PETM, and might be linked to the increased pCO_2 which would have affected plant growth, digestibility and ultimately herbivore growth (Gingerich, 2006).

From the Eocene to the Oligocene: *Descent into the Icehouse*[3]

6 The $\delta^{18}O$ record indicates that shortly after the PETM, a climatic optimum was reached, making the early Eocene the warmest period of the Cenozoic. Recent records suggest that climate variability existed during this period, causing climate shifts from warm to very

warm (hyperthermal) states. At the end of the early Eocene a global cooling began that culminated at the Eocene-Oligocene transition, at 32 Ma. At that time continental drift had made Earth look closer to its present-day appearance: the Drake Passage, separating Antarctica and South America, had opened following an earlier opening of the Tasmanian gateway (separating Antarctica from Australia). India had drifted northward to collide with Asia, thereby starting the uplift of the Tibetan Plateau.

7 The isotope shift observed at 34 Ma in the $\delta^{18}O$ record has been explained both by the inception of the Antarctic ice sheet (at least on the western edge of the continent) and by global cooling (Hansen et al., 2008). Initiation of the Antarctic ice sheet could have been linked to two factors which likely interacted. First, the opening of the Drake Passage would have profoundly changed global ocean circulation and allowed the Circum-Antarctic Current to be activated, ultimately isolating the Antarctic continent. The second factor is the lowering of pCO_2 throughout the Eocene, from more than 1,000 ppmv to less than 750 ppmv (Pearson et al., 2009), a threshold that climate model studies have shown to be crucial to initiate a glaciation over Antarctica (DeConto & Pollard, 2003). No conclusive explanation for the CO_2 reduction during the Eocene exists but many consider that the uplift of the Himalayas played a major role. With the Himalayan orogeny, a lot of organic carbon from the continent was buried through sedimentation in the deltaic regions such as the Bengal fan, thereby activating the marine biological pump and enhancing atmospheric CO_2 consumption. This mechanism was active during the whole Himalayan orogeny and consumed 2 to 3 times more CO_2 than silicate weathering (Galy et al., 2007).

8 In the oceans, Eocene cooling has been associated with a major extinction in tropical nannoplankton, foraminifera, bivalves and gastropods (Prothero, 2004). On the continents, Antarctic vegetation shifted from an evergreen forest dominated by *Nothofagus sp.* to a tundra vegetation (Thorn & DeConto, 2006). Neotropical fossil palynoflora show a continuous decrease in diversity, likely linked to global warming or to available area for species (Jaramillo et al., 2006). In North America, broad-leaved deciduous forests replaced paratropical forests within 500 thousand years, while several indicators show widespread increase in aridity. The consequences of climate change for North American faunal biodiversity are still a matter of debate, but recent studies suggest that the rise of the Oligocene fauna was likely linked to the immigration of Asian taxa following the sea-level drop induced by growth of the Antarctic ice sheet (Figueirido et al., 2012). In Eurasia, climate cooling at the Eocene-Oligocene boundary is associated with a major faunal turnover called “Grande Coupure”, during which 60% of endemic European fauna (82% of placental mammals) went extinct; subtropical taxa declined and new taxa (e.g., rhinoceroses) migrated from Asia. The vertebrate records from Mongolia also show a strong turnover with Perissodactyla replaced by lagomorphs and rodents (Yuanqing et al., 2007), consistent with a trend to aridification indicated by the lithology (Dupont-Nivet et al., 2007; Kraatz & Geisler, 2010) and by changes in rodent dental patterns (Gomes Rodrigues et al., 2012).

9 After the Eocene-Oligocene transition, the global climate was marked by strong fluctuations, as testified by variations in the benthic foraminera $\delta^{18}O$ record. A continuous record from the equatorial Pacific shows that these variations involved events in the carbon cycle and glaciations. Detailed analyses of the signal revealed that these events followed fluctuations in the earth’s orbit, i.e. linked to periodical variations of insolation (cyclical changes in eccentricity and obliquity of the earth’s orbit) (Pälike et al.,

2006). Over these variations, there was a global warming trend between ~27 Ma and 24 Ma, with increases in deep-ocean temperatures and a reduction of the ice volume accumulated just after the Eocene-Oligocene transition. Afterwards, several records show an increase in deep-sea $\delta^{18}O$ values at the Oligocene-Miocene transition. This increase corresponds to a transient cooling event (called Mi-1) involving a major increase in continental ice volume and a 2°C decrease in deep-ocean temperature, ~23 million-years ago (Lear et al., 2004).

Miocene climate changes and vegetation revolution

10 One of the main characteristics of the Miocene period is the reorganization of the regional climates in tandem with important changes in paleogeography, including mountain uplifts and seaway opening and closing. China provides a detailed record of environmental changes for the Oligocene and the Miocene. Several indicators including coal, pollen assemblages, saline lake deposits, and pedogenic carbonates, as well as the analyzed of soil-forming processes, show that Chinese atmospheric circulation was dramatically modified ~22 million-years ago. Paleoenvironments organized in a typical zonal pattern during the Oligocene, with southern humid belt and subtropical desertic areas, were replaced by monsoon-like regimes, including two-season rainfall patterns and inland arid regions (Guo et al., 2008). At that time the Asian continent was particularly affected by tectonic-driven changes, with the ongoing uplift of the Himalayas and Tibetan Plateau, as well as with the shrinkage of the Paratethys Sea (including the creation of the African-Eurasian land connection by the late Miocene). Numerous climate modeling studies have been carried out to understand how these tectonic parameters drove climate changes through the Neogene. The idea that an uplifted Tibetan Plateau was necessary to maintain strong seasonal temperature contrasts between the ocean and the continent has been put forward since the 80's (Ruddiman & Kutzbach, 1989), though recent studies suggest that the Himalayas even without the Plateau were a sufficient driver to set up a monsoonal circulation (Boos & Kuang, 2010). Other studies have suggested that the withdrawal of the Paratethys seaway helped the monsoon onset (Ramstein et al., 1997; Fluteau et al., 1999), which has been further confirmed by different models (Guo et al., 2008).

11 Another example of the tectonics-climate-ecology link is South America during the Miocene. Although debate continues to rage concerning the exact timing and speed of the Andes uplift, it is clear that this unique mountain range, covering over 7,000 km south to north, with peak elevations in excess of 6,000 m, got uplifted from 25 Ma to 5 Ma. This uplift had several consequences on South American environments. Nowadays, the Andes act as a massive orographic barrier that deflects zonal winds and associated moisture fluxes coming from the Pacific and the Atlantic oceans. Climate zonation of South America shows widespread rain-shadows, as in Patagonia, where there is a strong rainfall contrast between the very humid western slope of the Andes that collect all the westerly-winds rainfall and the eastern slope which is very arid. Interestingly, the palynological records of eastern Patagonia show a transition, during the Miocene, from forested environments (Nothofagaceae, Podocarpaceae) to arid-adapted floras (Asteraceae, Chenopodacieae), that can be plausibly explained by the uplift of the southern Andes and the onset of the rain-shadow effect (Barreda & Palazzesi, 2007). The Andean uplift also affected the Amazon basin in many ways: the uplift of the northern cordilleras closed

water channels between the continent and the Pacific and led to changes in river routing. From northward-flowing wetland systems (Pebas Lake), the Amazon drainage pattern was reorganized into a river system close to the present-day one, i.e. a long river originating in the Andes foothills and flowing into the tropical Atlantic. The causal relationship between these environmental changes and the outstanding present-day biodiversity of the Amazonian basin is a huge and fascinating research topic. Recent studies, combining fossil records, phylogenetic data, geology, sedimentary and paleoclimatological information (Hoorn et al., 2010), suggest that the Andean uplift drove climate changes (Sepulchre et al., 2010). Phylogenetics on plants have shown that the Andes favoured the appearance of island-like habitats, thereby fostering very rapid diversification (Hughes & Eastwood, 2006) and helped the dispersal of neotropical taxa to the South (Antonelli et al., 2009).

12 The Miocene was a period of important paleoecological changes in Europe as well. During the Mid-Miocene Climate Optimum (MMCO), European climate became warm enough to allow the expansion of subtropical forests and associated hominoids in Europe. Numerical experiments with climate and vegetation models have recently shown that this climate change in Europe depended on particular values of pCO_2 (between 560 and 700 ppmv), but was also linked to the size of Antarctic ice sheet that impacted the Atlantic ocean circulation, surface temperatures and moisture transported towards Europe (Hamon et al., 2012).

13 As with South America, tectonics changes were also active in eastern Africa during the Miocene. Several geological indicators show that the Eastern African Rift System (EARS) got uplifted from ~20 to 3 Ma, inducing the building of a 6000-km-long elevated orographic barrier, mostly oriented north-south and bordered by peaks reaching between 1500 and 5100 m. The study of tooth enamel $\delta^{13}C$ from the East African records shows a marked shift towards more positive values of $\delta^{13}C$ between 10 and 8 Ma. This shift, together with paleontological data, suggests a change in ungulate feeding habits, switching from tree-leaves to grasses. Numerical simulations with the high-resolution General Circulation Model LMDz suggest that the gradual uplift of the EARS, by deflecting northward the moisture flux coming from the Indian Ocean, drove the aridification of eastern Africa and likely the subsequent changes in vegetation cover, the tropical forest being replaced by savannah and open grassland (Sepulchre et al., 2006).

14 These changes took place with the context of a larger paleoecological revolution, namely the worldwide forest-to-grassland transition and the subsequent expansion and rise of the C_4 grasslands displacing C_3 vegetation. The terms C_4 and C_3 have to do with two physiologically distinct photosynthesis pathways used by plants; which one is dominant depends on growing season temperature and atmospheric CO_2 concentration. Basically, at high temperatures and low CO_2 concentration, the Rubisco enzyme of C_3 plants barely distinguishes O_2 from CO_2, which leads to photorespiration, ultimately lowering the photosynthesis yield. Conversely, a CO_2-storing strategy helps C_4 to plants prevent photorespiration, but this process has an energy cost that is higher than the C_3 photorespiratory cost at low temperatures and high CO_2, while C_4 photosynthesis is also less effective in low-light conditions. The critical thresholds of temperatures and CO_2, defining the point where one pathway becomes dominant over the other, can be calculated. Under present-day pCO_2, this temperature threshold lies between 20 and 25°C. In tropical environments the pCO_2 threshold is ~500 ppmv (Osborne, 2008). The present-

day geographical distribution of C_3/C_4 corresponds quite well to these constraints: C_4 grasslands are found mainly in subtropical and tropical areas, while forested areas are dominated by the C_3 pathway (Edwards et al., 2010).

15 Recent phylogenies (reviewed in Edwards et al., 2010) suggest that C_4 photosynthesis likely evolved several times, but that the earliest probable origin was during the early Oligocene, ca. 32-30 Ma. Phytoliths record the presence of C_4 grasses in North American grasslands by 19 Ma, but their dominance over C_3-plants came only several million years later (Edwards et al., 2010). Likewise a worldwide study (Pakistan, Great Plains of North America, East Africa) of $\delta^{13}C$ measured on paleosols and fossil teeth of herbivores shows that C_4 plants started to dominate low-latitude ecosystems on a global scale only around 8 million years ago (Uno et al., 2011).

16 As C_4 photosynthesis is favoured under warm temperatures and low CO_2, authors have long suggested that the evolution towards this system and the subsequent rise of C_4-plants were linked to the Cenozoic decrease in atmospheric pCO_2 (Cerling et al., 1997). As recent pCO_2 reconstructions show a marked drop in pCO_2 at the Eocene-Oligocene (Pearson et al., 2009; Pagani et al., 2011), a link between pCO_2 and evolution towards the C_4 pathway at that time is highly probable. However, there is no clear declining trend in pCO_2 during the Miocene (Pagani et al., 2009), while C_4 abundance in vegetation composition increases (Edwards et al., 2010). Thus, other processes have been explored to explain the rise of C_4-grasslands during the Miocene. Recent hypotheses involve two climate forcing factors, namely rainfall and the occurrence of fire (Osborne, 2008). One possibility is that the abrupt intensification of monsoon systems, which corresponds to the development of a seasonal climate (i.e. with a wet season and a dry season), could have increased wood-plants mortality and favoured C_4-grassland expansion during the Miocene. An alternative viewpoint, based on $\delta^{18}O$ records from Asian freshwater bivalve shells, suggests that the overall annual amount of rainfall could have decreased (without particular seasonal changes) during the Miocene, and that enhanced aridity favoured grasslands. Both mechanisms would have increased the frequency and intensity of droughts, thereby favouring grassland expansion. Development of seasonal climates is also thought to have increased the frequency of fires, by sustaining high biomass production during the wet season and reducing fuel moisture and generating frequent lightning strikes that can ignite fires during the dry season. Fires kill wood-plants and open up the habitats, favouring high-light conditions in which C_4 grasses overtake C_3 grasses, increasing primary productivity and production of dead foliage. As dead foliage of grasses is an efficient fuel for fires, there is a positive feedback ultimately leading to C_4-grassland expansion (Keeley and Rundel, 2005; Scheiter et al., 2012). In order to confirm that these paleoecological processes drove the diversification of C_4 as well, future studies will have to include both paleoenvironmental and phylogenetical information.

17 For years, the Mio-Pliocene transition to grasslands in eastern Africa was thought to have been the main driver of hominid evolution. Indeed, until 1994 and the discovery of the australopithecine "Abel" in the Chad basin, all hominids were exclusively recorded in eastern or southern Africa, and palaeontologists were thinking in terms of the 'East Side Story' scenario, in which early hominids evolved in the savannah east of the Rift Valley, while early African apes remained in the tropical forest, west of the Rift (Brunet, 2010). However, older hominids were subsequently discovered west of the rift, with *Sahelanthropus tchadensis* being the earliest at ~7 Ma (Brunet et al., 2002). These

discoveries led to reconsideration of the eastern African evolution hypothesis and to further analyses of paleoenvironments and paleoclimates of western Africa. The fossil fauna and sedimentological evidence associated with *S. tchadensis* showed that this hominid evolved in a perilacustrine environment, i.e. a mosaic of environments close to the present-day Okavango inland delta (mosaic of swamps, forests, savannahs and desert areas). Records also show repeated oscillations between dry and humid environments culminating in megalakes (Vignaud et al., 2002). Therefore the new challenges concerning paleoecology and paleoclimate for this period are first to understand what were the drivers of such climatic oscillations and second to quantify the links between changing environments and hominid evolution.

Pliocene warm period and the role of seaways

18 During the last five million years, Earth's climate completed its transition to a full "icehouse" state, i.e. a state in which ice sheets are present at both poles. Considering the benthic $\delta^{18}O$ record, the Pliocene (5.3 Ma-1.8 Ma) can be divided into three sub-periods: the early Pliocene warm period (5.3 Ma-3 Ma), the mid-Pliocene warm interval (ca. 3 Ma), and the late Pliocene climate deterioration until the Pleistocene (Haywood et al., 2009). Sea surface temperatures estimated from Mg/Ca measurements and $\delta^{18}O$ records show that the early Pliocene was 3 to 5°C warmer than present-day climate at mid-latitudes. Moreover the early Pliocene was also characterized by a weak (1.5 ± 0.9°C) SST gradient between the western and eastern Pacific, typical of sustained, permanent, El Niño-like conditions (Wara et al., 2005). The forcing mechanisms of the Pliocene warmth were several and are still very much debated; they include higher level of pCO_2, enhanced ocean heat transport and strong ice-albedo feedback (Haywood et al., 2009). The Pliocene warmth was followed by a climate deterioration that ultimately led to the onset of the northern hemisphere ice sheet and glacial-interglacial cycles. It has long been thought that the closure of the Central American Seaway (CAS, also called Panama isthmus) could have driven this onset by enhancing the thermohaline circulation, increasing atmospheric moisture transport to high northern latitudes and allowing heavy snowfall on Greenland (Haug et al., 2001; Bartoli et al., 2005). However, this view is changing as (1) climate modeling experiments showed that pCO_2 played a larger role in ice sheet initiation than did tectonics (Lunt et al., 2008) and (2) both geological and biological evidence demonstrates that the final constriction of the seaway occurred during the Miocene (Montes et al., 2012; Montes et al. 2015; Bacon et al. 2015). Ongoing research aims at providing constraints on the timing of the isthmus closure as the connection between North and South America was a crucial biogeographical event, with the so-called Great American Biotic Interchange (GABI), i.e. a major exchange of flora and fauna between the two continents. Among land mammals, the GABI was, surprisingly, a very asymmetric process. Indeed, the faunal evolutionary pathways clearly diverge between the two continents, as taxa of northern origin successfully diversified in South America, whereas southern taxa showed little or no diversification once in North America. This pattern has two consequences on extant fauna; one is that more than half (53%) of extant South American genera descend from taxa of northern origin. The other is that tropical North America was conquered by taxa from Amazonia, whereas the temperate North American fauna shows only 4 surviving genera from South America (Webb, 2006). The final closure of the CAS has also been invoked to explain the major extinction of Caribbean reef corals

and mollusks at the end of the Pliocene. Mechanisms involved include the collapse of planktonic productivity with a closed seaway. However a detailed study of extinction rates of mollusks and corals has shown that a 2-million-year time lag between the environmental changes and the actual extinctions, suggesting that environmental change was not the sole driver of the extinctions (O'Dea et al., 2007).

19 On the opposite side of the globe, another ocean gateway is also thought to have played a major role in Pliocene climate and environment changes, namely the Indonesian seaway, involving the Indonesian throughflow, or ITF. Tectonics shows that New Guinea and Australia lay 2-3° south of their present-day position during the Pliocene, while Halmahera, an island that reduces the Pacific flow in the Indian Ocean, was much smaller at that time. Ocean circulation simulations including this paleogeographic information suggest that these changes of the ITF during the Pliocene brought colder waters from the South Pacific to the Indian Ocean, thereby reducing evaporation and associated rainfall over eastern Africa. Authors also propose that the ITF likely stimulated the growth of ice sheets, by reducing atmospheric heat transport to high latitudes (Cane & Molnar, 2001). Aridification of eastern Africa is very well documented throughout the Miocene (see previous section) and the Pliocene, thanks to pollen records (Bonnefille et al., 2004). It is thought that this trend influenced early mammals and human evolution in eastern Africa, especially *Australopithecus afarensis*.

20 This short synthesis of climate-biosphere interactions during the Cenozoic shows the complexity of interactions between life and abiotic factors. Whether climate and tectonics have been the main drivers of paleoecological changes through time or not is an ongoing question in Earth and Life sciences; still the Cenozoic seems to demonstrate it.

21 Although the impact of modern humans on climate and ecosystems has no equivalent, in terms of range and speed, in the geological record, it is tempting to compare modern-day loss of species richness and human-driven climate change to what happened in the past. Climatologists attempt to compare anthropic climate change to the PETM in order to assess the environmental consequences of massive carbon input in the atmosphere (Hansen et al., 2008). Biologists now wonder whether Earth's sixth mass extinction may be on its way or not. As more and more evidence suggests an affirmative answer (Barnosky et al., 2011), studying what happened in the past appears to be more and more relevant for biodiversity conservation purposes.

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NOTES

1. ppmv stands for parts per million volume. It describes very small quantities of gaz concentration. 1 ppmv means 1 part in 1,000,000 parts that is 0.0001%.
2. 65 to 75 % of extant fauna follows Bergman's rule.
3. This title is directly inspired from E. Thomas *Research Focus* published in Geology (2008).

INDEX

Mots-clés: climat, paléoclimatologie, biodiversité, Cénozoïque
Keywords: climate, paleoclimatology, biodiversity, Cenozoic

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Environmental Descriptions of European Travelers in Ethiopia (16th-19th c.)

Deresse Ayenachew

1 A number of publications are available on the environmental history[1] of Ethiopia. James C. McCann and Richard Pankhurst are pioneers in this area of study (Pankhurst, 1972; Pankhurst, 1995; McCann, 1997). Dessalegn Rahmato has also contributed several papers on contemporary issues on the history of the environment (Dessalegn, 1998). Recently, a few studies have been also conducted on the ancient environmental history of Aksumite civilization and the regions of Tegray and Wällo (Bard, 2000; Bahru Zewde, 2008). They shed light on the impact of environmental degradation on social unrest and on changes of regime both in the ancient and modern periods of Ethiopia. Medieval environmental history is rarely studied in Ethiopia. The objective of this paper is to reassess the historical background of the environmental situation of medieval and post-medieval Ethiopia. This paper will deal with the environmental situation along northern and northeastern routes of Ethiopia.

2 The accounts of European travelers in Ethiopia describe various aspects of the country from different perspectives. They entered the country motivated by missionary concerns, colonialist interests and a few from scientific motives. All travelers to Ethiopia had a culture of gathering published information before their arrival into the country, but their descriptions of Ethiopia usually originate from their encounters with the people or the environment. With regard to the environment, they collected information regarding their physical difficulties or their disastrous impressions during their journeys to reach the royal court or regional lords. The attempts of environmental descriptions of these travelers can be observed from the narration of the physical geography of the country like the watersheds, topography, the seasonal rainfall and vegetation or the description of forest and the wildlife during their short stay in the country. It is clear that most of the environmental descriptions of the European travelers during the period under discussion were not a systematic collection but rather reflected descriptions of the curiosity of

explorers. However, some travelers presented a systematic record of the climatic annual variations in the 1840s in Shäwa (Beke, 1844: 67-68; Rochet d'Héricourt, 1841: 33, 123, 177 – see Annex 1).

3 In the beginning of the 16th century the European explorers traveled to Ethiopia in search of the famous rich, powerful Christian king, Prester John. The European explorers sought to ally with this legendary king (Sergew Hable Selassie, 1974) to counter the expansion of the Ottoman Empire and the Ottoman domination over the Red Sea trade (Abir, 1980: 109-132). Individual adventurers recorded their sojourn in Ethiopia and went back to Europe with ample information on the environmental situation of the country.

Early 16th-century descriptions

4 The early 16th-century travel accounts fall into two categories. The first is the collection of the Italian compiler Alessandro Zorzi, who collected data on Ethiopia from two important classes of informants. Ethiopian pilgrims to Jerusalem later came to Italy and informed him about their country. The other informants of Zorzi were European travelers or adventurers who were in search of the legendary Prester John on the coast of the Indian Ocean.

5 The second category involves the official diplomatic relations between Portugal and Ethiopia in the 16th century. The Portuguese dream of finding a Christian alliance on the Red Sea coast was finally achieved when the first Ethiopian delegate came to the court of the Portuguese King Emmanuel with an official letter from King Na'od under the advisory of Queen Eleni (Sergew Hable Selassie, 1972: 157-182). In turn, King Emmanuel sent a delegate to Ethiopia who reached the court of King Lebnä Dengel in 1520. The Portuguese delegation stayed six years. The account of the embassy was written by Francisco Alvares, the chaplain of the embassy, who provides ample information on the environment and seasonal situation of their stay in the country. Both Zorzi's collection and the account of Alvares have important common narratives of the environment they encountered during their journeys. Particularly, the Portuguese embassy followed almost the same trajectory as Zorzis's informants to reach the royal court of the kings. These European travelers' descriptions of environmental situations were narrated just before the rise of Imam Ahmad in 1527 and the overwhelming expansion of pastoralists towards the north, particularly the Oromo people.

6 The collection of Zorzi and the account of Alvares mostly agree on environmental observations. Zorzi describes a large part of the kingdom extending from Hamassen (Eritrea) as far as the present day Ifat or Gedem in North Shoa. He mentions the existence of wild animals, particularly elephants and lions. Besides, he refers to a number of large forests throughout the geographical distribution of these animals:

> Elephants are found in large numbers in the land of the Presta, and most where there are large woods [boschi] and hills in damp woody places where there is water and mud, as in the region and province called Geden and Gen and Anguot and Geda and Tegre and Messoa, where there are large woods (Crawford, 1958: 176-177).

7 Alvares with his embassy to the court of King Lebnä Dengel in 1520 repeatedly mentions observing of wild animals like elephants, lions and leopards approaching the villages in Angot and Amhara. He describes on his way south (from Massawa, Tegray, Angot, and Amhara and to Shäwa) the presence of dense forests:

> It is a great peril traversing this evil pass, because it is a two days' journey, all through level ground and very large woods, and very high and dense thickets of thorn bushes; and in these two marches, besides that the road is flat and very long, and that they frequently cut them, that is, the thorn bushes near the road, and set fire to them, yet they do not burn, except those that are cut and dried, and some that have withered at the roots, because the thorn bushes which are standing remain in their strength. It is about two leagues from this road to the district of the Dobas, at the commencement of the mountain range, and the ground is flat throughout these thorn thickets. There are in these lands or mountains an infinite number of elephants and other animals, as in the other mountains (Alvares, 1881: 111).

8 He notes that on his route many villages were visible not far from woodland areas (Alvares, 1881: 111). He was struck by the cotinual struggle of the people with the wild animals that attacked the villages in search of food (Alvares, 1881: 115). He narrates that one night their pack animals were snatched from their camps by wild animals and that some members of the embassy observed elephants not far from the villages in the vicinity (Alvares, 1881: 114). This may have been the last elephant population in these regions because elephants were no longer mentioned in later travel accounts.

9 Any visitor to Ethiopia today knows that the heavy rainy season (*kremt*) is from June to September. The early 16th-century accounts report the same thing:

> In this land of the Presta it rains in June, July and August, and mid-September, and at no season does it ever snow or freeze, nor there storms (Crawford, 1958: 170-171).

10 But both Zorzi and Alvares reported unseasonal floods. Zorzi refers to his informant Brother Thomas in 1519, one year before the arrival of Alvarez, who narrated remaining one month at the frontiers of Amḥara and Shäwa at a place called Ahya Fäj. The rainfall was so heavy that they could not cross the Wonchit River (Crawford, 1958: 44, 139). The embassy of Portugal escaped a flash-flood near Angot that carried away much of the baggage of the delegates (Alvares, 1881: 113).

11 Alvares also recounts seeing people burning the woodland for the clearance of the caravan routes and also for the extension of farmlands (Alvares, 1881: 111). Descending farther to the south in Angot (the land of Bugna and Lasta) the vegetation was reduced and the mountains and hills were dry (Alvares, 1881: 134-135).

12 Though the collections of Zorzi remain silent, the Portuguese embassy witnessed a swarm of locusts over a large area of the northern provinces that include Hamassen, Tegray, Lasta, and Angot through the Amhara provinces. The swarms of locusts devoured all green vegetation. Many agricultural lands were devastated and the people were obliged to quit their homes and go to other places:

> In these parts and in all the dominions of Prester John there is a very great plague of locusts which destroy the fresh crops in a fearful manner. Their multitude, which covers the earth and fills the air, is not to be believed; they darken the light of the sun. I say again that it is not a thing to be believed by anyone who has not seen them. They are not general in all the kingdoms every year, for if they were so, the country would be a desert in consequence of the destruction they cause: but one year they are in one part, and another year in another. [...] Another time we saw the locusts in another country called Abrigima, whence the Prester ordered provisions to be given us, in the kingdom of Angote. This country is distant from Barua, from which place we were thirty days in travelling the journey. While we were in this country I went with the ambassador who came from Portugal, and five Genoese with us, towards a country named Aagao. We travelled five days through country

> entirely depopulated, and through maize canes [sic] as thick as canes for propping vines, it cannot be told how they were all cut and bitten, as if bitten by asses, all done by the locusts. The wheat, barley, and *tafo* [teff], as though they had never been sown there, the trees without any leaves, and the tender twigs all eaten, there was no memory of grass of any sort, and if we had not been prepared with mules laden with barley and provisions for ourselves, we and the mules would have perished. This country was entirely covered with locusts without wings, and they said these were the seed of those which had been there and destroyed the country, and they said that as soon as they had wings they would at once go and seek their country. I am silent as to the multitude of these without wings, because it is not to be believed, and it is right that I should relate what more I saw in this country (Alvares, 1881: 67-69).

13 He narrates the massive flux of people migrating to other places:

> The people were going away from this country, and we found the roads full of men, women, and children, on foot, and some in their arm with their little bundles on their heads, removing to a country where they might find provisions (it was a pitiful sight to see them) (Alvares, 1881: 71-72).

14 A hundred years later, the Jesuit missionary Manoel de Almeida agrees with Alvares on the plague of locusts that destroyed the harvest particularly in northern regions like Tegray. Almeida comments that the recurrent invasions of locusts were one of the sources of the poverty of the country:

> The plague of locusts [...] does not leave a grain of food (Beckingham & Huntingford, 1954: 46)

Post 16th-century Ethiopia

15 We have learned that in the northern part of early 16th-century Ethiopia there was extensive woodland that sheltered elephants. The wars of Imam Ahmad mark a new historical period in Ethiopia (the "post-medieval" or early modern period); the immediately ensuing Oromo expansion changed deeply the demographic picture of Ethiopia. In the middle of the 16th century, the Christian kingdom was forced to retreat to Gondar and Gojjam. Inevitably, all this warfare and large geographical displacements in the troubled kingdom would probably must have caused huge environmental degradation.

16 The 17th-century and 18th-century European travelers reported the absence of wood and that the people had developed the use of animal dung for their fires. The member of the Jesuit mission Manoel de Almeida criticizes Alvares for his wrong information on the woods and wealth of Ethiopia. He doubted whether the Portuguese embassy in 1520-26 visited this country or some other (Beckingham & Huntingford, 1954: 46). However, his criticism of Alvares's descriptions came a hundred years later (he arrived in Ethiopia in 1624). He remarks that "generally speaking there is not much woodland in Ethiopia". According to him, the royal court moved from place to place due to lack of firewood.

17 James Bruce during his stay collected and sketched different types of plants and expressed interest in their use in traditional medicine. He published this information in the 5th volume of his travel account (Bruce, 1790). His third volume also gives interesting information regarding the ecology of the northwest. Bruce describes here his journey from Arkiko to Gonder passing through the woods and bush of the Serawe-Adwa-Shire-Lemalemo-Weggera-Gonder route. Clearly, he followed the caravan trade routes. He mentions different types of birds and wild animals he saw on the way. He notes that his

best mule was carried off by hyenas. He reports hearing the roaring of lions during his journeys. In Weggera he reports that along with the bandits in this northwestern area, its fertile lands were threatened by insects, mice and rats (Bruce, 1790: vol. 3, 196). The environmental descriptions of Bruce focus mostly on the northwest except for some information he collected on the south of Ethiopia.

18 In the first half of the 19th century, several European travel accounts on Ethiopia including detailed environmental descriptions have been published. Ethiopian diplomatic relations with European countries revived in the 19th century. Particularly, the kingdom of Shäwa appears to have dominated the international relations of the *zemene mesafent* period (1769-1855). Independent Shäwa enjoyed diplomatic relations with European countries because the kingdom was an island of relative peace and order in central Ethiopia. The common entry route to Shäwa was now redirected towards the east, principally via the Zeyla-Harar-Alyu Amba-Ankober route (Ankober was the capital of the kingdom of Shäwa). Among the many travelers, the German missionary envoy Johann Ludwig Krapf is of special interest to our topic because of his return journey via a northern route that lays probably not far from the early 16th-century route. His reports and descriptions indicate that major environmental changes had occurred.

19 The area of Amhara and the Angot-Lasta-Tegray route were travelled by Krapf and he primarily deals with these regions, particularly telling how the Wällo (Amhara and Angot) area had been overrun by the Oromo clans. According to his account, in 1842 he traveled through the eastern escarpment of the district of Tehuledere (south of Kombolcha), where he was informed that the country had been depopulated six years earlier due to outbreak of cholera, famine and the ravages of war. He compares the fertility of the land with southern Shäwan region:

> The nature of the territory of Tehooladere is most conspicuous and excellent, and gave me the appearance of those Galla countries which I have traversed in the south of Shoa. The soil of Tehooladere is excellent for cultivation, if there were only hands enough to cultivate the black fallow ground. I was told that the population of this tribe was very considerable six years ago; but that it was considerably thinned, first, by the cholera, which raged six years ago almost over the whole of Abyssinia and the countries beyond; secondly, by a famine which laid waste so many tracts of Abyssinian provinces; and finally, by a war, in which Ali Marie, the former Chieftain of this tribe, was engaged with the Chiefs of Worra-Kallo, Lagga Gliora, and Worra-Himano, who assisted the present Chief of Tehooladere against Ali Marie, his relation, who was entitled to the government by right (Isenberg & Krapf, 1968: 398).

20 During his travels northeastward towards the sea outlet of Massawa, Krapf remarks that the country was arable until he reached the lands of Tegray, where the rainfall decreased and the country became arid. In Lasta and Wag, he reports that he found fresh water, beautiful scenery and even juniper trees and acacia in abundance. But he was amazed at the absence of life in this rich area. He narrates: "We saw no inhabitants; we met no travelers; nor did we see any wild beasts, but beautiful birds of the finest plumage (Isenberg & Krapf, 1968: 459)." He describes the difficult situation in Lasta that originated from war and natural disaster:

> The present population of Lasta seems to be almost nothing, having been destroyed by famine, war, and sickness, as I was told by the natives whom I asked about this subject. Ras Ali was blamed for having ravaged the country several years ago in the most barbarous manner (Isenberg & Krapf, 1968: 459).

21 Krapf tells of the degradation of the environment around the regions of Angot and Lasta up to the region of Tegray. The absence of wildlife is remarked along this route. Natural

disaster and regional conflicts probably led to both human and wild life migration. The lack of encounters with elephants could indicate that they were exterminated for the sake of their lucrative ivory.

Conclusion

22 Travelers' accounts show that the 16th century traumas fundamentally disturbed the environmental (and demographic) situation of the northeastern part of the country. The ecology was degraded and people were forced to migrate. Travelers remarked that in spite of the fertility of the country poverty was extremely high due to recurrent environmental disasters (drought, floods, locusts, etc.). The absence of descriptions of woodlands and wild animals (like elephants) along the main travel route of northeastern Ethiopia in post-16th-century travel accounts bears witness to obvious environmental changes. The Oromo pastoralist expansion from the south and southeast may have aggravated the situation in terms of demographic and economic pressure. European travelers described that the people adapted to environmental changes in different ways. For example, people could migrate en masse to other areas; regarding the scarcity of wood, it is narrated that people made use of animal dung as fuel. Demographic and economic pressure on the environment of the northeastern highlands may have led to the recurrent famine and social unrest in the contemporary history of these regions (Lanz, 1996; Rubenson, 1991).

23 In the future, we will continue our investigation by focusing on internal sources, particularly Ethiopian chronicles and *gedlat,* which will further augment the environmental history studies in Ethiopia.

Annex 1. Temperature registration of Rochet d'Héricourt for weather conditions in Ankober in 1840.

Observations thermométriques recueillies, au mois de décembre, à Angobar.

Le thermomètre de Réaumur marquait,

	à 9 h. du matin :		de 9 h. à 3 h. du s. :		
20 décembre. .	10 degr.	1/3 . . .	19 degr.	2/3.	Vent du S.
21	11 —	2/3 . . .	20 —	2/3.	
22.	12 —	1/3 . . .	21 —	1/3.	
23.	13 —	0 . . .	22 —	0.	Vent d'E.
24.	12 —	1/3 . . .	20 —	0.	
25.	13 —	0 . . .	22 —	2/3.	
26.	13 —	2/3 . . .	24 —	0.	
27.	13 —	1/3 . . .	24 —	1/3.	Vent d'E.-S.-E.
28.	14 —	2/3 . . .	25 —	0.	
29.	14 —	0 . . .	25 —	1/3.	
7 janvier 1840.	14 —	2/3 . . .	26 —	0.	Vent d'O.
8.	9 —	0 . . .	17 —	1/3.	Vent du N.
9.	7 —	1/3 . . .	15 —	2/3.	
10.	7 —	0 . . .	16 —	0.	
11.	9 —	1/3 . . .	19 —	0.	Vent du S.
12.	8 —	2/3 . . .	17 —	0.	
13.	9 —	0 . . .	17 —	1/3.	
	11 —	19/51 . .	20 —	40/51.	
	14,22 centigrades .		25,20 centigrades.		

L'abaissement de température, au mois de janvier, n'est dû qu'aux averses qui tombaient de temps à autre.

Source: Rochet d'Héricourt, 1841. Editor's note: To convert Réaumur temperatures to Celsius, multiply by 5/4.

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NOTES

1. Environmental history in Ethiopia is offered at the master level only in Baher Dar University where good MA theses have been produced.

INDEX

Mots-clés: végétation, faune, récits de voyage, paysages, déforestation
Keywords: fauna, travel accounts, landscapes

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Water always Flows Downhill: A Case for Participatory Forest Management (PFM) and Decentralization of Forest Governance in REDD+ Implementation

Julia Blocher

1 Forest loss has been considered in recent decades not only as an environmental concern to the local communities who depend on natural resources, but also at the national level as a possible loss of future sustainable development potential and as a contributor to national greenhouse gas emissions.

2 Aside from emissions from land use change, deforestation can also cause damage to agriculture and infrastructure and contribute to an increased frequency of flash floods, landslides and consequent displacement as well as loss of life (NEMC, 1995). Land degradation, reduction in agricultural productivity and loss of land area for communities downstream from serious erosion decrease the livelihood security of rural households. Deforestation, broadly considered here as "temporary or permanent clearance of forest for agriculture or other purposes" (Grainger, 1993), has many contributing factors. Expansion and clearance for small-scale and commercial agriculture, in particular for cash crops such as cotton and tobacco, have been a leading cause of deforestation and encroachment on forest reserves in developing countries for decades. Felling trees for fuelwood, charcoal, building poles, overgrazing, indiscriminate bush clearing and bush fires have also contributed (MTNRE, 1994).

3 Government programs across sub-Saharan Africa have sought to curb the loss of natural resources. Established in 2008, the United Nations collaborative initiative on Reducing Emissions from Deforestation and forest Degradation in developing countries[1] is the world's leading forest conservation and management program, with global scope. It is characterized as the forest component in internationally agreed initiatives to reduce greenhouse gas emissions resulting from land use changes, first elaborated in 2005 in

discussions surrounding the United Nations Framework Convention on Climate Change (UNFCCC, 1992). It has been proclaimed as "a new direction in forest conservation" (Anglesen, 2009: 125). By providing financial incentives to reduce forest loss, UN-REDD seeks to build mechanisms whereby developing and especially tropical countries can better protect and manage their forests while minimizing the emissions released by land use changes, by providing financial incentives to reduce forest loss (UN-REDD, 2013). The initiative was taken forward in collaboration between the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), and the Food and Agricultural Organization (FAO) grounded in a financial incentives-based approach proposed by UNEP, World Bank, and Global Environmental Facility (GEF). Nine pilot countries were chosen to develop the program's strategy in phases, preparing developing countries for participation in future REDD carbon credit mechanisms. The pilot countries are: Bolivia, Democratic Republic of Congo, Indonesia, Panama, Papua New Guinea, Paraguay, Tanzania, Vietnam and Zambia. The program has since added five countries and refocused on "REDD+" climate change mitigation strategies, which go beyond deforestation and forest degradation in including the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in reducing emissions[2].

4 A number of criticism have been leveled against UN-REDD, ranging from the practical (such as the lack of adequate baseline data to calculate reference forest emissions, cf. Burgess et al., 2010) to the socio-cultural (for example, the program stimulates a process of redefinition of socio-natural landscapes and socio-natural relations, cf. Farris & Bassett, 2012). This paper mainly confronts the issue of policy coherence, exploring the way that REDD is implemented vis-à-vis the achievement of program objectives, as well as the prospect of engendering unintended and potentially maladaptive outcomes. The core argument presented below is that elements of REDD programming which create an impetus towards recentralization of forest governance are counterproductive to the ultimate aims of UN-REDD, and risk producing damaging and maladaptive[3] effects.

5 A review of REDD policies and strategies demonstrates that despite a commitment to community participation at face value, there remains a dearth of sensitivity to local contexts, accountability to local institutions, and agency of the local community members. The focus remains on instituting financial incentive mechanisms that would require implementation at the centralized level (Katani et al., 2015) while community participation is mainly manifested in strategies to build local capacities to measure and monitor carbon stocks effectively and cost-efficiently in order to enable the allocation of carbon credits (Karky & Skutsch, 2010; Danielsen et al., 2013). Together these strategies are what is commonly referred to as "REDD+ readiness" (c.f. UN-REDD, 2012).

6 In questioning the possible impacts of potential recentralization of forest management as a downstream effect of REDD+ implementation, this paper ultimately argues for Participatory Forest Management projects (PFM) as the future of effective programs for reduction of forest loss and emissions. It argues that genuine and effective local participation is necessary to ensure the policy coherence of REDD+, for several key reasons. The first is that it provides the local community members with a more concrete and reliable picture of forest use and tenure rights. In most current systems in which centralized government hold ultimate ownership of a country's extractable and non-extractable forest resources, local community participation is critical for clarifying who will ultimately benefit from REDD+ benefits (i.e. carbon offsets), for avoiding centralized monopolization of forest resource benefits that takes resources away from local

communities without proper compensation, and for minimizing perverse outcomes of REDD+ incentives, for example, rezoning of forest reserves in order to maintain net negative carbon emissions. Clarifying forest use and tenure rights also reduces the insecurity of forest user communities, which can lead to project abandonment, precipitate inter-community and inter-village tensions, and may contribute to maladaptive livelihood choices that exacerbate forest loss (for example, illegal charcoal production by "livelihood stressed" people).

7 Second, and equally important in terms of policy coherence, is that by virtue of its phases of implementation (these can broadly be categorized into incubation, transition, and consolidation) PFM promotes local management of sustainable forest. Local cotrol promotes program adoption, decreases compliance costs and helps to ensure effectiveness and sustainability of the program. Even the most sophisticated and well-equipped force for policing, monitoring and enforcement would not be as effective as the commitment of local stakeholders to reducing overexploitation of forest resources (M. Tarimo, pers. comm.; C. Leonard, pers. comm.). These dynamics are discussed in greater detail below.

Rationale and questions

8 The impacts of climate change can be devastating to climate-dependent communities and vulnerable peoples around the world. Reducing emissions due to land use changes, of which forestry is a major contributor, as well as maintenance of forests as "carbon sinks" is thus of paramount importance to international efforts to mitigate climate change (IPCC, 2014).

9 Yet global and generalized initiatives to mitigate climate change through carbon accounting-dependent and land use change-related projects have in the past proven to be complex and rife with ultimately maladaptive inconsistencies, as in the case of biofuels (Fargione et al., 2008; Searchinger et al., 2008; UNEP, 2009; Blocher, 2010). To reduce emissions from deforestation and forest degradation, in tropical developing countries in particular, potential incoherencies and sources of carbon leakage in the early years of REDD+ need to be addressed.

10 In addressing the policy coherence of REDD initiatives at the local level, this paper seeks to better understand the circumstances in which forest management mechanisms engage the local community in protection and sustainable management of forests. With the ultimate goal of informing strategies relevant to this subject at the national and international level, it explores the strengths and weaknesses of REDD+ projects, broadly in terms of coherence between objectives and intentions and more specifically as regards improving the livelihoods of local people and maintaining project sustainability (compliance). One concern presents itself as key to understanding the potential outcomes: the re-centralization of forest resources which REDD+ initiatives threaten to engender. How this can be avoided is the primary concern of this paper.

11 In the process of analyzing a model case study of forest conservation and management efforts in Kilosa District of Tanzania – albeit, by no means a very extensive and exclusively positive one – a number of potential means to improve on existing initiatives are suggested for integration into future projects. This paper does not seek to provide one-size-fits all solutions for REDD+ programs, quite the opposite; through the analysis, I advocate for greater sensitivity to contextual cultural and social circumstances as a

necessary basis for successful implementation of REDD programs. A spotlight is placed on areas in which community- and empowerment-based projects can go farther than internationally conceived programs which ultimately require centralized governance.

Methods and approach

12 This study is based on a review of REDD policies and strategies, academic and "grey" literature and case studies of implementing REDD initiatives, as well as on observations and key informant interviews conducted in Dar es Salaam and Kilosa District in February 2015. As the goal of this study was a qualitative understanding of motivations and outcomes, no quantitative survey or carbon accounting was undertaken. Some initial findings and reflection are presented here, although it is too early to make concrete conclusions based on a short-term project (2009-14) that just beginning to review results. Longitudinal research and carbon assessments of the area of study would be needed to fully assess the dynamics of how communities respond to REDD+ initiatives and whether these efforts have positive or maladaptive effects.

Case study selection

13 As a leading country in developing participatory forest management programs for over two decades, as well as one of the nine initial pilot countries for UN-REDD and thus where much of the program's objectives and strategy were elaborated, Tanzania provides the ideal setting to explore the elaboration of REDD+ initiatives. The case of a community forest project from Kilosa district in central Tanzania is presented, currently being carried out by the Tanzania Forest Conservation Group (TFCG) and the Community Forest Conservation Network of Tanzania (MJUMITA).

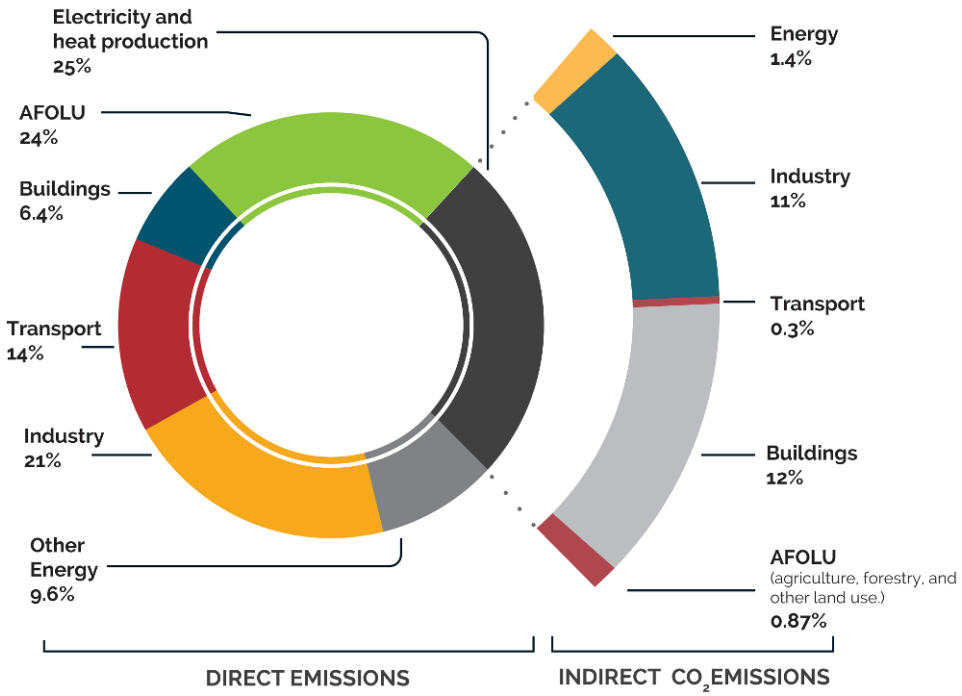
14 The following sections are structured as follows. First the rationale and developments in climate science leading up to the UN-REDD program and its focus on developing countries are briefly reviewed. Next the concerns raised by the potential recentralization of forest governance are considered with regard to local tenure, use and access rights. Finally, the strengths and weaknesses of REDD+ are laid out employing an illustrative example from Tanzania, providing arguments for how Participatory Forest Management (PFM) can address some incoherencies of REDD programming. The concluding section offers a reflection on the advantages of implementing PFM, along with concrete recommendations for Tanzania and the wider East African community.

Goals of REDD+ and its importance in East Africa for mitigation of carbon emissions

15 Deforestation is the second-largest anthropogenic source of carbon dioxide in the atmosphere, exceeded only by fossil fuel combustion (van der Werf et al., 2009). Despite moderate commitments to mitigation of greenhouse gas, forest conservation and management at the international level since the establishment of the United Nations Framework Convention on Climate Change (UNFCCC) in 2001 and the Kyoto Protocol (1997), "land use, land use change and forestry" (LULUCF)[4] also show a rise in carbon emissions overall; although the rate of deforestation globally was slightly lower in the 2000-2005 period than in the 1990-2000 period (IPCC, 2007: 541-584), LULUCF emissions

grew by 40% between 1970 and 2004 (IPCC, 2014: 3). Current research suggests that approximately 10% of all human-related carbon-based emissions in the past decade are from land use change, estimated at 3.3 billion tons of carbon dioxide equivalent annually (ibid.). Only moderate agreement exists among scientists in regards to the total LULUCF emissions – of which emissions from deforestation are a subset – owing largely to significant data uncertainties and some persisting incoherencies in carbon accounting for land use change (Blocher, 2010). The latest findings from the Intergovernmental Panel on Climate Change (IPCC), combining agriculture, forestry and other land use into one measurement, shorthanded as AFOLU, showing that the AFOLU sector is globally the largest emitter after energy, representing 20-24% of all direct emissions (IPCC 2013: 997) (Fig. 1). Experts contend that deforestation is the largest contributor to this sector, representing 6-17% of annual anthropogenic emissions (Baccini et al., 2012).

Figure 1: Direct and indirect production of CO2 per sector



INDIRECT EMISSIONS: FOR EXAMPLE, LOSS OF CARBON PREVIOUSLY SEQUESTERED IN GRASSLAND AND FOREST ECOSYSTEMS WHEN LAND IS CLEARED OR CONVERTED. THESE INDIRECT EMISSIONS ARE LIKELY TO BE SIGNIFICANT AND VERY CHALLENGING TO CALCULATE.

IPCC, 2014

16 In developing countries, forestry is a major contributor to net emissions compared to upper-middle and high income countries, where greenhouse gas emissions (hereafter CO2e)[5] from energy, industry and transport are more significant (IPCC, 2007:566-67). Furthermore, it was found that for non-member countries of the Organisation for Economic Co-operation and Development (OECD), the agriculture and forestry sectors represent the largest supply-side economic mitigation potential, that is, the most carbon mitigation could be achieved at the lowest cost per ton of carbon equivalent per year (IPCC, 2014)[6].

17 Findings indicate that emissions from deforestation in the latter half of the twentieth century, and showing overall a continuing upward trend in recent decades, run parallel to evidence in regard to forest resources in Sub-Saharan Africa.

Think global, act local: incoherencies and Inadequacies of REDD

Decentralization of forest management

18 The highly centralized nature of forest management across Sub-Saharan Africa has persisted until recently as a remnant of colonial rule, added to by a spate of other governance concerns. Efforts began in the late 1970s and early 1980s to address this, accomplished by "trickling down" forest governance to the local level, through district and village councils.

Benefits bypassing the forest users and rights-holders

19 In most Southern and East African countries, as much as 80% of all forestland is owned by national governments (Takacs, 2009). One criticism leveled against UN-REDD is that without clear definitions and strategies for benefiting from the outcomes of REDD+, the beneficiary of the program as well as the beneficiary of the forest resources themselves may not be the community occupying the forestland. This holds true in most cases where there is lack of secure forest use and carbon rights, whether legally explicit, implicit, or contractual (USAID, 2011).

20 A risk of the REDD program is therefore that central governments may assert "ownership" of the forests and reclaim forestland from communities with usufruct rights. Governments furthermore could do so without appropriately compensating the affected communities (Knox et al., 2010; Barnes & Quail, 2010). These states have the authority to legally seize forests and not to recognize existing rights or withdraw them altogether. Where the rights are not clear in existing laws, such a situation would apply both to non-extractive resources (e.g., wood and timber products and non-timber forest products such as fruits, nuts, medicinal plants, grasses and leaves), over which the government can claim ownership for the "public good", as well as extractive resources (e.g., sequestered carbon, so-called payment for environmental services such as watershed protection) (USAID, 2012).

21 There is considerable evidence that involuntary evacuations of populations are already occurring (Mosi, 2013). On one hand, intensified activities of growing populations in environmentally sensitive areas have numerous negative downstream effects on income sources and inter-communal cohesion for populations in mid and lowland areas (M. J. Mbonile, pers. comm). This situation may have the perverse domino effect of leading to an increase in abandonment of conservation efforts and to unsustainable deforestation in livelihood-stressed communities. On the other hand, without planning compensation for evacuees, environmentally degrading activities may simply be displaced elsewhere. Involving local communities in forest management planning presents itself as a vital means to minimize maladaptive effects of forest conservation and management planning (Gebara et al., 2014).

22 In nearly all cases of centralized forest ownership it is unclear if the political will exists to allocate REDD+ benefits on the basis of recognition or existence of property rights and/or use rights over forest resources. In Tanzania, for example, sharing of REDD+ benefits is intended as part of the REDD+ readiness strategy; however, the persistence of unclear governance, lack of clarity or enforcement of rights, and insecurity of land tenure preclude the possibility of success and equity of benefit sharing (Campesen 2012).

Participatory Forest Management and REDD+: Lessons from Tanzania

23 Participatory forest management has a strong basis in Tanzania's local government institutional frameworks, which formalize the role of local communities in forest protection and management. For this reason and because Tanzanian forests are testing grounds for REDD+ initiatives, the country provides an ideal context for exploring strengths and weaknesses. The following section explores a special PFM project in Kilosa district of Morogoro region. First, a background survey of forestry and forest conservation in Tanzania is provided, along with an outline of the relevant legal and institutional frameworks. Next the conditions of forest tenure, access and use as well as carbon rights in the country are discussed. Finally the case study of one participatory forest management project currently being conducted is presented to clearly bring out the points raised.

Land and forestry in Tanzania

24 Tanzania has the largest forest area in East Africa, with 35.3 million hectares of forests in 2005 (excluding Zanzibar's forests) or 39.9% of its total land area (FAO, 2009). Approximately 14.3 million hectares of various forest types are declared as forest reserves, 2.5 million hectares are proposed forest reserves and around 2 million hectares are in game reserves or national parks (TZDPG, 2009). The forest reserves mat come under the authority of the central government (national reserves), District Councils (local authority forest reserves) or village governments (village land forest reserves, private and community forest reserves); they are classified either for production (managed for timber production and other productive uses) or for protection (i.e. for water catchment and/or biodiversity conservation functions). The remaining 16.5 million hectares of forests are classified as village or general land.

25 Decentralization became a core element of the forest policy developed starting in the 1990s: the National Forest Policy of 1998 (URT, 1998), the Forest Act of 2002 (URT, 2002), but also the Land and Village Land Acts of 1999 (URT 1999a; URT 1999b). The National Forest Program of 2001–2010 (URT 2001) was established as the implementation tool of the Forest Policy of 1998. In 2010, the Tanzanian Forest Service Agency was established and given the responsibility of managing the central government forest reserves.

26 Under Tanzania's Land Act of 1999, the President is the trustee of all land, and controls it for the people. Like many – if not most – governments, Tanzania grants rights of occupancy and forest product use rights, but not property rights, to communities, individuals and private entities.

27 Land is divided into three categories: (1) Reserved Land, including national parks and wildlife reserves; (2) Village Land, including registered Village Land, land that has been designated as Village Land by village councils and land that has been occupied and used by villages for more than 11 years under customary law; and (3) General Land, which is all land that is not Reserved or Village Land (ITW Charles, 2015; USAID, 2011). Importantly, the Village Land Act also recognizes several categories of land use for individual use and settlement, including land set aside for future use. This also provides for land for agricultural and housing and for communal use, including land use for grazing and harvesting forest products. All unoccupied or unused Village Land is considered to be General Land under the Land Act (C. Leonard, pers. comm.; USAID, 2010). General Land is a status that can create disputes over land use.

28 The Forest Act of 2002 governs the use and management of forests in Tanzania. Section 1 (3) defines forest products as "anything which is produced by or from trees or grows in a forest or is naturally found in a forest [...]" It furthermore establishes three main categories of forests: (1) national and local forest reserves, including parks and reserves, Village Land Forest Reserves, and forests on General Land; (2) Village Land Forest, for which a Village Council manages the forest; and (3) private forests.

Deforestation and forest degradation in Tanzania

29 In almost no other area of Sub-Saharan Africa are the effects of deforestation as evident as in central and coastal Tanzania. Some hills have been so blatantly manipulated by human hands and expunged of any rooted vegetation that they resemble terraced agricultural lands.

30 Tanzania has seen a large part of its forests decimated since the beginning of the twentieth century. By some estimates, well over 70% of the Usambara forests have been cleared since 1905 (NEMC, 1995). Considerable sections of the forests in the Shinyanga region and Kilimanjaro Forest Reserve have also been lost. Some estimates place the average annual rate of forest loss at 1.16% of the total forest area (FAO, 2010; Vatn et al., 2013). Deforestation is blamed on inadequate funds and capacity to monitor and police national forest reserves, parks and game reserves. However, most forest loss occurs outside reserves in the village and general lands, where the expanding human population lives (Hall et al., 2009; Tabor et al., 2010).

Participatory forest management

31 Participatory Forest Management (PFM) has been a feature in East African forestry over two decades as a strategy to sustain and conserve forests. It can be loosely defined as a forest management strategy that formally recognizes the role of communities in managing and owning forests in pilot projects, policies and legislation.

32 Tanzania led the development of these strategies in the 1990s with the first pilot projects in the forests of Duru-Haitemba, Mgori and Suledo (TZDPG, 2009). By 2008, PFM applied to over 4.1 million hectares of forest land attached to over 2,300 villages across the country (Blomley et al., 2008; Burgess et al., 2010; TZDPG, 2009). Concretely, Tanzania has implemented two basic approaches to participatory forest management: Community Based Forest Management (CBFM) and Joint Forest Management (JFM). Joint forest management is based on an agreement between local communities, for example through

a Village Council, and government authorities to manage a local or central government forest reserve. Community-based forest management (CBFM) applies to forests for which the local villages, or sub-groups within the villages, are the sole forest manager by virtue of the local community declaring the land to be Village Land Forest Reserve (VLFR) or Community Forest Reserve (CFR). These terms are defined and described in the Tanzanian National Forestry Policy (MNRT, 1998), Forest Programme (MNRT, 2001) and Forest Act (URT, 2002).

33 Despite ultimate ownership of all resources of the forest by the central government, the Village Council or committee representing multiple villages assumes legal control over the use of all forest resources and produce upon declaration of a VLFR or CFR (Wildlife Conservation Society of Tanzania, 2010). Thus, "by establishing VLFRs or CFRs, communities obtain full legal rights to manage and benefit from their forests" (Wildlife Conservation Society of Tanzania, 2010: 15.)

Duties *and* benefits are transferred to forest users

34 Taken together, the Village Act, the Forest Act, and the Land Planning Act bring legal ownership of the forests to the village level (B. Luguwe and E. Fundi, pers. comm.). By-laws enacted in 2012 establish the village as being in control over the revenue gained from extractive forest products; these national laws, implemented at the local level through the authority of village councils, can be equated to a village forest management strategy and implementation plan (C. Leonard, pers. comm.). This situation provides for a number of practical benefits – for example, people can apply for permits to produce charcoal at the village level rather than at the district level (C. Leonard, pers. comm.). This cuts out unnecessary administrative complications, delays and travel, generally reducing the cost of compliance for the "typical" forest resource user.

35 By empowering the local community and making the inhabitants the principal forest stakeholders, the participatory management project encourages people to assume responsibility for the protection of the forest against external and often illegal exploitation. The community receives multiple tangible economic and social benefits. First, certain individuals directly gain income generated from the sale of charcoal. Second, the villages benefit by being the recipients of increased revenues, particularly from taxes levied against forest resource use and transport of charcoal, which they are themselves responsible for allocating through the village councils. Finally, this local political empowerment has intangible benefits, particularly for remote communities. The local inhabitants are assured the right to benefit from sustainable exploitation of local resources and, in the larger sense, the pursuit of improved economic conditions, educational and personal fulfillment, the highest attainable standard of physical and mental health, and the improvement of their surrounding environment (ICPR, 1966).[7]

36 In the next section the downstream effects of the forest management plan are discussed in greater detail in regard to the case of the participatory forest management in Kilosa district.

Seeds of change? Participatory forest management in Kilosa district

37 Tanzania started its engagement in REDD+ in 2008 after signing a letter of intent on a Climate Change Partnership with the Norwegian Ministry of Foreign Affairs through the Norwegian Embassy in Dar es Salaam. UN-REDD also provided support (UN-REDD Programme). Two REDD+ readiness processes are manifest. First, a series of nine pilot projects were established and are run by various NGOs directly contracting with the Norwegian Embassy. Secondly, there is the national process including the establishment of a national REDD+ task force, a REDD+ secretariat and a set of technical working groups. In 2013 a national REDD+ strategy and action plan were endorsed by the government. In parallel, a national climate change technical committee was established to oversee climate change policy implementation, including REDD+. A REDD+ fund, which is potentially part of a more general climate change fund, is outlined in the strategy.

38 The REDD+ pilot in Kilosa (2009-2014) is part of the project "Making REDD Work for Communities and Forest Conservation in Tanzania." It is implemented by the Tanzania Forest Conservation Group (TFCG) in partnership with the Tanzania Community Forest Conservation Network (MJUMITA) and is one of the NGO-led REDD+ pilot projects that have received funding from the climate change partnership between Norway and Tanzania (TFCG, 2009; Norwegian Ministry of Foreign Affairs, 2009). TFCG is Tanzania's largest forest conservation NGO, while MJUMITA is a national network of 108 affiliated community networks involved in PFM from across the country (Vatn et al., 2013).

The Kilosa REDD+ project

39 Kilosa District is a geophysically diverse and largely natural area in the Eastern Arc Mountains about 300 km west of Dar es Salaam. It was chosen to host the pilot REDD+ project partly due to its substantial amount of forested area (TFCG, 2009). About 28% of the land in the district is under government management, mainly for the large national park at Mikumi (approx. 22.5%) and the rest in forest reserves (approx. 5.5%); the rest is village land, general land and a handful of small urban areas (M. Tarimo, pers. comm). Importantly, only general land and village forests were included in the Kilosa pilot, not governmental land. The district is subdivided into nine divisions, 37 wards and 168 villages. Fourteen villages, mainly to the west of Kilosa town, were included in the original Kilosa project (Vatn et al., 2013); the project was implemented until the end of 2014 in ten villages (B. Luguwe and E. Fundi, pers. comm.). The population of the pilot villages is around 25,000 (Vatn et al., 2013).

40 The REDD+ pilot project in Kilosa District was initiated and designed by a direct contract with the Norwegian Ministry of Foreign Affairs of Norway. Following consultation and endorsement by district and village authorities in the site selection process (M. Tarimo pers. comm.), PFM guidelines ensured the participation of the local population through the establishment of village natural resources committees (VNRC), village assembly meetings, and a participatory resource assessment (PRA) process that necessarily included a forest resources assessment (Mosi 2013; Vatn et al. 2013). By 2012 all the village councils had drafted by-laws and proposals for the allocation, access, utilization and management of all forest reserves within the village boundaries, all of which were

defined to be 'under REDD' (Vatn et al., 2013). In most villages these by-laws established a system in which all forest resource access and use required a permit and supervision by a member of the VNRC (*ibid*). Farming, human settlements, grazing, and mining are prohibited altogether and subject to fines. Taking firewood, cutting poles for building and starting fires are highly regulated. Collecting timber and burning charcoal require both permit and payment.

41 The establishment of a number of test income-generating groups within the project boundaries was or became a core component of MJUMITA's involvement (see below), aiming at improving local people's traditional livelihoods and ensure maintenance of sources of income (B. Luguwe and E. Fundi, pers. comm.). A small number of households in a limited number of villages were included in these test groups.

Aims and implementation

42 TFCG aims to foster community-based forest management (CBFM) across the country by supporting a reclassification of general land into formalized and secure village forests (C. Leonard, pers. comm.). CBFM guidelines require that the village natural resources committees (VNRC) be established along with village forest reserves governed by forest resource management plans and/or village land-use plans, establishing village-land titles and creating by-laws defining rules for access to and utilization of forest resources as well as "attractive" distribution of payments for carbon (TFCG, 2012).

43 MJUMITA seeks to validate emissions reductions through verified standards. The initial aim was to develop a self-financing carbon payments system by the end of the project timeline (TFCG 2012). Local capacity building to ensure monitoring, reporting and verification (MRV) comprising emissions-relevant data is an essential component in achieving this aim, which is also implicit in the participatory forest assessments at village level and MRV built into CBFM projects. The pilot also aims to be "replicable, equitable and cost-effective" in reducing drivers of deforestation and to reduce the amount of emissions-producing activities that are merely moved across project sites. This can be an intentional or unintentional result of such projects known as "carbon leakage" reduces the accuracy of carbon accounting. Advocacy for equitable and effective REDD+ benefit sharing and building capacities of stakeholders is also a priority (TFCG 2012).

44 A general dearth of employment opportunities in the district is considered to be the main reason for high levels of poverty in the area (MJUMITA, 2014). The employment conditions, together with the prohibitive cost of traveling to larger urban areas such as Morogoro and Dar es Salaam as well as barriers to obtaining (skilled) employment in this area, are often cited as primary contributors to unmanaged forest loss caused by shifting cultivation, charcoal production, timber harvesting, and other extraction of forest resources. With the aim of reducing these drivers of deforestation, TFCG/MJUMITA has supported projects to enhance income-generating activities, and improved efficiency of charcoal production in particular.

45 The project has two core components. First, to train locals in a more efficient mode of charcoal production, which includes means for reducing heat loss and improving the carbonization of wood. Second, to raise awareness on the importance of managed forests as a means to sustain the forests and maintain their value for the future. The by-laws in many villages ensure that income from taxes on charcoal production and transportation, which village councils are empowered to allocate (as stated above), will go towards

community activities. Given proper calculations of both current total forest resources and the optimal use that still allows for forest regeneration,[8] total project compliance would reduce emissions from land use changes all while ensuring forest users significant direct income as well as indirect benefits from charcoal production (B. Luguwe and E. Fundi, pers. comm.).

46 Following the initiation and establishment phases, a third core step was defined in the contract agreement between TFCG/MJUMITA and the Norwegian Ministry of Foreign Affairs to introduce payments for reduced deforestation and CO2 emissions. MJUMITA began implementing a trial payment mechanism – staggered, as villages were in different stages of village land use planning processes – in September 2011, based on an "individual dividend", implying that the external REDD+ income would be given to each eligible villager as agreed by the villages' general assemblies (Vatn et al., 2013). Because of negative attitudes towards charcoal producers, in practice the payments could not be made on the basis of financially incentivizing persons producing charcoal or with other carbon-intense professions to reduce the emissions of these activities, as would be a common way to motivate emissions reductions. Village assemblies supported a TFCG/MJUMITA proposal that compensation be made in the form of an undifferentiated payment to each eligible inhabitant; this includes all inhabitants over six months of age, with some limits on the number of eligible persons per household (Vatn et al., 2013). Village assemblies chose what purpose the dividends – along with the revenue from permits and taxes – e.g., on charcoal transportation – would serve. In many cases projects with tangible community-wide social benefits were chosen for funding, such as building clinics and secondary schools (M. Tarimo, pers. comms.; C. Leonard pers. comm). An improvement in socio-economic indicators is the expected outcome; this would require longitudinal research to verify.

Case study Analysis

Strengths

47 The interviews conducted for this study as well as previous studies indicate a high level of satisfaction with the TFCG/MJUMITA pilot project from all stakeholders involved (c.f. Ngabo, 2013; Mosi, 2013; Vatn et al., 2013).

48 These findings underline an overall level of local participation that was accentuated in the project implementation. Indeed, the project fostered collaboration with district authorities as well as collaboration among villagers. Importantly, engaging in the project, the act of collaboration, the common sense of purpose, and the concrete community-wide benefits reflected in the heartfelt thanks expressed for the funded community projects (e.g., schools and clinics) helped foster a kind of social contract among the villagers. Such peer pressure serves as an effective policing measure that reduces the incidence of project abandonment, encroachment on project land, and illegal harvesting of forest products.

49 More research would be needed to explore if the expressions of satisfaction just noted are genuine or are otherwise motivated – for example, as an expression of conformity to the will of district leaders, or of a generalized desire to support community-based projects and income diversification.

50 In addition, it appears that the increased direct and indirect income from charcoal production supported by MJUMITA through the "income generating groups" (see below) has been positive overall for participating villages. While not necessarily changing local attitudes to charcoal producers and "invaders," i.e., external illegal charcoal producers, the benefits of tax revenue are perceptible, even to villagers not involved in the groups.

Challenges

51 As one goal of the project was to emulate the current carbon trading schemes, which market-driven price of emissions reductions, the very low current price in carbon markets was used for the payments. Many participants considered their compensation to be inadequate and not worth the income loss resulting from restriction in forest resource use (C. Leonard, pers. comm.). Encroachments on land for grazing, agriculture and other uses were reported or discovered (M. Tarimo, pers. comm.). Illegal charcoal production and illegal timber harvesting were reported in some villages in 2012 (TFCG, 2012), 2013 (Mosi, 2013; Vatn et al., 2013) and again by residents in 2015. Charcoal and timber makers naturally disagreed on the amount of land that should be declared for village forest reserves given the high opportunity cost (Vatn et al., 2013). A number of village participants were designated into "income generating groups," hand-picked and directed by the project leaders, were formed as part of the project. These groups were dedicated to generating income, especially through trainings and facilitation to produce charcoal efficiently. Given low carbon prices and limited number of participants in the income generating groups certain villages for which timber or charcoal production anchored the livelihoods of a high number of inhabitants did not appear to benefit significantly, and risked losing income.

52 The results of a project assessment survey published by the International Institute for Environment and Development (IIED) demonstrated that land demarcation, including size and quality, presented the most significant issue for respondents (Mosi 2013; Vatn et al. 2013). In one context, a foreign investor had previously taken a large swath of land for a plantation, creating land scarcity and leaving inhabitants, agriculturalists in particular, distrustful of outside plans for local land. Other villages expressed concern for the trustworthiness of the district and central government's intentions for forest management plans, believing that the government would be the primary beneficiary of REDD+ payments. TFCG made significant efforts to assuage fears that the pilot project would operate in a similar way to previous foreign "land grabs" and previous land reallocations by the central government. These tensions are of particular importance to forced evacuations of mountain inhabitants to make way for the establishment of REDD+ forests and national forest reserves (Mosi, 2013) as well as to Maasai pastoralists in the district, who were apparently not consulted throughout the process (Vatn et al., 2013). Most tense situations appear to have been intra- or inter-communal, rather than involving conflict with TFCG/MJUMITA or with authorities; this would appear to support the argument that the fact that some people stood to benefit or be harmed more by REDD + benefits than others added to tensions.

53 A lack of trust between villages and their leaders was highlighted in the IIED assessment (Vatn et al., 2013), a problem which still persisted in 2015 (C. Leonard, pers. comm.; B. Luguwe and E. Fundi, pers. comm.). One key reason is simply the differing involvement in and benefits experienced from the project, which the villagers and village councils had

little influence on. The villages in the pilot were chosen for a number of reasons, some of which are described above, yet these factors may not have appeared valid or relevant in the eyes of inhabitants of neighboring villages. The collective projects funded by the MJUMITA payments and tax revenue from the income-generation activities were noticeable symbols of the project's success.

54 In addition, villages within the project had varying levels of concrete positive outcomes. In a few instances, either little funding was allocated for community projects or the resources were held by MJUMITA in a fund until the village was deemed "ready" (Vatn et al., 2013: 43).

55 An important issue concerns the carbon price, which is essentially determined at the international level. Villagers complain that the compensation they receive is small and they are unsure if another payment will come (Mosi, 2013). Funding for projects is a concern. After the pilot's official conclusion in June 2014, the project has continued in uncertainty, although PFM and CBFM existed before and will continue in Tanzania. As for the carbon financing mechanisms, villagers may become less trusting of outside projects or even feel cheated. This reality runs counter to the purpose of local participation and positive sustainable outcomes of such a project.

Incoherencies of REDD+ exposed: Increasing inter- and intra-community inequality, vulnerability

56 In contrast to villages where implementation of a TFCG/MJUMITA pilot project is occurring, a different story emerges from community members in villages that are involved only in REDD+ readiness. As the benefits of REDD+ offsets remain uncertain, due in part to the legal uncertainties described above, perceived ownership of the program is low. Villagers are concerned that their existing forest use rights and benefits – for many, their main source of income or an occasional risk insurance, as a means to smooth household consumption – will be undermined by REDD+ implementation. Similar concerns have emerged in other studies. A visible result has been less emphasis on protection of the forest from "invaders," often external charcoal producers, and more concern with encroachment on protected land by external individuals and village community members (C. Leonard, pers. comm).

57 An additional concern highlighted in the case of Kilosa is the fostering of equity between communities (Katani et al., 2015). If certain communities receive REDD+ revenues while others do not, the latter may feel unfairly treated and be discouraged from supporting the REDD mechanisms. This contributes to the abandonment of sustainable forest management efforts and to further forest encroachment, which may or may not be captured in carbon auditing. Importantly, certain communities and specific groups within communities are less likely to benefit from fair distribution of benefits, leading to social tensions, increased inequality, and increased vulnerability. Appropriate and participatory knowledge input and assessment mechanisms are needed to avoid these maladaptive effects of policy implementation.

58 Intra-community inequalities are also critical. The income-generating activities appeared to be poorly understood and involved few inhabitants (Vatn et al., 2013). As stated above, in general charcoal and timber producers were initially dissatisfied with the amount of land demarcated for their use. However, in the long run the large-scale producers have

the economic incentive to support the project as it ensures them a constant and legal supply of charcoal. Given the fixed tax on the maximum weight of charcoal that is allowed to be transported, a more predictable supply of charcoal means that people involved in commercial and year-long charcoal production are able to maximize their profit margin. By contrast, the marginal gain is low for smaller producers or those who produce charcoal for fast cash for each additional unit of charcoal. Thus a situation is created in which large-scale producers are given incentives to continue producing large amounts of charcoal while those whose is livelihood insecure cannot gain enough to pull themselves up by much. They also have incentive to continue producing inefficiently. Whether the goal to optimize charcoal production has been met or if the new practices have been adopted at all would need further research, although some indications from locals suggest mixed results. Such research is needed for an accurate assessment of overall emissions reductions.

Conclusions and recommendations

Ensuring the continuation of decentralized governance of natural resources

59 The preceding sections have sought to present the arguments as to why certain elements of PFM address many of the incoherencies of REDD+ programming. Part of the motivation of this paper has been to address some of the pitfalls of REDD+ planning, which has been on the table in UN discussions since 2005, so that an adequate and effective program for reducing emissions from forest loss can advance.

60 The case study presented of REDD+ supported forest management in Kilosa District of Tanzania has all the earmarks of being one in which participation was very central to the process. However, issues of accountability still rear their head. First, there are issues of villagers tending not to trust more central political institutions, especially when it comes to questions of land tenure and land use. Villagers were, at least initially, suspicious of REDD+ initiatives because of past circumstances in which land had been appropriated for use by other, and foreign, entities. Local NGOs TFCG/MJUMITA had to work to alleviate these concerns. The way in which the pilot project was established, bilaterally with the Norwegian (Mosi, 2013; Ngabo, 2013), may reflect both the expectation that NGOs could deliver REDD+ better than the state authorities could, and sensitivity to local distrust of central government interference in forest land access and use.

61 It is planned that after the pilot phase, the carbon benefits element of the project will be handed over completely from TFCG (a large NGO run by committee) to MJUMITA (a membership organization). This means that MJUMITA will act as an intermediary between villagers and international carbon markets (Mosi, 2013; Vatn et al., 2013). The accountability of MJUMITA is thus to national and internationally regulated carbon.

62 Potentially cutting out local and national political bodies is a shortcut. Commodification of carbon without clear forest tenure and use rights – as well as carbon rights – at the local and district level would imply a recentralization of forest land use and land-use planning. A national REDD+ strategy thus must prioritize a shift of responsibility to the villagers. The participatory forest management program, independent of the REDD+ carbon markets, is making strides to achieve this. If such programs could overcome the

problem of inadequate resources, for example by receiving financing from REDD+, current participatory forest management may become more effective in reducing carbon emissions and increasing forest carbon stocks, promoting sustainable management of forests and delivering significant social and environmental co-benefits (Zahabu & Jambiya, 2007; Burgess et al., 2010).

63 A number of recommendations are drawn from the study above:

- Issues of verification of emissions and lack of adequate financing have marred the potential of UN-REDD to successfully reduce emissions from deforestation. Participatory forest management within the framework of REDD+ must therefore include capacity building for monitoring, reporting and evaluation (MRV) processes, which are prerequisite to the establishment of carbon offset systems. Previous research has demonstrated local communities' ability to carry out this work (Skutsch et al., 2009; Burgess et al., 2010). Monitoring is also needed for the social and governance aspect of local management, which has been shown to increase equitable distribution of benefits (Stuart-Hill et al., 2005).
- Forest land tenures, access and use rights must be trickled down to the forest communities themselves. Inconsistent laws – particularly those related to non-extractive forest resources (e.g., carbon, « payment for ecosystem service" i.e. in the case of protection of ecologically critical or sensitive areas such as water catchment zones) into forestry laws and forestry management policies.
- Significant efforts must be made to deal with the concerns of communities about their right to make decisions about natural resources and to benefit from those resources (Katani et al., 2012). The findings above supporting this recommendation are confirmed by previous studies that have also evidenced local concerns about community involvement and benefits from REDD+ (Katani et al., 2015).
- Projects must incorporate sensitivity to promoting equity between the communities. If certain communities receive REDD+ revenues while others do not, they may feel unfairly treated and be discouraged from supporting the REDD mechanisms. Particular attention must be paid to households whose livelihood is insecure and which are severely impoverished, as well as specific vulnerable groups.

64 Overall, effective and coherent UN-REDD programming has the potential to secure livelihoods and increase community welfare and resilience. REDD+ funding in communities that are already involved in participatory forest management projects would serve to contribute to income diversification and risk spreading (Karky, 2008; Malimbwi & Zahabu 2009; Katani et al., 2012).

65 In order for the international community to deliver this potential and assist developing countries in promoting sustainable forest management, international funding and programming should promote decentralized management and empowerment of local communities, have greater sensitivity to contextual specificities and prioritize projects that actively address important socio-cultural aspects of forest management.

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NOTES

1. Hereafter referred to as UN-REDD in regard to the program administration and as REDD+ when referring to the proposed carbon offsetting mechanism.
2. Other multilateral REDD+ initiatives include the Forest Carbon Partnership Facility (FCPF) and Forest Investment Program (FIP), hosted by The World Bank.
3. Maladaptation here is considered "an action taken ostensibly to avoid or reduce vulnerability to climate change that impacts adversely on, or increases the vulnerability of other systems, sectors or social groups" (Barnett & O'Neill, 2010: 211), including climate change actions that may ultimately have a net zero effect on emissions or result in their increase.
4. The term LULUCF used here and in the IPCC assessment describes the aggregate emissions from deforestation, biomass and burning, decay of biomass from logging and deforestation, decay of peat and peat fires; it does not include carbon uptake by biomass.
5. Carbon dioxide equivalent (CO2e) is a measure used to compare the emissions from various greenhouse gases based upon their global warming potential.
6. The IPCC fifth assessment report (2013) suggests that on the supply side, economic mitigation of 7.18 – 10.6 GtCO2e per year can be achieved with a price for carbon up to 100 USD/tCO2e.

Mitigation of about a third of that many gigatons of carbon dioxide equivalent can be achieved at less than 20 USD/tCO2e. (IPCC, 2013).

7. All citizens have a right to use and enjoy the natural resources of the state, equitably and sustainably; it is the State's duty to ensure that people, including future generations, may enjoy this right. General Assembly resolution 1803 (XVII) in 1962 gave this principle momentum under international law in the decolonization process. In this important resolution the Assembly declared, *inter alia:* "The right of peoples and nations to permanent sovereignty over their natural wealth and resources must be exercised in the interest of their national development and of the well-being of the people of the State concerned..." and "The exploration, development and disposition of such resources, as well as the import of the foreign capital required for these purposes, should be in conformity with the rules and conditions which the peoples and nations freely consider to be necessary or desirable with regard to the authorization, restriction or prohibition of such activities." Article 1 (2) of the Covenant on Civil and Political Rights and the Covenant on Economic, Social and Cultural Rights provides: "2. All peoples may, for their own ends, freely dispose of their natural wealth and resources without prejudice to any obligations arising out of international economic co-operation, based upon the principle of mutual benefit, and international law. In no case may a people be deprived of its own means of subsistence."

8. The determination of calculations presents a major issue, given the inadequate baseline forestry data sets needed to calculate reference emission levels (Burgess et al., 2013). More information would be needed on types and figures for current forest resources, rates of forest loss, regeneration rates as well as optimal types and numbers of trees for harvesting, as well as participants' compliance with these and rates of attrition of project participants These issues are beyond the scope of this paper.

INDEX

Mots-clés: foresterie, gouvernance, séquestration du carbone, climat, environnement
Keywords: forestry, governance, carbon storage, climate, environment

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Investment in the National Park? Encounters between Land Investment and Wildlife Conservation in Gambella Regional State

Mehdi Labzaé

1 Located in Ethiopia's western lowlands bordering South Sudan, the Gambella Regional state has repeatedly made the headlines of international newspapers over the last five years (Al-Jazeera English, 2014; Vidal, 2011; Smith, 2014 & 2015; Stienne, 2013). The place is described, with some reason, as one of the world's land-grabbing hotspots. Over the past fifteen years, several thousand hectares have been transferred to private investors announcing their intention to engage in commercial farming in the region.

2 Gambella region is also home to a natural park that has been, for some time, under threat. National parks are key components of a country's biodiversity conservation and environmental policies as well as symbols of a nation's (re)presentation of its natural and cultural heritage, and Ethiopian national parks are no exception. However, in Gambella, the priority seems to have been put rather on allocating land for private investors, rather than upgrading the national park by providing rangers with sufficient resources to effectively protect the area. Land grab could have encroached into the park, with deep consequences in terms of wildlife conservation. But generally speaking, this did not happen, and the park was redelineated in 2011 so as to make sure land investment would not threaten protected areas.

3 Even if it is hosted by a panel focusing on conservation policies, this communication does not deal directly with conservation matters. Rather, it aims at shedding light on how the Ethiopian government administers its land resources in a peripheral region. This, in turn, informs us on how the conservation policy is negotiated in practical terms. Based on ethnographic observations of land administration agents' work, the paper does not focus on the park *per se* but on what surrounds the park – *i.e.*, investment land. It shows how

the land investment policy implemented by the government meets conservation objectives, and how these two policies are articulated on the ground.

4 I will first give a brief overview of the government's agricultural policies. The policy of encouraging land investment is a rather new trend in Ethiopian agricultural policies, which used to focus almost exclusively on the peasantry. In a second section, I will give further details on how land is transferred. In contrast to analyses that look only at procedures in the abstract, without considering how these procedures are implemented, my work is grounded in in-depth observation and interviews with land administration and national park agents. Then, in a brief third section, I will try to show how this land policy meets the conservation agenda, with regard to the national park.

Leasing land to private investors in the peripheries

5 The transferring of land to private investors is a manifestation of the government's shift in its agricultural policy. Up to the mid-2000s, the *Ethiopian Peoples' Revolutionary Democratic Front* government followed a policy of Agricultural Development-Led Industrialisation (ADLI) that aimed at rendering the peasantry self-sufficient. Public ownership of land was a key element of this policy (Lavers, 2013), since the government wanted to protect smallholders from potentially harmful market forces. The provision of seeds and fertilisers, aiming at allowing substantial productivity gains by modernising the peasants' techniques, is also to be counted as a core element of this policy (Planel, 2014). Although it is not our main concern here, it has to be noted that this policy was also directed, to a large extent, at the political control of the peasantry (see Lefort, 2010; Lefort 2012).

6 In 2005, a new plan was issued. The Plan for Accelerated and Sustained Development to End Poverty (PASDEP) did not entirely disavow former measures such as fertiliser sales to the peasantry; nevertheless, it allocated a new place for agricultural investment and large-scale agriculture (MoFED, 2005; Dessalegn, 2011; Lavers, 2012). Agricultural investment replaced the peasantry as Ethiopia's agricultural engine, and the peasants are now encouraged to engage in market-oriented production. In a capital-poor country like Ethiopia, a substantial role was to be given to foreign investors as well. Tax exemptions were designed to attract investors, as were ridiculously low rents. In 2011, the yearly land tax paid by farmers investing in Gambella was 35 birr per hectare, *i.e.* the same amount the peasants had to pay. This tax was increased in 2014 to 111 birr per hectare, which still remains very competitive when compared to international standards. Foreigners who export more than 50% of their production are exempted from tax on profit for 5 years, and special customs are in place for investors desiring to import machinery.

7 As Dessalegn Rahmato underlines, land deals already existed before 2005; but they assumed a new scale after the adoption of the PASDEP, and still more critically during 2008-2011. According to the figures compiled by Dessalegn, 3,600,000 hectares were singled out for transfer in 2009; of these, 829,199 hectares were located in Gambella[1]. At the national level, the target as stated in the Growth and Transformation Plan was to have 3,3 million hectares transferred by 2015 (Dessalegn, 2011). Together with other lowland regions such as Benishangul-Gumuz and lowlands areas of Oromiya region, Gambella will host major land deals. In the widely spread national perception, Ethiopia remains divided between a highland centre and lowland peripheries (Markakis, 2011)[2]. This dichotomy remains very powerful when the central government identifies land to be

granted to investors. Lowland peripheries are considered as empty, 'underdeveloped', and land resources are thought to be waiting for investors to develop them.

8 There are many reasons to think, following Dessalegn's estimates (2014), that the national target of 3,3 million hectares was indeed reached in 2014. However, not all the parcels allocated to investors are farmed, investors blaming the lack of infrastructure or environmental phenomena such as floods to explain the delay in commencing their activities. Squabbles between the Ethiopian government and the Indian firm Karuturi are now an open secret (Berhanu, 2015), and the government seems to be adapting its policy by favouring Ethiopian investors, and by being more rigorous in checking the ability of investors to implement their business plans. Allocating huge plots to foreigners seems to be a thing of the past (Dessalegn, 2014). But many hectares continue to be granted to Ethiopian investors. In 2014, out of the 382 investment projects in Gambella, only 7 were owned by foreigners (not including Ethiopian diaspora).

9 These figures about land deals are either quoted from the literature or taken from administrative reports from Gambella's Land Administration Authority. However, I have to make it clear that they cannot be taken as face value, or as faithful representations of the reality, for two reasons. The first is the opacity of information surrounding land leases. The media coverage on this issue makes it a sensitive one, on which inquiries cannot be conducted freely. Secondly, the local Land Administration Authority itself is not a depositary of full information when it comes to large land leases to foreign companies, as these leases are administrated directly at the federal level by the Ministry of Agriculture.

10 Anyhow, figures never talk by themselves, and other raw facts and tangible elements are needed to comprehend fully how land is being allocated. The 'great Ethiopian land grab' (Lefort, 2011) must be understood in terms of procedures put in force, negotiated and administrated by civil servants, investors, peasants, etc. In short, land grabs deserve to be analysed as an ensemble of social practices.

Official procedures and informal practices: who transfers land, and how?

11 Here, I will concentrate on the administrative procedure that investors must go through in order to get land. One of the prerequisites for investors is to get an investment permit[3]. To acquire this permit, candidates have to submit a business plan to the regional Investment Bureau. The business plan contains the committed capital, the number of people the investor is planning to hire, and other information concerning the project, sometimes including the location of the parcels the investor wants to farm. Most of the time, the administration remains in charge of identifying the parcel. Basically, the Investment Bureau is only in charge of issuing the investment permit, the allocation of land being formally the task of the Land Administration Authority. But from 2010 to 2014 at least, the Investment Bureau also gave parcels of land – even though it was not legally allowed to do so. A federal land administration expert complains:

> The investment agency shouldn't give both the investment permit and the land! Wait, look, a driving training centre, does it give the car with the driving license? No! So here it's the same! The Federal Investment agency is giving both the license AND the car! Normally, they should only check if the investors have a good business plan, and if they have the capacity to implement it correctly... if they have the

> capital needed [to implement it] and all those things. They shouldn't give the land too (Interview, translated from Amharic by the author, Mekelle, February 2014).

12 In 2013, the Regional Cabinet of Gambella put an end to the conflict by reconfirming the Land Administration Authority's jurisdiction as the sole administrative entity responsible for the allocation of land in the region. Before that date, at least four different administrations were granting parcels to private investors in the region: the federal Investment Agency, the regional Land Administration Authority, the regional Investment Agency, and the regional Cabinet. Although I didn't checked this piece of information on the field, rumour has it that some weredas contracted land deals with private investors in the early 2010s. Indeed, some wereda officials have been sued on that ground. The quasi-absence of communication between these many administrative entities led to a situation where one and the same parcel was sometimes granted to several investors at the same time. To fully understand how blurred the situation was, one has to remember that there is no rural cadastre (land register) in Gambella, and the work towards construction of such a document began in one qebelé only in 2011 (see below).

13 From 2014 on, the Land Administration Authority succeeded in making other administrative branches respect its prerogative; it now effectively acts as the investors' main partner concerning the allocation of parcels. Nevertheless, conflicts over how land should be transferred and about how federal authorities should actually administer land in the peripheries are still taking place. Local land administration agents regularly complain about the lack of information concerning the precise location of the parcels granted to foreign investors. Federal authorities do not communicate with lower levels about the size of the parcels or the identity of the lessees. Even if some authors (Cherie, 2013) argue that Federal authorities only administer parcels larger than 5,000 hectares, this is not confirmed on the ground. Regional states remain, theoretically, in charge of administering land, but the Federal Investment Agency does transfer land plots, be they smaller or larger than 5,000 hectares. Behind this problem of determining where regional prerogative ends, the main issue is the opacity of federally administered land deals. Asked about the information communicated to his office, a national park agent makes this statement:

> We don't know where the investors' parcels are. What we know is that 90% of the land that has been given to them is still not farmed. For now, they cultivate maybe only 1 or 2% of what they have been given. At least 90% hasn't been cleared. We just know they have huge parcels. And we don't know their location. What we know is that Karuturi had 100,000 hectares. They used to talk about bigger figures, but there have been renegotiations. For example, we have got some land back. For the rest, we don't know. And we have no way to know (Interview, translated from Amharic by the author, Gambella, March 2014).

14 Miscommunication between different administrative levels is not the sole reason behind the lack of information at the Gambella Land Administration Authority. As I underlined earlier, no land book is to be found in the offices, although land administration experts are currently working on the task of registering the land users' rights. The aim, after the completion of this work, is to have an up-to-date and geographically referenced rural cadastral map for Gambella. Among the announced goals behind this undertaking are the securing of peasants' land rights, and providing a clear picture of the situation for the state, which remains in crucial need of information about where to find 'free' land to develop – i.e., to transfer to private investors.

15 However, during the whole year 2014, land administration agents were unable to go to the field, and had to spend their days at the office in town. The Land Administration Authority lacked sufficient budget to carry out registration activities. Registering the peasants' land rights implies hiring between 15 and 20 contractual surveyors in charge of making the cadastral surveys, under the supervision of land administration experts. In the absence of a dedicated budget, this additional workforce could not be hired. Furthermore, no money was at the civil servants' disposal to fill the motorbikes petrol tanks, forcing them to stay at their office. In 2011-2012, the parcels of one of the qebelés around Gambella were registered thanks to funds allocated by the World Bank through its Sustainable Land Management Programme. During the spring of 2015, the release of the budget of this programme's second phase enabled civil servants to start registration again. But between 2012 and 2015, no measurement or registration of peasant landholdings took place. Rather, for more than two years, the focus was not on peasants but on investors: one of the main activities of the Authority's employees was to take measurements and to issue maps of the investors' holdings.

16 At this point, one might think: "so, how could these civil servants find the budget to leave their office to measure the investors' parcels, if they cannot do the same for the peasants' landholdings?" The thing is easy: everything necessary for the civil servants to work is provided by the investors. Wishing to make his holding more secure, an investor would come and present his investment permit to the Land Administration Authority office. After a short talk with the head of the Bureau, he would arrange a meeting for the following day, when he could come early in the morning with a car, to pick up one or two land administration experts. Then, they would drive to the parcel the investor had been granted (whether by the Investment Bureau, the federal Investment Agency or the Land Administration Authority), and register the location of the parcel with a hand-held GPS. Back in the office in the evening, civil servants could generate a map of the parcel, after downloading the GPS coordinates in a Geographical Information System software. The investor would usually pick up the map in the following days. One last detail, the investor also provides for the civil servants' per diem, paid in cash. It is paid hand-to-hand, usually once back in town. The amount is negotiated between the investor and the civil servants, but the former usually gives a rather high sum from the beginning, to make sure that the end of the procedure will go smoothly. Daily per diem can be as high as 1600 ETB, which can be more than the agent's monthly salary. A land administration agent recounts:

> There is no fixed amount. It's the investor who pays, as he wants. You know, he wants to make a map, you go with him to the field, but the per-diem is not fixed. It is the way they want. When an investor wants to make a map, he pays. For the expert who comes with him, for the head of the Bureau and for the 'work process owner'. This is the way it works. Then, the head of the bureau shares between the agents. But sometimes, there are investors who directly give you. There is no fixed amount, it is not calculated by day, it is the way the investor wants. Myself, the maximum I ever had was 1300 birr. The guy was happy, it was a remote area, we had to climb a mountain to reach his parcel, and we damaged our clothes to reach there, so the guy was happy, he gave 1300 for each of the two of us. To A., and to me, when we came back to town (Interview, translated from Amharic by the author, Gambella, March 2014).

17 This excerpt shows that to some extent, the payment of the per diem by the investor implies compensation (or a service) by the civil servant, in return. The agent quoted here made physical efforts when climbing the mountain, and thus he was hoping for a higher amount. It also goes the other way round: expecting a generous per diem, civil servants

might well be inclined to listen to the investors' suggestions during the measurement of the parcel. Frequently, investors ask the experts to take a GPS point 'under the next tree', some 200 meters outside the supposed boundaries of the parcel, thus adding substantial surface area to the registered parcel. It is worth noting that since the above-mentioned interview, the head of Gambella's Land Administration Authority has been jailed on corruption charges, as well as several land administration experts.

18 However, civil servants insist that per diems should not be considered as mere bribes. When I asked a young civil servant if the Anti-Corruption Commission was not inquiring about these practices, she answered: "But this is not corruption! This is just like that, it is the way they want" (Fieldnotes, translated from Amharic by the author, Gambella, March 2014). She insists she doesn't ask for a bribe: "it is the way they [the investors] want". The fact that administrative agents ranking high in the hierarchy not only know about the per diems but even take a share of it and announce it to the investors as a normal part of the procedure gives to this form of "corruption" the aspect of an official, bureaucratic practice.

19 To some extent, land administration experts only reproduce a practice which is widespread in Non-Government Organisations (Ridde, 2012), the main difference being the lack of transparency in the practice, and the possibility for both sides to negotiate the amount[4]. The per diem should be considered as a reflection of bureaucratic practices. It is an unofficial rule that arises *"as a result of the state's incapacity to provide sufficient resources to its administrations"* (Oumarou Hamani, 2014: 146). Together with the providing of a car by the investor, the per diem enables state agents to carry out their duties, and to deliver state services. Admittedly, parcel measurement or car delivery is not a "public or collective good and service" (Olivier de Sardan, 2014), and poorer farmers do not bother to pay any per diem for having their land registered: they just don't have it registered. Hence a situation arises where the activity of land administration offices is oriented towards the delivery of services for richer beneficiaries. And yet, despite everything, the construction of the cadastre is taking place, against all odds, thanks to these coping mechanisms put in force by civil servants. As long as the Land Administration Authority continues to be the single body in charge of land deals, the situation will hopefully become less blurred.

20 One question remains: in this context, how to explain the fact that the national park has been spared by land grabbing in recent years?

Land issues and the national park

21 The boundaries of the national park were made official in 2011, after having been redelineated, thereby reducing the total area of the park from 5061 km² to 4575 km². Although some area was lost, the park agents nevertheless consider it a good step, since they now have a precise map of their park, which used not to be the case.

22 If the boundaries were officialised, they were not publicised or published, and many land users around the park do not know the precise location of the borders. In fact, the park authorities remain, together with the Cabinet and some weredas, the only administration that knows precisely where the park starts and ends. It is true that the redrawing of the boundaries was done through a rather unofficial technique. By negotiating with investors and with the federal government, park authorities managed to have key parcels

retroceded to them. Such parcels included areas where migrating species settled during some months of the year, at the edge of Africa's second-largest migration corridor of large mammals (Cherie, 2013; Gatluak, 2015). Armed with hand-held GPS devices, employees from the national park went deep into the bush, taking GPS coordinates as far as they could. These coordinates were then declared the new boundaries of the park, and the regional Cabinet later recognised them. Even if the national park is a federal entity that depends on the Ethiopian Wildlife Conservation Authority created in 2007, the recognition of the boundaries by the Cabinet was crucial, since this body is responsible for many land leases.

23 After the redrawing of the boundaries, the national park was made a member of the Investment Board of the Region. Bringing together eight administrative entities including the regional Land Administration Authority, the Investment Bureau and the Agricultural Bureau, the Investment Board is thought to control land leases and to seek to reduce corruption in land deals. Although it works under the supervision of the Cabinet, many civil servants remain largely sceptical about the effectiveness of such a council, as one employee from the National Park underlines:

> There are eight offices in the Board [...]. As a national park, we are a federal entity, but we have a chair in the Board. [...] Most of the time, there is no preliminary study. There are no studies done. They give land away just because the investor wants it, or because he pays. It should not happen this way. Well, this is a personal point of view, not the park's. We, as a national park, we just make sure that land investments are not located inside the park's boundaries. (Interview, translated from Amharic, Gambella, February 2015)

24 If land administration agents appear to know more about the precise location of investment land, the allocation process remains to a large extent an obscure one. Likewise, although the large land-sell-out policy towards foreign investors has stopped, the 'great Ethiopian land grab' that Lefort described continues to benefit national investors.

25 Lately, the national park has also had the support of foreign-funded programmes, international institutions and NGOs such as *Horn of Africa,* which is taking part in the setting up of a land use plan for the Gambella region. The national park also gets the support of the African National Parks Network, which sent experts to study how the park could be upgraded so as to host more (foreign) tourists. In April 2015, shelters were built for rangers in at least two places, enabling tourists and campers to spend the night in the park.

26 I will close this presentation with an anecdote that will help to explain why the national park was, to some extent, spared by the land-grab phenomenon. Many parcels given to investors, including a great deal of what had been granted to Karuturi, were located in swamps and wetlands that are completely flooded each year during the rainy season. No agricultural activities could be carried out in these places without involving huge amounts of money necessary to drain the swamps. Here, nature itself became the best conservation tool we could imagine!

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NOTES

1. These figures concern land put in the « Federal Land Bank », which is a pool where parcels are administratively stocked before being allocated to private investors.
2. This is not the place to go more deeply into detail about the structuring of the Ethiopian polity over the centuries. Let us just keep in mind that the centre, where the practice of settled agriculture maximised the appropriation of surpluses by state-like entities, only succeeded in integrating the peripheries during the twentieth century (see Markakis, 1974, 2011; Donham & James, 2002). This integration of the peripheries to the core Ethiopian state was achieved by violent conquest.
3. Here, I am dealing with Ethiopian investors only. There are other procedures and administrative measures designed for foreign investors. People from the Ethiopian diaspora are considered first as Ethiopians, but many of them engage in joint ventures with a fellow citizen inside the country.
4. However, one could argue that NGOs also negotiate the amount of the per diem with their consultants before signing a memorandum of understanding or contract.

INDEX

Mots-clés: agriculture, enjeux fonciers, conservation, parc national, administration
Keywords: land issues, national park, Gambella

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University Museums and the Promotion of Conservation Policies on the Pre-Revolutionary Campus of Addis Ababa (1950-1974)

Thomas Guindeuil

AUTHOR'S NOTE

This paper is an English and slightly shortened version of an article previously published in French (« Nature, culture, même combat ? Sciences et conservation sur le campus d'Addis-Abeba (1950-1974)", *Études rurales*, 197 [special issue « Pour une histoire environnementale de l'Éthiopie », Guillaume Blanc & Grégory Quenet, eds.], 2016, 125-146).

1 This paper aims at showing that the project of a "conservatory Ethiopia", both in the area of traditions and of wildlife, strongly relied on foreign scholars based in Ethiopia before the Revolution, and that museums were seen by them as strong tools to reach the Ethiopian public – and leaders. In this regard, culture and nature belonged to different individual and institutional initiatives and processes. Nevertheless, they followed parallel paths and seem to have inspired each other during the whole period.

2 The first institution of higher education Ethiopia, the Addis Ababa University College, was created in 1950. This public college was directed by a Canadian Jesuit, Lucien Matte, who carried the recruitment of the teaching staff in the name of the Ethiopian imperial government. When the Addis Ababa University College was included in the newly founded Haile Selassie I University, in 1961, 50% of the teaching and administrative staff of the Ethiopian university was foreign (Balsvik, 1985: 28-29). Most of these expatriates came from North America and Europe. Disappointed by the general content of the official curriculum, a part of these foreign staff members progressively developed extramural

non-teaching activities, taking the opportunity to expand their knowledge of the country. Most of them found themselves on a brand new terrain, and hence specialized in Ethiopia during their stay. Research and fieldwork became usual, and scholars from the humanities or natural sciences started reference collections – of artefacts, of specimens – aimed at establishing inventories. Following these initiatives, university museums were created.

3 In the Ethiopian capital city, it is still possible to visit the two university museums that came out of these activities: the Museum of the Institute of Ethiopian Studies, created in 1963 on the campus of social sciences, and the Natural History Museum, created in 1964 on the Science Faculty campus – but probably really opened to the public only at the beginning of the 1970s (Kassa Wolde Mariam, 1963; Natural History Museum, n.d.). The Museum of the Institute of Ethiopian Studies exhibits ethnographic artefacts and ancient Christian art from Ethiopia. The Natural History Museum consists in a zoological gallery with stuffed specimens. Both museum projects were initiated by foreign staff members of the university working for the Ethiopian government. The museums aimed first at being showcases for research undertaken at the university, but they both finally ended with another mission: developing the idea of "heritage" and promoting conservation policy in Ethiopia. With the 1974 Ethiopian Revolution and the collapse of the monarchy, these foreign staff members left the country and the university, where they were systematically replaced by Ethiopian scholars. University collections and museums remained. The Revolution froze the Natural History Museum in its infancy, while the Museum of the Institute of Ethiopian Studies, after being reorganized twice, still constitutes one of the main cultural institutions of Addis Ababa.

4 The notion of "national heritage" underwent important changes during the second reign of Haile Selassie, who came back from exile in 1941 after the Italian occupation (1936-1941). These changes are part of the institutional reforms that characterized this period (Clapham, 1969: 21-27, 36-44; Bahru Zewde, 2002: 178-179, 201-215). Besides the higher education system, the National Library and the National Museum were created. A Department of Antiquities was instituted to supervise the Ethiopian Archaeological Institute – a French-led expert mission working for the Ethiopian government, which opened its own museum until the latter was incorporated into the National Museum (Anfray, 1963: 15-16). In the 1960s, growing international pressure on wildlife conservation led to the creation of the Ethiopian Wildlife Conservation Organization, and the decision to create national parks was enacted in 1965 (Blanc, 2015: 22-23). In all these domains, the Ethiopian government followed the advice and initiatives taken by foreign experts, especially from international organizations. On the wildlife side, a very influential character was Leslie H. Brown. A British expert from the World Wildlife Fund working for the Ethiopian government in relation with UNESCO to establish an environmental conservation policy program, he collaborated on a long-term basis with the Ethiopian university – between 1961 and 1963 through the East African Natural Society, and in 1971 as a visiting lecturer at Haile Selassie I University (Brown, 1973: ii). Brown can be recognized as the "father" of Ethiopian national parks. Because he was both a scholar and a conservation expert, Brown reflects the ambivalent position of the foreign staff members of the pre-revolutionary Ethiopian university. They initiated the first Ethiopia-generated research, and they imported, at the same time, natural and cultural conservation policies and tools. University museums were part of this since they were intended to "educate" Ethiopians in the making of heritage.

“Traditional” furniture, stuffed animals and butterflies at the Addis Ababa University College (1952-1963)

5 Both the natural history and the ethnographic collections of Addis Ababa University find their origins in the activity of Stanislaw Chojnacki, the librarian of the Addis Ababa University College. A polish emigrant, Chojnacki had no relation with Ethiopia before taking up his position (Chojnacki, 2010: 1-2). In 1951, he strongly supported the creation of a student association, the Ethnological Society, dedicated to the collection and study of Ethiopian traditions. Its members were among the first university graduates of Ethiopia, and they got key positions afterwards, especially in the university (Pankhurst A., 2002a: xiv-xxiii). The association lasted until 1963, Chojnacki being its advisor until 1958 (when Georges Savard, a professional anthropologist, took over the position). The Ethnological Society published 11 issues of a journal, the *Addis Ababa University College Ethnological Society Bulletin*, from 1953 to 1961, the first social science periodical published in Ethiopia. Articles reflect the activity of the society, and especially the collective and individual field trips undertaken by its members (Pankhurst A., 2002b). Little by little, the *Bulletin* started an ethnographic inventory of the Ethiopia of the 1950s.

6 Starting in 1952, Chojnacki initiated a parallel project: the construction of a museum at the Addis Ababa University College. Until 1963, the museum was established inside the college library building, and attracted the attention of Ethiopian authorities to the point that official diplomatic delegations (including Charles de Gaulle’s visit in 1953) were often taken to view the gallery while visiting the college (Chojnacki, 1990: 30). The museum collection was at that time composed of ethnographic artefacts and preserved specimens of animals, comprising both gifts from the university staff and students and objects collected by Chojnacki himself during his trips in the countryside. In 1955, the remaining elements of a zoological and ethnographic collection created by the Italian colonial authorities for a natural history museum project were included in the museum collection (Patrizi, 1940; News and Views, 1962: 11; Chojnacki, 1990: 30). But Chojnacki was also himself a specimen collector. In 1961, he was part of a Yugoslavian naturalist expedition to the Eritrean coast (News and Views, 1961a). Among his colleagues, Chojnacki was known and is still recalled as a butterfly collector (Ethiopia Observer, 1958: 199-200; Chojnacki, 2010: 20). His butterfly collection can still be seen in the Natural History Museum of the Science Faculty of Addis Ababa University.

7 Since the early 1950s, there may have been concurrent projects (the facts are unclear) regarding natural history collections on the campus. Members of the Science Faculty seem to have asked the university authorities for the creation of a zoological exhibition as soon as 1952 (Largen, 1969: 38). After the creation of a proper natural history museum in 1964, the foreign staff of the Science Faculty may have rejected Chojnacki’s initial project which was non-scientific in essence. Indeed, Chojnacki’s gallery looked very similar to the mixed collections of animals and objects realized by 19th-century travelers in Ethiopia, such as Eduard Rüppell, for which Chojnacki expressed much admiration (Chojnacki, 1961: 86-87).

8 In 1960, the Ethnological Society published an *Information Bulletin* that settled the aim of the association, as well as its relation with Chojnacki’s museum project. The aim of the society was then “to preserve and, if needed, to revive traits of Ethiopian culture that

have a lasting value". It asserted that "modernization [...] if is to be really successful, [...] should not be forced from the outside but implanted in the good soil of Ethiopian culture and firmly rooted in it" (Ethnological Society, 1960: 3). In this *Information Bulletin*, the Society defined its role in promoting the "preservation" of "Ethiopian culture". A committee was created to help Chojnacki in building his museum, thus binding the association, the museum and the making of its collection.

9 The Society, as well as Chojnacki himself, never fully explained the aims and scope of the museum while they were working at it. In 1988, in the context of the 25th anniversary of the Museum of the Institute of Ethiopian Studies, Chojnacki described his initial project in these words:

> It was a pleasure to see visitors at the UCAA Library and Museum watching, enchanted, a display of animal heads as well as fully stuffed specimens, including birds, the collection of which was greatly expanded, and in between, pottery, weapons and shields, baskets, agricultural implements and other objects, all shown in a bric-à-brac fashion, but giving an impression of the variety and richness of Ethiopia's environment and craft (Chojnacki, 1990: 30).

10 This might have meant that the goal of the first Ethiopian university museum was to provide a comprehensive view of "traditional Ethiopia", and that in this "traditional" (and rural) Ethiopia, humans and animals lived together as part of a whole. But it is also very plausible that Chojnacki's personal project was first driven by the esthetic of the combination of artefacts and animals.

The development of modern research facilities and the influential "hard" sciences

11 Was Chojnacki's initial project out of phase in the late 1950s? Starting in the second half of the 1950s, the Addis Ababa University College experienced some institutional changes, partly as an effect of the extra-curricular and progressively recognized scientific activities of its foreign staff members. Specialized research departments in the fields of earth science and biology were created.

12 From 1957 to 1959, a Geophysical Observatory was installed on the campus with the support of the International Union of Geodesy and Geophysics (Science Faculty, 1980: 137-138). The observatory was part of a worldwide network of such institutions, and contributed to the global observation of tectonic movements. Its foreign staff was part of the Science faculty. A mineral study collection could have been created during this period of emulation (Science Faculty, 1980: 81).

13 On the biological side, the fore-front of scientific research lay in the fields of botany and forestry. The development of these fields came from the individual project of another foreign staff member, Herbert F. Mooney. A forestry expert from the British colonial government in India and the Middle East, Mooney undertook fieldwork in Ethiopia in the 1950s, and published a first vernacular glossary of Ethiopian plants in 1956 (Mooney, 1956). This was done in the same year he started to work at the Addis Ababa University College to develop a forestry department and a National Herbarium. The National Herbarium officially opened in 1959 and was based on Mooney's personal specimen collection (Horticultural Society, 1978-1979). This institution, like the Geophysical Observatory, was involved in international cooperation, for example with the Kew Botanical Garden, in England, which provided identification for specimens and training

for the Ethiopian staff (Mooney, 1963: vi). When Mooney retired in 1961, the botanical collection was briefly transferred to Chojnacki, but only in order to await the return of a trained Ethiopian staff member from the United Kingdom (News and Views, 1961b).

14 During his five years of service at the Addis Ababa University College, Mooney developed his thesis about the need for a "rational" forestry management in Ethiopia based on European models. This had to be done, he wrote, in order "to save the remaining forests of this country from destruction, in spite of the devastation of past centuries and to build up a valuable heritage for future generations" (Mooney, 1959: 5-6). Although this was seriously challenged in the by historical research (McCann, 1995: 31-38; McCann, 1997; Crummey, 1998; Gascon 1998), Mooney's views about traditionally destructive Ethiopian practices regarding forests have been very influential, and still are today (Nyssen *et al.*, 2015: §3, 8). This thesis was echoed in 1961 in a report from the Food and Agriculture Organization of the United Nations (Huffnagel, 1961: 395, 405-406).

15 At this point, "forests" and Ethiopian traditional culture seem to be contradictory "heritages". Mooney argued that the forest had to be protected from the "bad practices" of "traditional" people. The Ethnological Society, by contrast, defined the conservation of traditional ways as its priority. Despite this contradiction, the environmental conservation issue raised by Mooney seems to have convinced the future staff of the Institute of Ethiopian Studies. From the late 1950s to the 1960s, the topic of deforestation appeared frequently in the pages of the *Ethiopia Observer*, an English-language magazine run by the Pankhursts – a family of English scholars and intellectuals, strong supporters of Ethiopia during the Italian-Ethiopian war (1936-1941), and settled in Ethiopia since 1956. Most of the contributors to this publication belonged to the foreign staff of the college and, starting from 1961, the university. The magazine advertised the activities of the Ethnological Society and Chojnacki's museum project (EthObsUnivCollege, 1958: 199-200, 217-220), and equally gave space to Mooney who got the opportunity to discuss his research on the flora of Ethiopia (Mooney, 1961). Chojnacki revealed himself as sympathetic to the issue of deforestation in Ethiopia. In the first issue of the *Journal of Ethiopian Studies*, the journal of the Institute of Ethiopian Studies, he adopted the arguments of Mooney in an article entitled "Forests and Forestry Problem as Seen by Some Travellers in Ethiopia" (Chojnacki, 1963). The *Ethiopia Observer*'s chief editor Richard Pankhurst discussed the topic in the pages of *Ethiopia Observer* the same year (Pankhurst R., 1963). Chojnacki, as an active member of the Ethiopian Horticultural Society, published another article on this matter in a 1975 issue of the society's bulletin (Chojnacki, 1975).

16 After the departure of Mooney, the National Herbarium continued to develop under the direction of new foreign staff (Mesfin Tadesse, 1979: 1). The collection included 6,000 specimens in 1968 (Science Faculty, 1980: 28), and the institution carried on after the Revolution and the replacement of the foreign staff by Ethiopian nationals. After 1974, the National Herbarium kept working through international connections, such as Uppsala University (Sweden), and participated in the creation of the first Ethiopian flora encyclopedia in the 1980s and 1990s. It has to be noted that, while the aims of the Ethnological Society were far from achieved at the beginning of the 1960s, Mooney's thesis received full acknowledgement from the academic institution. The conservation policy defined by the forestry specialist was undoubtedly closer to the ideal of modernization promoted by the Ethiopian monarchy than was the preservation of "traditional" culture. The humanities had to adapt themselves to the modernization of

academic institutions. The creation of the Institute for Ethiopian Studies in 1963 can be seen as an answer from scholars of the human sciences to the development of strong international research institutions in the Science Faculty.

Chojnacki takes the lead in the Ethiopian cultural heritage policy (1963-1974)

17 In 1963, the Addis Ababa University College was replaced by the Haile Selassie I University. In the transformation process of the Ethiopian higher education institutions, the creation of the Institute of Ethiopian Studies, including an ethnographic museum, was suggested by the last director of the old Addis Ababa University College, the Israeli historian Zvi Yabetz (Pankhurst R. & R., 2013: 107). The process of creating the Natural History Museum, attached to the Science Faculty, was initiated in 1964. The two institutions seem to have followed parallel paths: collections were first constituted as study materials, and progressively became tools to develop a pedagogical discourse about conservation and to advocate for a stronger Ethiopian national policy in this regard – which meant laws and actions to protect cultural artefacts as well as fauna and flora. This role eventually legitimated both museums in the eyes of the Ethiopian authorities.

18 *De facto*, the Institute of Ethiopian Studies institutionalized the objectives of the former Ethnological Society. The curator of the new museum, Stanislaw Chojnacki (who moved from the library of the former Addis Ababa University College to the institute at its foundation), declared in 1969 that the role of the institute was to "promote the study of Ethiopian culture" (Tereffe Asrat, 1969: 15). The institute was organized into three departments: research library, ethnographic museum, and publications (Kassa Wolde Mariam, 1963). The publication department started to publish its international journal, the *Journal of Ethiopian Studies*, in 1963. The British historian Richard Pankhurst was the director of the Institute of Ethiopian Studies until 1974 and his replacement by a transitional – and Ethiopian – committee. The clearly defined missions of the institute naturally led to the specialization of its museum, which was now dedicated entirely to the ethnography of Ethiopian peoples. Zoological collections were left to the Science Faculty – a situation that Chojnacki openly regretted twenty-five years later:

> The first step was to divide the UCAA collections, the zoological part remaining in the Science Faculty at Arat Kilo Campus. The Danish professor entrusted with setting up the Natural History Museum, insisted on signing an official act of separation. This was duly performed, but the procedure somehow exhausted his energy. All the stuffed animals, as well as the collection of insects I donated to the UC, were packed into one room, and waited there for years to be displayed (Chojnacki, 1980: 32-33).

19 Despite this loss, the museum was undoubtedly favored by these institutional and localization changes. First, the new Institute of Ethiopian Studies was lodged in a former palace of Haile Selassie, ceded to the University in 1961. This new setting made the ethnographic museum a must-see for official visits, especially of foreign representatives, whose number was increasing with the creation of the Organisation of African Unity in 1963 (fig. 1). The museum did not benefit from direct support by the Emperor, at least during its first years, but Chojnacki was aware of the Emperor's interest in its potential: for foreign, and notably African, leaders visiting the Ethiopian capital, the museum showcased Ethiopian culture (Chojnacki, 2010: 35-36). The collection grew significantly

during the 1960s and the beginning of the 1970s, and welcomed an important donation by the Ministry of Agriculture (Institute of Ethiopian Studies, n.d.) besides numerous gifts from Ethiopians. Starting from the middle of the 1960s, acquisitions reflected the will to achieve legitimacy on two fronts, both in anthropological research and in heritage conservation. The museum worked with foreign anthropologists who were "opening up" new fields in Ethiopia, such as David Turton, Ivo Strecker and Loren Bliese, who participated in the collection of objects from underrepresented cultural groups from the Omo valley and the Afar (Institute of Ethiopian Studies, n.d., vol. 1). The contributions of these agro-pastoralists groups, whose material cultures looked very different from those of the highland agrarian peoples, deeply influenced the new display (fig. 2). The anthropological exhibition was organized around a central "masterpiece", an Afar tent with elements of a nomadic camp (Chojnacki, 2010: 55). The museum fundamentally tended to reflect the diversity of Ethiopian peoples and environments, although Chojnacki felt that Ethiopia was much more characterized by a certain unity in terms of material culture – a unity he defined by its simplicity (Chojnacki, 1965). He insisted on the educational and conservatory role of his institution (Chojnacki, 1965; Tereffe Asrat, 1969: 16).

Fig. 1. A visit of Queen Sofia of Greece, Queen of Spain, at the Museum of the Institute of Ethiopian Studies

FROM THE PERSONAL COLLECTION OF GIRMA FISSEHA.

Fig. 2. A visit of Princess Ann of the United Kingdom (with Stanislaw Chojnacki). The anthropological exhibition was – and still is – organized around the Afar tent brought by Loren Bliese

FROM THE PERSONAL COLLECTION OF GIRMA FISSEHA.

20 This conservatory dimension was developed during the second half of the 1960s, when Chojnacki adopted a new acquisition policy towards Ethiopian Christian antiquities. This time, the action was coordinated with members of the imperial family (and especially Princess Ruth Desta), and it mobilized a network of Ethiopian social elites and expatriates who came together in the Society of Friends of the Institute of Ethiopian Studies (Chojnacki, 2007). The aim of this mobilization was to prevent Ethiopian antiquities from being illegally exported, in a context of a growing demand for Ethiopian art on the international art market (Tereffe Asrat, 1969). Financial donations collected through the society allowed the institute to buy up artefacts from Ethiopian antiquarians. This action gave the museum a prestigious collection wrapped in a strong political message. Indeed, the Institute of Ethiopian Studies assumed an unprecedented public role in salvaging a part of Ethiopian cultural heritage which was seen as having a particular significance in the eyes of the predominantly Christian political and social elite. The institute took over this role from the Department of Antiquities of the Ethiopian government, thus revealing the latter's inefficiency in terms of legal and practical control over the trade in Ethiopian antiquities. Indeed, in a way it overshadowed the Ethiopian Church itself, which was seen as partly responsible for the dramatic rise of this illegal trade (Chojnacki, 2007; Chojnacki, 2010: 56-57). On October 25th 1968, the Emperor himself approved the action of the Society of Friends by inaugurating the first exhibition of Ethiopian Christian antiquities at the institute (Chojnacki, 2010: 62).

The Natural History Museum: A project linked to the development of national parks (1964-1974)

21 On the natural science side, the process of building a strong institution promoting natural (and mostly zoological) heritage appears, at first, more chaotic. The Natural History Museum was created as a full-fledged department of the Science Faculty in 1964. It was first directed by a Danish entomologist, Jørgen Birket-Smith, and, starting from 1968, by two zoologists, Emil K. Urban (ornithologist) and M. J. Largen (who published several articles on mammals and amphibians) (Largen, 1969; Natural History Museum, n.d.). They worked together to establish inventories of Ethiopian fauna, and the exhibition was designed to reflect their work. The 1964 project was ambitious. The Natural Herbarium was expected to be included in the Natural History Museum, and other extensions, such as a zoo, an aquarium and a botanical garden, were planned. But none of these sub-projects materialized. The collection which was displayed first in the main Science Faculty building, relied strongly on Chojnacki's initial work. Between 1966 and 1967, the African Wildlife Leadership Foundation funded the construction of a provisional metal building on the science campus at Arat Kilo (Largen, 1969: 40). The museum targeted primarily a student audience, and seems not to have served for official visits – unlike the Museum of the Institute of Ethiopian Studies.

22 Starting in the second half of the 1960s, the museum benefited from the activities of its directors who aimed at collecting more specimens in order to enlarge the collection. For example, in 1967, sixty staff members of the Science Faculty collected amphibians in Addis Ababa and its surrounding areas, thus initiating the first collection of Ethiopian amphibians, which was studied in Chicago before being sent back (Urban, 1967). This international connection gave the institution a certain legitimacy in the field of the study of Ethiopian fauna. But the institution remained limited by its infrastructure, until it moved back into the Science Faculty building, where a proper gallery was finally opened at the end of the 1960s. In 1969, Largen published his intentions, as director of the museum, in the first issue of the journal *Walia*, published by a newly created public institution, the Ethiopian Wildlife Conservation Organization. In this article, the director bound his own museum to the current development of a strong policy regarding the conservation of Ethiopian fauna through the creation of national parks, realized during the second half of the 1960s. Largen intended to make his museum part of this policy, through its role as the main pedagogical tool in this regard (Largen, 1969: 40). Since the museum had to be attractive enough to attract wider attention, Largen commissioned an artist for the realization of dioramas representing the various Ethiopian environments, following the pattern of natural history museums in Europe and America (Largen, 1969: 40) (fig. 3 and 4).

23 The display of the Natural History Museum has been kept as it was since the 1974 Ethiopian Revolution. It looks like a conventional zoological gallery, including sections presenting in a separate way each major zoological group: marine and land invertebrates, amphibians, reptiles, mammals and birds – although some beautiful stuffed specimens seem to have been placed where they are now for esthetic reasons. The museum also includes an introductory room that explicitly lays out the objectives of the museum: raising awareness on issues related to wildlife conservation, and especially endangered animal species.

Fig. 3. The bird section of the Natural History Museum

PHOTOGRAPH BY THE AUTHOR.

Fig. 4. The introductory room of the Natural History Museum

PHOTOGRAPH BY THE AUTHOR.

24 The textual contents of this room seem to have been directly derived from Leslie H. Brown's work – mentioned above. As an invited lecturer at the Science Faculty of Haile Selassie I University in 1971, Brown was a collaborator of Largen. Brown's talks were published at the university press in 1973 under the title: *Conservation for Survival. Ethiopia's Choice*. This book includes a preface by Kassa Wolde Mariam, the Ethiopian Minister of Agriculture who patronized Brown's work. At the beginning of the 1970s, Brown's book, Largen's publication, the display of the Natural History Museum and Kassa Wolde Mariam jointly constituted the Ethiopian wildlife conservation policy. It is interesting to note that, in the meantime, the Ministry of Agriculture supported the development of the IES Museum through important donations. The two conservation policies – of wildlife and of "traditional" material culture – seemed to go hand in hand, as pointed out by Brown in 1966, in the journal *Nature and Resources* published by UNESCO, where he presented the plan supported by UNESCO to enhance the natural heritage conservation policy in Ethiopia. In conclusion, he wrote:

> More important still, perhaps, the attack on the wildlife conservation situation may have far-reaching effects in educating the public to greater appreciation of the need for a widely based conservation policy in Ethiopia, including forests, scenery, habitats for animals, plants, and man – and historical and religious monuments, with all of which Ethiopia is so richly endowed (Brown, 1966: 9).

25 The Natural History Museum thus constituted an accompanying instrument for governmental measures related to the creation and reinforcement of the Ethiopian national parks. It can be said that the Natural History Museum found its "usefulness" in "educating the public" – and the Ethiopian elites – about conservation issues, thus following the lead of the Museum of the Institute of Ethiopian Studies

26 Interestingly, nothing of this kind seems to have been achieved with regard to flora, although the idea was undoubtedly in the air. M.G. Gilbert, the director of the National Herbarium who succeeded H.F. Mooney after his departure, wrote two articles between 1973 and 1974 that aimed at emphasizing the role of his institution in a conservation policy devoted to plants (Gilbert, 1973-1974; Gilbert, 1974). Gilbert contrasted the popularity of the *Walia ibex* – which became the symbol of Ethiopian endangered species in the 1960s – and the lack of knowledge about threatened plant species. In making this point, Gilbert highlighted the lack of a tool comparable to the Natural History Museum for issues concerning plant conservation. The National Herbarium was – and still is – a research institution without a showcase. Gilbert was undoubtedly particularly well aware of the prevailing necessity to link fundamental research institutions to the conservation policies promoted by UNESCO, and aware that this link could give him the possibility of a more direct dialogue with Ethiopian authorities. The idea of connecting the National Herbarium to public outreach survived the Revolution and the departure of the foreign staff, and in 1976-1977, Getachew Aweke, an Ethiopian botanist, suggested – without success – the creation of a public botanical garden (including an arboretum and greenhouses) after a long study leave at the University of Wageningen in the Netherlands (Getachew Aweke, 1976-1977).

Conclusion

27 During the years preceding the Revolution, both of the university museums of Addis Ababa, at the time clearly separated in terms of specialization, remained associated in the

promotion of a stronger Ethiopian conservation policy devoted to nature as well as culture. Initiated by foreign individuals with various agendas, these institutions found their way in the Ethiopian intellectual landscape by conveying a common political message, inspired by worldwide concerns about endangered animals as well as disappearing cultural productions. They accompanied and sometimes anticipated the growing interest of the Ethiopian government in these questions. The two museums justified their existence through this pedagogical mission, following the same procedure and goals. In 1969, Largen, the director of the Natural History Museum, defined three objectives for his institution: the establishment of reference collections, the promotion of publications on Ethiopian wild fauna, and the development of the educational role of the museum towards a wider audience including students, grade-schoolers and non-school attenders (Largen, 1969: 41-44). In 1973, the Institute of Ethiopian Studies defined itself in terms of the collection and study of Ethiopian material culture, but still saw as its main objective the widening of its audience (Institute of Ethiopian Studies, 1973). At the beginning of the 1970s, Chojnacki discussed the role of his museum and singled out the younger generation as its main targeted audience, insisting on the importance of transmission (Chojnacki, 1971: 7-9).

28 In the 1960s and 1970s, international institutions such as UNESCO strongly supported the conservation policy of the Ethiopian government; but this support was realized locally by the apparently isolated but ultimately convergent initiatives of foreign scholars established on the Addis Ababa campus. These scholars, trained abroad, came to speak the "language of heritage" and interacted at least indirectly with the Ethiopian government and, sometimes, anticipated it. Their museums represented the first steps towards a heavier investment by the Ethiopian authorities in the international heritage sector, which was symbolized by the inclusion of the Lalibela churches and the Simien Mountains National Park in the UNESCO world heritage list in 1978 – after the Revolution. In this post-revolutionary context, foreign experts were no longer dominant in the Ethiopian academia, but they maintained a strong influence through the international institutions.

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INDEX

Mots-clés: conservation, patrimoine, environnement, université, musées, collections, histoire des sciences, éducation
Keywords: heritage, environment, university, museums, science history

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Knowledge Management on Climate Change Adaptation

Analysis of Information Exchange Processes and Collaboration Networks in Rural Ethiopia

Maxi Domke and Jürgen Pretzsch

AUTHOR'S NOTE

This paper is based on a presentation at the conference "Road to Paris. Coping with Climate and Environment Change in Ethiopia and the Horn of Africa" in Addis Ababa.
Maxi Domke gratefully acknowledges the invitation and funding for attending the conference by the French Centre for Ethiopian Studies (CFEE) and the French Embassy to Ethiopia.
Maxi Domke would like to thank the German Federal Ministry of Education and Research and the German Academic Exchange Service (DAAD) which are financially supporting her PhD studies in Ethiopia within the "Welcome to Africa" program.

1 Over recent centuries, people in regions of the Global South have found their own ways to adapt to changing climate conditions (Parotta & Agnoletti, 2012), partly complemented by scientific approaches and modern technologies. But the increasing complexity and dynamics of climate change demand more comprehensive and long-term solutions (Agrawal, 2010; Adger et al., 2009). Particularly in the Global South a changing climate has an accelerated impact on the livelihood situation and natural resources. According to the International Panel on Climate Change (IPCC) "Africa is one of the most vulnerable continents to climate change and climate variability [...] aggravated by [...] low adaptive capacity. [...] African farmers have developed [...] options [...] but such adaptations may not be sufficient for future changes of climate" (2007: 435). In regard to adaptation the IPCC further underlines the "adjustment in [...] human systems in response to actual or expected climate stimuli" (ibid, 869).

2 In this regard, the key role of human systems is the capacity for self-organization and learning (IPCC, 2007; Plummer/Armitage, 2007) deriving from social factors like trust, social networks and experiences (Folke et al., 2005). Communication is the process of exchanging information through a variety of devices to achieve mutual understanding (Leeuwis & van den Ban, 2004; Rogers & Kincaid, 1981). Analyzing networks can identify problematic relations and ensure that key groups are not marginalized (Reed et al., 2009). Understanding social barriers to adaptation, based on individual and cultural values, institutions and governance, is thus essential, but is still given little attention (Adger et al., 2009). One essential pre-condition to activate and strengthen social aspects of adaptation is the existence of a basic physical and social infrastructure. Rural areas are defined by a remote location, poorly developed basic infrastructure and limited integration in urban spheres. This determines the quality of lives in rural societies (Darr et al., 2014).

3 This paper is part of an ongoing research project that investigates knowledge management within the process of climate change adaptation by looking into social, socio-economic and governance aspects. In the following, selected preliminary results from a survey in the Central Rift Valley in Ethiopia are presented. The local community's situation is determined through perceived climate and environmental changes and the community's applied coping mechanisms. Relevant actors and networks are identified to analyze information distribution and communication processes from district to household level. Challenges and opportunities for successful knowledge transfer are revealed through the individual perceptions of community members and institutional representatives. Finally idle potentials are determined that could facilitate knowledge transfer to enhance the adaptive capacity of local communities.

Ethiopia's background on climate change and agricultural extension

4 Ethiopia is on its way to becoming a regional player and partner for other parts in the world. It is a politically stable country in the Horn of Africa that attracts investors and has a high GDP growth rate of around 7% (CIA 2014). 83% of the country's population lives in rural areas (CIA 2014) and depends on agriculture and natural resources, which are sensitive to climatic and environmental change. Forecasts indicate that Ethiopia will face a warming and a rainfall variability over the coming decades (Conway & Shipper, 2011; Funk et al., 2012). Countrywide a high number of ongoing activities and governmental campaigns on natural resource management are supported by international organizations. But a coordinated program on climate change is lacking due to unclear ownership and absence of coordination (Conway & Schipper, 2011). With the Climate Resilient Green Economy (CRGE) strategy (FDRE, 2011), the Ethiopian government aims to enhance the country's adaptive capacity through various mitigation and adaptation measures. To implement the CRGE strategy Ethiopia's government has to facilitate a social environment suitable for collective action across sectors and administrational levels. But the conditions at the grassroots level pose challenges due to a high pressure on land, traditions, and limited infrastructure and capacities.

5 From a historical point of view, Dessalegn Rahmato (2009) states that in Ethiopia the farmers' situation has not changed significantly during the three regimes over the last

fifty years. During that time the state became almost the only active force in rural life; thus the gap between the public and private sphere, as well as the scope of action for independent initiatives has narrowed. The management of development is mostly one-way directed and the limited infrastructural networks are not sufficient for the scattered rural population, according to Dessalegn. People are closely interlinked with bureaucracy through all administrative levels. Hence, the governmental Development Agent (DA) as the key consultant for the farmers attracted attention. Different studies analyzed the DAs' performance in disseminating technology (Gebru et al., 2012), agricultural education and technical competence (Melak & Negatu, 2012) and concluded with a lack of infrastructure, training, skills and capacity (Lemma & Hoffmann, 2007).

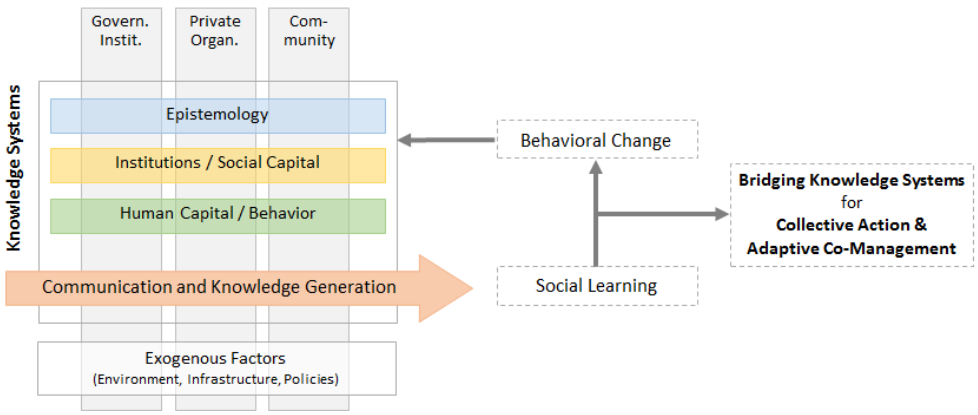
6 The role and involvement of women have been analyzed in single studies (i.e. Pankhurst, 1992; Kassa, 1991) that present limitations of women's rights and their disadvantages in decision making due to the clear division of work and social roles. Dessalegn (1991) emphasized the importance and effectiveness of informal women's support groups for securing their livelihood.

Methodology

Research concept and study design

7 Stakeholders' intentions and actions are influenced by their knowledge system which is comprised of epistemology (worldview, culture), institutional arrangements and social capital (social networks, power structures), and individual human capital and behavior (expertise/practices, motivation). The interlinkage between various knowledge systems generates knowledge and communication between relevant stakeholders (Fig. 1). These component systems are not isolated but rather overlap and interact with each other. Besides socio-cultural and individual components, external factors (environmental impacts, infrastructure, policy) can also influence the processes within the systems.

Fig. 1: Conceptual framework of knowledge systematics within climate change adaptation



Own compilation based on Röling & Jiggins, 2000, Rogers, 2003, Leeuwis & van den Ban 2004, Berkes 2012.

8 As part of this overall research, the present study explores and investigates parameters that characterize and affect knowledge processes. It focuses on information exchange and communication facilitation between social entities tackling issues relevant for climate

change adaptation. The qualitative and exploratory character of this research required a case study approach involving analysis of real-life events where boundaries are not clearly evident (Yin, 2009).

9 An analysis of the situation, stakeholder system and social networks was conducted at local level with the district (Woreda) and village groups (Kebele[1]) as main units of analysis. The selection was done by judgmental sampling on the basis of consultation with scientists, staff of governmental institutions and non-governmental organizations. Selection criteria were: (1) vulnerability to climate change (sensitivity to hazards, i.e. droughts, rain-dependent areas), (2) differences in the activities related to climate change adaptation (high and low), (3) presence of a diverse stakeholder pool (governmental, research, civil-society organizations, NGOs), (4) optimal accessibility and feasibility given the available study time.

Study site

10 The selected Woreda Adami Tulu Jido Kombolcha Woreda (ATJK) is located in the East Shewa Zone, Oromia Regional State in the Central Rift Valley (CRV) (Fig. 2). Ranging in attitude between 1500 and 2300 m, the Woreda lies in the Weyna Dega agro-ecological zone and has an average annual rainfall of 600-800mm (Oromiyaa.com; Interview with the Natural Resource Department, Woreda Office of Agriculture, Adami Tulu Jido Kombolcha, 27.11.2014). Farming is the main economic activity and food source but only started in the 1950s, after the people turned from a purely pastoral lifestyle to agro-pastoralism (Regassa et al., 2010). The Woreda is densely populated with 100 persons/sq m (FDRE, 2007; Oromiyaa.com). Despite a mixture of rain-fed and irrigated farming (Shiferaw, 2008) most areas are dependent on the two rainy seasons (short: February to April; long: June to September). This leads to the identification of ATJK Woreda as a nutrition hotspot that is highly affected by food insecurity (UNOCHA, 2015). 22 Kebeles out of 43 in ATJK are supported by the Safety Net program (Interview with the Woreda Office of Education, Adami Tulu Jido Kombolcha, 27.11.2014). Previous studies have stated that the CRV and ATJK area is highly affected by climatic change in the form of erratic rainfall and extended droughts (Regassa et al., 2010).

Fig. 2: Selected study site in Ethiopia

Data collection and analysis

11 According to the case study requirements of a research approach with multiple sources of validity (Yin, 2009), participatory tools were used namely semi-structured questionnaires and group discussions with community members at the village site (micro level) and key-person interviews with representatives from governmental and non-governmental institutions at the Woreda (meso level). Open questions made it possible to gather contextual information about in situ aspects. Personal observations served to support or question the results of the survey. The data were collected in 2014 in three selected Kebeles: Kermo Gerbi, Korme Bujure, and Suro Kudusa. Eleven key informant interviews with representatives from governmental and non-governmental organizations were conducted at the Woreda and Kebele level. 77 semi-structured questionnaires were conducted with community members from different households, 35 with women and 42 with men of various ages. A balanced sample of gender and age made it possible to reach more marginalized groups. Not all 77 respondents answered all questions and some gave multiple answers. Therefore in the assessment the range of the data basis changed slightly.

Tab. 1: Overview of Population and Selected Respondent for the Survey

Kebele	Population	HH	Respondents	% HH
Kermo Gerbi	2665 (m: 1345, f: 1320)	410	28 (m: 15, f: 13)	6.8%

Korme Bujure	4515 (m: 2248, f: 2267)	686	24 (m: 14, f: 10)	4.4%
			group discussion: 6 women	
Suro Kudusa	4693 (m: 2508, f: 2185)	620	25 (m: 13, f: 12)	4.0%

Source: Kebele Administrations 2014.

12 To capture the complexity of the local context, data were analyzed both through qualitative content analysis and through a quantitative data assessment using SPSS and Excel. The answers to non-standardized questions were summarized in categories. This combination served to define the local situation, and to detect and explain coherences and dependencies.

Limitations of the study

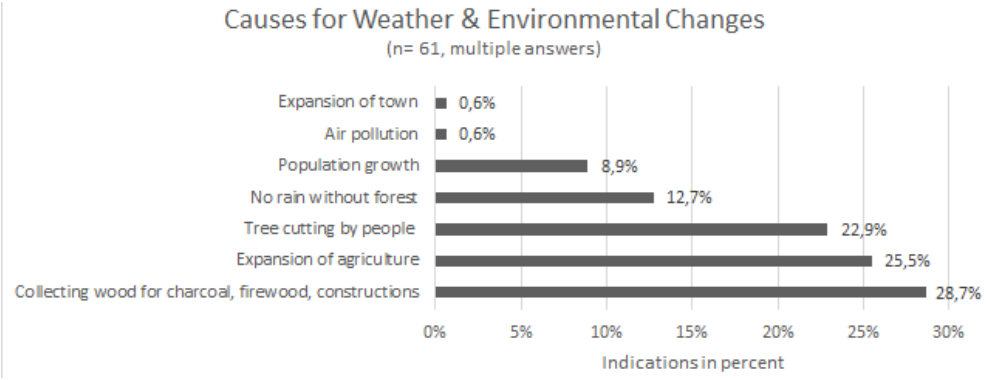
13 Obstacles to this kind of study can be misunderstandings in questions and responses due to cultural differences and language problems. A local translator was assigned who is not part of institutions working particularly in this area. Assigning a local person as translator on one hand facilitates access to the local population but on the other hand can also lead to a loss of data if the translation in both directions is not complete (due to unspoken mutual understanding on the part of the speaker and translator). Approaching community members of all ages and both genders also means including people that are more marginalized and are not able to respond to all questions because of not knowing or not understanding particular aspects. Interviews on interpersonal and social matters can lead to answers that may reflect social desirability rather than the actual situation because the respondents may potentially expect benefits or fear disadvantages from their answers. Even though the anonymity and confidentially of the respondents and their answers were emphasized, the environment where the study was conducted might influence the scope of disclosure, as most activities within the Kebele are inevitably observed and recognized by other villagers.

Results of the case study analysis in Adami Tulu Jido Kombolcha Woreda

Knowledge and activities of climate change adaptation at the community level

14 The three main weather irregularities mentioned by the communities are: shortage of rain (33.8%), variation of rain (25.6%) and the lack of rain or droughts (32.8%). The major environmental changes are considered to be forest and vegetation loss (66.7%) and soil degradation (24.1%). Consequently, three-quarters of the respondents see deforestation as main driver for these changes, which is related to tree cutting without further specification, expansion of agriculture and mainly through the use of wood for construction material, making and selling charcoal and firewood, as shown below (Fig. 3).

Fig. 3: Causes for Weather and Environmental Changes Mentioned by Community Members in the Kebeles Kermo Gerbi, Korme Bujure, and Suro Kudusa

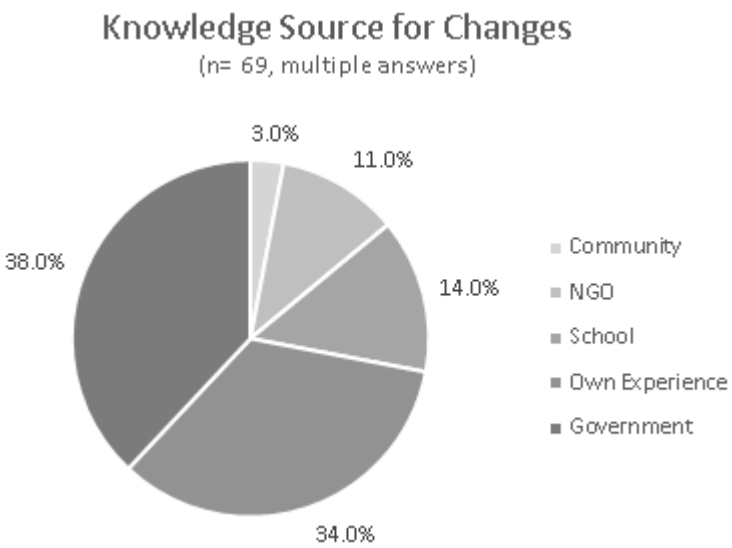


Survey 2014.

15 Communities are aware of the basic causes of environmental degradation. One noteworthy answer by the farmers is to explain the shortage of rain by the loss of forest. This interlinkage is not scientifically proven. A local researcher who worked as consultant in this Woreda explained that this explanation is promulgated by the government with the aim of preventing tree cutting by linking this target with what the people don't want to lose – the rain (Interview 24.11.14).

16 Government entities are the main provider of information related to climate change (Fig. 4). Almost 40% of the community members got their knowledge primarily from Woreda staff members, called Woreda Experts by the people, and to a small degree from DAs and the Peasant Association (PA). Some farmers mentioned directly the trainings on soil and water conservation activities that are led mainly by Woreda Experts once a year (Tab. 2). One-third gained their knowledge through the own experiences and observations. Non-governmental organizations (NGO) and schools are the knowledge source for one-quarter of the respondents. The community (family, elders, group leader) plays only a minor role for this type of information.

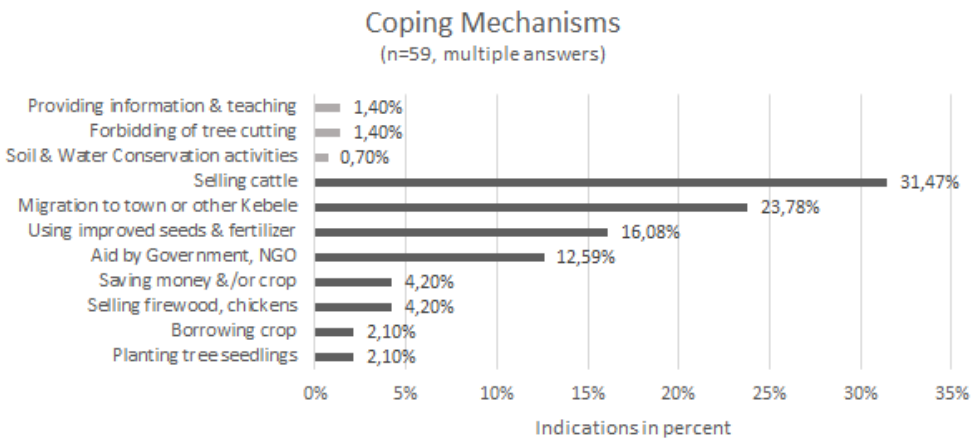
Fig. 4 and Tab. 2: Knowledge source for weather and environmental change related issue of community members in the Kebeles Kermo Gerbi, Korme Bujure, Suro Kudusa



Government entities	%
Woreda experts	25%
Development agent	7%
Peasant association	6%
Total	38%

17 To cope with the negative effects of a changing climate and environment, to secure their livelihood almost one-third of the respondents sell their cattle, followed by the decision to leave their home by almost one out of four (Fig. 5). Community members migrate seasonally to town for a job or to another Kebele to live with relatives and receive foodcrops. Two active counter-measures that are applied are the use of improved seeds and fertilizer to enhance agricultural production, and the planting of trees provided by the government to decrease soil erosion. These measures are chosen by only one out of five. Explanations given for this by the farmers are the high price of improved seeds and fertilizer as well as the low survival rate of trees due to shortage of water. The trees are mainly planted at the homesteads in order to better protect them from goats and to make it easier access in order to water them.

Fig. 5: Coping mechanisms adopted to secure the livelihood of community members in the Kebeles Kermo Gerbi, Korme Bujure, Suro Kudusa



Survey 2014.

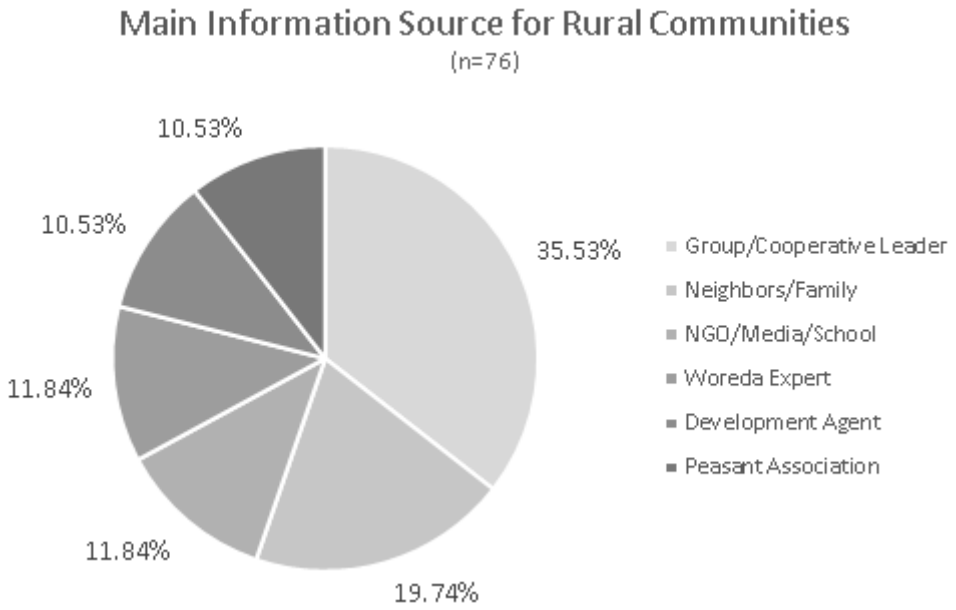
18 A small number of respondents mentioned steps to be taken in a broader and communal sense through education, rules and soil and water conservation activities.

Information networks and socio-economic aspects

19 The daily information network for issues related to livelihood differs from the above-mentioned source for knowledge on climate change-related topics. It is dominated by community actors (more than 55%). Primarily the group leader or, if there is one, the cooperative leader is the main source of information, followed by neighbors and family

members. Government entities cover one-third, almost equally distributed between Woreda Experts, DAs and PA. Meetings are conducted mainly at the the Kebele office and the Farmers' Training Centers, seldom at the Woreda town.

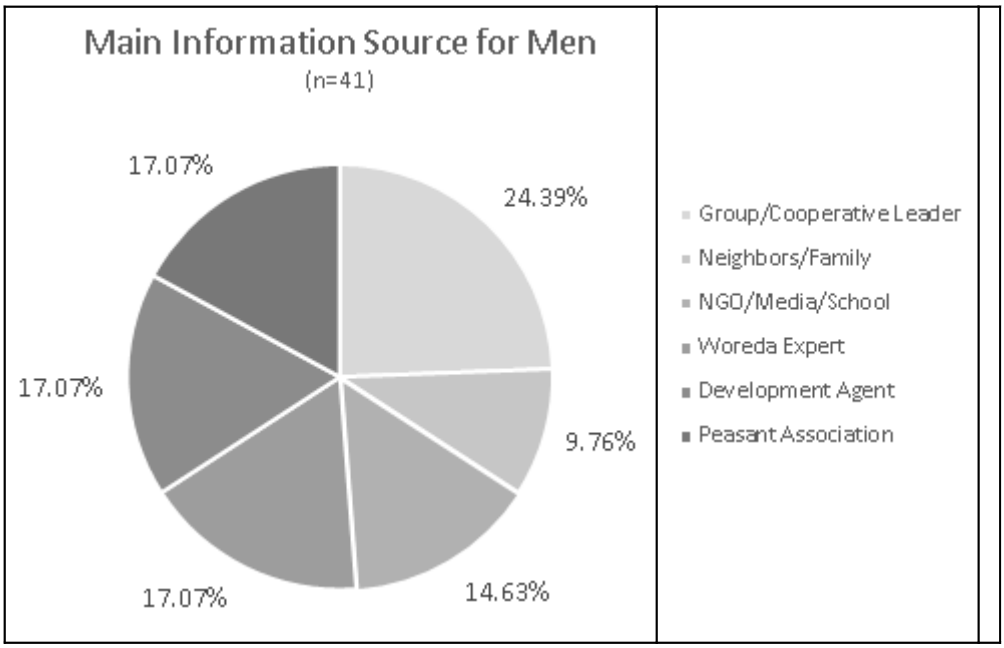
Fig. 6: Dominant information sources on daily livelihood related issues for community members in the Kebeles Kermo Gerbi, Korme Bujure, Suro Kudusa

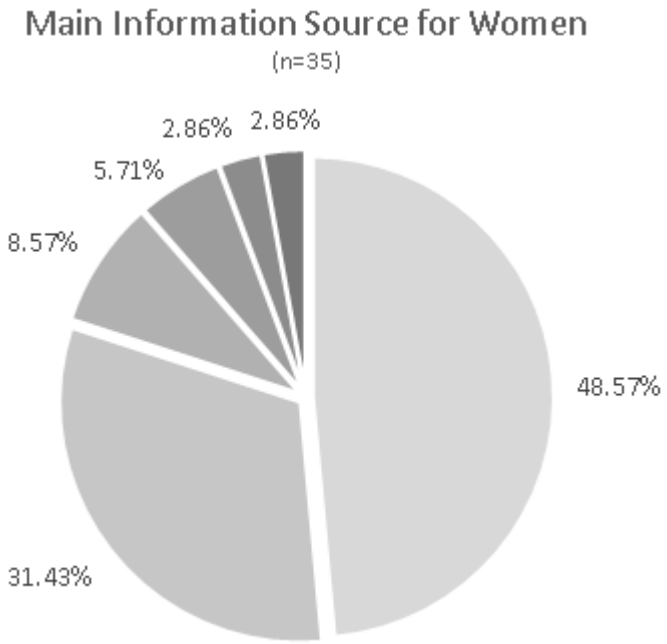


Survey 2014.

20 When we consider the gender variable, these results show an unbalanced access to information from institutional entities. Only 20% of the women receive information on livelihood issues from formal entities compared to 66% of the men.

Fig. 7: Dominant information sources according to gender in the Kebeles Kermo Gerbi, Korme Bujure, Suro Kudusa



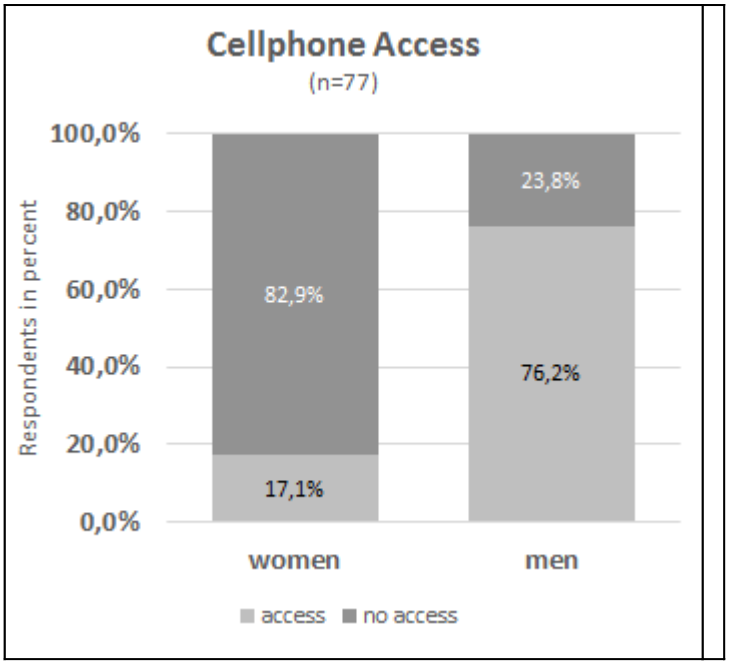


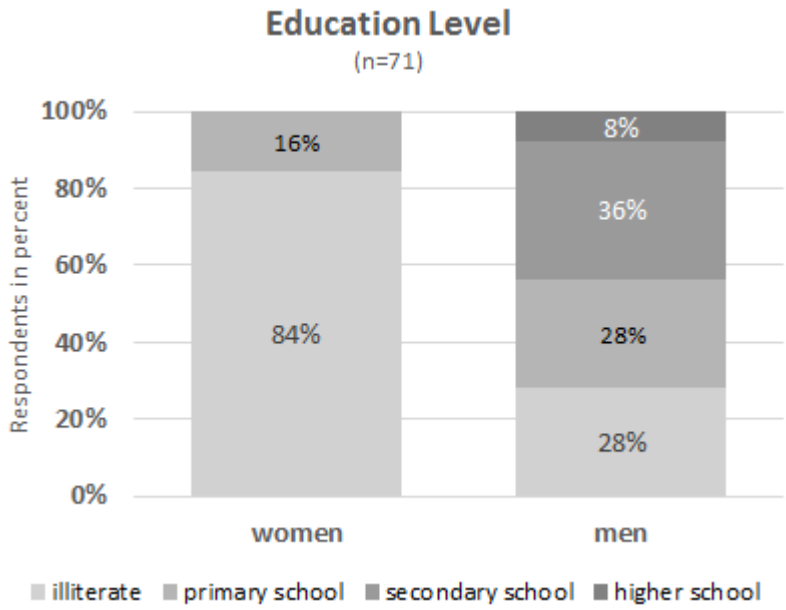
Survey 2014.

21 Reasons given for the domination of community information networks among women, as indicated by the survey and by observations, are their role in the society and their duties which keep them at home and prevent them from attending meetings at the Peasant Association. Young women in particular mention being afraid to speak up in meetings, and particularly to men. Market days and trips for fetching water are another context involving primarily meetings among community members.

22 Besides personal contacts, cellphones are the main means of communication for half of the respondents (49.4%). But dividing the group according to gender, the imbalance it shown as among the group of men more than three-quarters of them use cellphones and among the group of women it is less than 20% (Fig. 8a). The women's own explanations for this pattern reveal three main reasons, that are additionally confirmed by a women group leader in Korme Bujure: (1) no money to buy a cellphone – a financial constraint that also applies to men; (2) the husband does not allow his wife to use a cellphone for fear of her talking to other men – a cultural constraint; (3) no knowledge of how to use the cellphone – illiteracy.

Fig. 8a and 8b: Cellphone Access and Education Level of Women and Men in the Kebeles





Survey 2014.

23 The large majority of the women are illiterate. Particularly young men have a higher level of education. Primary school enrollment in the three selected Kebeles is altogether 929, which is quite low considering that 51% of the population in ATJK is under 10 years old (FDRE 2007), i.e. 6055 children in the three Kebeles. Nevertheless the gender distribution of the schoolchildren is equally balanced (Interview with the Woreda Office of Education, Adami Tulu Jido Kombolcha, 27.11.2014).

24 Infrastructural conditions determine the access to information in large, part as respondents and observations reveal. Scattered homes and far distances make it difficult

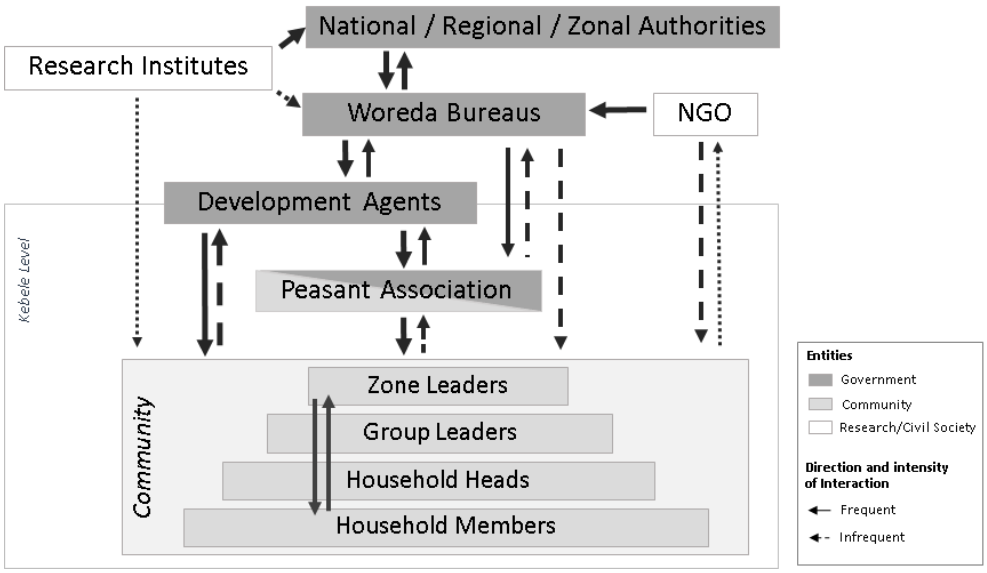
to regularly visit towns, schools and Farmers' Training Centers. The situation is aggravated by non-existent or damaged roads and the expansion of gullies. This situation and the lack of money limit the use of media like cellphones and radio. A trip into town is necessary to buy the devices, to buy phone credit as well as to charge and buy the batteries because of lack of electricity at the village level.

25 People also complain that the lack of sanitation, health facilities, and clean water enhances the risks of disease that hinder children from going to school and adults from attending meetings.

Agricultural extension and collaboration structures

26 The agricultural extension system (agricultural consultancy) reflects the above mentioned information networks. Explanations by the community members and stakeholders from the governmental and non-governmental organizations reveal that this is organized as a multi-level governance system (Fig. 9). It is dominated by governmental entities that are directly linked to the Kebele level.

Fig. 9: Structure of agricultural extension and interaction in Ethiopia



Own compilation, fieldwork 2013, 2014.

27 The dissemination of information down to the community level proceeds from the Woreda offices through the DA to the PA. The usage of the term PA and Kebele in the studied Woreda shows that the two are closely interlinked and even interwoven. The majority of the household heads are members of the PA. There are regular meetings at the Farmers' Training Center or PA office every one or two months, but in fact, information is passed to the households continuously. The Kebeles are subdivided into zones and household units. Community members assume the role of zone leaders who pass the information to a number of group leaders who in turn pass the information to a smaller group of farmers. An established mechanism is the system of 1-to-30 and 1-to-5 groups – one person is the linkage to either 30 or 5 people. Some Kebeles have a particular female group leader who is the link between the PA and the women in the community. Through this structure scattered homes can be reached. But the system is

unstable as it depends on individual persons and simple face-to-face communication. As the survey reveals, information arrives late or does not reach the household at all because no one is at home when the group leader visits the house and because of the lack of phone credit and mobile network when attempting to pass the information by phone.

28 The DAs, employed by the Woreda and working in the Kebeles, are the advisors to the farmers and are in charge of trainings at the Farmers' Training Centers. In the ATJK Woreda 104 DAs are employed for 43 Kebeles – two to three per Kebele, covering the areas of Plant Sciences, Natural Resources and Animal Sciences (Interview with the Natural Resource Department, Woreda Office of Agriculture, Adami Tulu Jido Kombolcha, 27.11.2014). The majority of the DAs (87.5%) are male. During interviews with key person in the selected Kebeles the DAs requested more logistics (i.e. transport facilities to access distant Kebeles), financial compensation (i.e. phone credit) and trainings (i.e. on climate change-related topics). Observations reveal that the Farmers' Training Centers are not sufficiently equipped: no telephones, no teaching materials or shelves with relevant literature, and, if at all, only hand-drawn maps of the area.

29 Interaction between the communities and NGOs is determined by governmental plans and actions. The collaboration and exchange of expertise among different NGOs is limited and is guided by the zonal and district government, according to interviews with representatives of three local NGOs (SEDA - Sustainable Environment and Development Action, Vision, WaSuPA – Water Supply Project for ATJK) working on environmental issues in the Woreda. The local government has the mandate to control the respective implementation areas to prevent overlapping in the work of different NGOs. The cooperation between civic and government entities primarily covers administrative issues like submitting annual and quarterly plans as well as monitoring visits and is based on a formal written agreement. None of the three organizations has a continuous linkage with the nearby research institute; the connection is limited to occasional contacts for trainings and advice. Two of the NGO representatives see a need for more collaboration and sharing of information among themselves. According to one, this should be supported by the government. But they criticize the low capacity of the Woreda to provide sufficient and up-to-date information due to a lack of documentation and computerization. The limited capacities and skills of Woreda staff for agricultural consultancy were observed in Korme Bujure where a women's training was held (Photo 1). Even though the majority of the women are illiterate, they were handed out written materials and were taught with text on a flip chart.

Photo 1: Training of women in Korme Bujure

Fieldwork, 2014.

Discussion

30 In the case study area, the residents have awareness and basic knowledge of the causes of weather and environmental changes in their area. But the information pool on climate change processes at the local level is still very basic considering that the topic has been on the national agenda and part of the CRGE in Ethiopia for the last five years. The term climate change is not used much at the local level, and farmers do not clearly distinguish between causes and consequences with regard to weather and environmental changes. Information related to climate and degradation of natural resources is provided only once a year for the communal activity of soil management and water construction – a governmental campaign. But the knowledge the farmers gain is partially not taught by the stakeholders in the right way, as the people think that good forest management induces rain which is not scientifically proven.

31 Even though officials and community members emphasize that tree cutting is not allowed, the ongoing expansion of agriculture is still a process that requires empty fields. Agroforestry is not an applied technique. The capacity to adjust to soil degradation and production is very low. By leaving the homestead and selling cattle as most farmers do, the farmers take a drastic step and thereby destabilize their livelihood and partly lose their culture. This extreme situation may well be aggravated by rapid population growth and the lack of a local agricultural tradition compared to other parts of Ethiopia. As findings show, in this situation, the agricultural extension service does not provide sufficient technology and assistance in developing adaptation measures regarding how to deal with climate change on the household level. The distributed tree seedling are not planted in the fields to stabilize the soil for crops. Dependence on improved seeds and fertilizer is insecure due to the volatile availability and high prices. There is the possibility of connecting with other areas in Ethiopia to transfer knowledge and share

lessons learned. The situation needs a more flexible communication and knowledge sharing environment as well as better infrastructural capacities.

32 The farmers and their families trust and follow the governmental extension service despite some complaints of unacknowledged requests and delay in delivery of materials. A reason might be that governmental entities are the most dominant and visible in the system, as it has always been through history. Self-initiative and self-organization is marginal. Community members and even NGOs see the legal power and duty to initiate actions and programs as lying with the government, the PA or the Woreda. As already shown by previous studies, the DA is not the main information source despite being the direct advisor to the community. NGOs also play only a weak role in the extension system and researchers are not even considered to be part of it. Cooperation and knowledge sharing between local non-governmental organizations without governmental involvement is rare even though the activities and targets are similar. But the local government as the main actor lacks the necessary capacity. More appropriate extension methods and materials are necessary to meet the communities' needs and create an interactive and creative environment. All these factors limit learning and creation of knowledge. Granovetter's theory of the "strength of weak ties" (1973) explains the importance of less intense and less frequently used weak ties that occur between qualitatively dissimilar stakeholders. These channels can offer access to a more diverse pool of information and knowledge (Prell et al., 2009) to enhance the creation and exchange of new ideas and inventions and building resources and capacities.

33 Information flow within and out of the communities follows exclusively a hierarchical line and seems to be unstable and one-way, as it depends on individual persons and partly non-media-based communication over long distances. Also even though the number and importance of mobile phones is increasing, their use is faces financial, social and infrastructural barriers. Access to a diverse pool of information is limited and is determined by physical remoteness (distance to town), age (higher school attendance for young people) as well as gender and cultural aspects (role of women at the homestead). Women have limited access to information and have only a minor influence in decision making even though they play an important role in securing the livelihood. NGO workers promote women because of their better performance in the cooperatives and particularly in dealing with money and savings. Also women themselves see more responsibilities on them in their current situation, as a group discussion with the women reveals. Even though most respondents do not perceive a lack of communication and information provision for women, the results show them to be in a disadvantageous position. Illiteracy is still widespread among women, the majority are not able to use mobile phones and their duties keep them mostly at the homestead. Due to the male-dominated society women are too shy and insecure to discuss relevant issues within the PA or with DAs. The establishment of women's groups is one effective mechanism of empowerment, as the female respondents and the NGOs admit.

Conclusion and outlook

34 Success in coping with and adapting to climate change depends on the local context. This comprises a complex interlinkage of institutional, socio-economic, governance, social and infrastructural conditions and capacities that facilitates the scope of action. Limitations in accessing social networks and infrastructure determine directly the access to

information and knowledge, the level of local participation, and the success of activities. Initial findings show that challenges occur in daily communication processes and that there are also idle potentials for broadening the scope of action and interchange.

35 In the environmental context local institutions play an important role in structuring, shaping and mediating individual and collective action (Agrawal, 2010). They can act as a broker between different stakeholders and as intermediaries to bridge the gaps between knowledge systems. The study reveals the importance of stabilizing the collaboration between different actors within natural resource management to combine multiple dimensions of knowledge to overcome today's challenges and lead to collective action. Hence, the focus has to be shifted to more conceptual and participatory actions if long-term learning effects are to be achieved. Furthermore a reliable infrastructure as well as skills and capacity have to be built to ensure an enduring knowledge flow and to initiate collective action.

36 This exploratory work has interlinked various disciplines like environmental, social and political sciences to integrate research results into an overall context. It offers a foundation for further quantitative research to improve the management and sustainability of knowledge in the context of climate change adaptation.

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NOTES

1. The rural Kebele represents the lowest administrational unit in Ethiopia that encompasses different villages. Sometimes it is also referred to as Peasant Association.

INDEX

Mots-clés: climat, capacité d'adaptation, analyse de communication, développement agricole, réseaux sociaux
Keywords: climate, adaptive capacity, communication analysis, agricultural extension, social networks
Geographical index: Rift (vallée)

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Women and Climatic Changes in Ethiopia: A Gendered Assessment

Margaux Herman

1 Within the broader issue of climate changes, the current discourse seeks to prioritize adaptation measures in tackling the adverse effects of global warming rather than a reliance only on mitigation efforts (Aguilar, 2009; UNFCCC, 2010). In this process, women are given an increasing role to play, as the gender approach has shown its enhanced potential in creating sustainable development. Indeed, on June 26th 2014, at Malabo (Equatorial Guinea), the Committee of African Heads of State and Government resolved to develop a "Women and Gender Program on Climate Change". However, behind the motives of this new approach are the same familiar challenges to be met, the same reports on the position of women within the society, the important role of women in situations of poverty, their low educational level, their difficulty in getting access to information and financial credit or in being included in decisions at political, community and family levels. We must wonder about the intrusion of the question of gender within consideration of the need for adaptation to climate change, which is a part of a wider movement linked with development aid in general. The public and private funding assigned to the resolution of this worldwide danger raises the questions of opportunism, financial confusion and/or lack of general consideration towards the actors involved in the promotion of gender equality. But we shall also take the opportunity to measure the transformations this all implies for the Ethiopian associations that advocate improvement of women's conditions. Finally, can the theme "Gender and Climate" in Ethiopia propose new paradigms for reflection?

2 The aim of this paper is therefore to understand how women have been recognized as effective and independent actors in answering some of the challenges posed by climate change. At the same time, we want to question the relevance and reliability of a gendered approach in overcoming the problems generated by climate change in the African context in general and the Ethiopian case in particular.

History of the gender approach to development projects

3 Only for the last 50 years or so have women been considered as a group of society to be taken in account by the international community. This is relevant to understanding the process of their recent integration within the issue of climate change. In the same manner, the gendered approach to development studies cannot date back before the late 1990s, a fact that delayed women's involvement in the problems posed by climate change.

4 Women were first included in the challenges posed to the international community in the context of confronting violence and inequality. The first international act considering women as a social group is dated from 1979, with the signature of the "Convention on the Elimination of All Forms of Discrimination against Women" (CEDAW). This action was complemented a decade later, in 1993, by the UN "Declaration on the Elimination of Violence against Women", the first international human rights instrument to exclusively and explicitly address violence against women. Finally, in the United Nations (UN), successive Security Council resolutions taken from 2000 to 2013 promoted women in leadership positions in peacekeeping and peacebuilding efforts, and improved protection of women and girls within a framework of rule of law and respect for human rights (UNDP, 2014). At a regional level, the African Union (AU) adopted in 2003 a "Protocol of Women Rights in Africa" that Ethiopia signed (but not ratified) on June 1st 2004 (AU, 2003; AU, 2013a). Thus women have been slowly integrated as actors within the process of peacemaking in order to diminish the various forms of violence they were facing and in a broader perspective of change of mentality to achieve peace (UNDP, 2014).

5 In parallel, during the 1980s and 1990s, the gendered approach was raised to face the issues of development and inequality following the 1985 "Beijing Platform for Action", "an agenda for women's empowerment", the first global commitment to gender mainstreaming as a methodology by which women's empowerment can be achieved. In 1994, the practice of women's empowerment was re-raised in Cairo in the context of the issues of poverty and population growth. During the 2000s, international organizations launched successive programs that took into account women's rights, women's empowerment and gender equality for the development community. Some aspects of the "Millennium Development Goals" (MDGs) and of the 2005-2011 " Aid Effectiveness Commitments" promoted gender equality and women's empowerment. In these efforts, program like the 2008-2013 UNDP strategy were specifically dedicated to this issue. Finally, in 2010, the United Nations General Assembly established the "United Nations Entity for Gender Equality and the Empowerment of Women" (UN-Women), seconded by the UN-SWAP (UN "System-Wide Action Plan") that implements its policy by establishing standard requirements for mainstreaming gender equality and women's empowerment in the following areas: accountability, result-based management, oversight, human and financial resources, capacity, and coherence, knowledge and information management (UN-Women, 2011; UNDP, 2014; UN-SWAP, 2014). It was followed, in Africa, by the call of the Ministers of Gender and Women's Affairs in the AU to declare 2010-2020 as "African Women's Decade" in Maseru, Lesotho, in December 2008. The latter aims at re-invigorating regional commitments to gender equality and women's empowerment (GEWE). In December 2012, the UN General Assembly passed resolution 67/226 to increase investments in and focus on outcomes and outputs relating to gender equality and the

empowerment of women, and to promote acquisition of sufficient technical expertise in gender mainstreaming. This resolution also encourages United Nations organizations to collect, analyze and disseminate comparable data, sorted out by sex and age, to guide country programming (UNDP, 2014).

TABLE : WOMEN, GENDER AND DEVELOPMENT AID

Year(s)	**Name**	**Plans/actions for women and gender mainstreaming**
1979	CEDAW	"Convention of Elimination of All forms of Discrimination against Women"
1985	"Beijing Platform for Action"	First global commitment.
1993	UN "Declaration on the Elimination of Violence against Women"	First international human rights instrument against violence.
1994	ICPD: "International Conference on Population and Development"	Equality and empowerment of women to eradicate poverty and stabilize population growth.
1994	Convention of Belem Do Para	"Inter-American Convention on the Prevention, Punishment and Eradication of Violence against Women"
2000-2013	Women, peace and security within UN Security Council Resolutions	To expand the role of women in leadership positions in prevention and resolution of conflicts.
2000-2015	MDGs: "Millennium development Goals"	To consolidate previous agreements for development.
2003	"Protocol on the Rights of Women in Africa" adopted by the African Union	First regional agreement on women's rights in Africa.
2005-2011	"Aid Effectiveness Commitments"	Developing countries and donors commit to ensure that their development policies follow gender equality.
2005-2015	HFA: "The Hyogo Framework for Action"	First plan to integrate a gender perspective in all forms of disaster-risk management.
2008-2013	First UNDP "Gender Equality Strategy"	
2010	Creation of the UN-Women	"United Nation Entity for Gender Equality and the Empowerment of Women"
April 2011	UN-SWAP: "United Nation System-Wide Action Plan"	To implement the UN policy on gender equality and women's empowerment.

Dec. 2012	UN General Assembly resolution 67/226	To increase investment, acquisition of sufficient technical expertise, and to collect, analyze and disseminate comparable data.
2014-2017	Second UNDP gender equality strategy	

SOURCES: UNDP, 2014; AU, 2003, 2013A.

The critical intersection of climate change and gender mainstreaming: a financial opportunity for Ethiopia?

6 It was only during the second part of the last decade that international attention began to be concentrated on the importance of the intersection of climate change and gender equality. This is surprising, as the consequences of climate change are by no means gender-neutral (African Development Bank, 2009). The starting point of these efforts to bring the two agendas together was initiated jointly by publication in 2007 of the UNDP report and the Intergovernmental Panel on Climate Change (IPCC) (Rodenberg, 2009). This was then followed by the Global Gender and Climate Alliance (GGCA), which was created by the International Union for Conservation of Nature (IUCN) (IUCN, 2007), the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), and the Women's Environment and Development Organization (WEDO). The objective was to ensure that climate change policies, decision-making, and initiatives at all levels should be gender-responsive.

7 Indeed, a strong relationship exists between climate change and environment-based livelihoods, which, in turn, are closely linked to gender (Alexander et al., 2011). In all developing countries, it has now been demonstrated that women are more vulnerable to climate changes and effects because two-thirds of women are poorer, they receive less education, and they are typically not involved in political and household decision-making processes that affect their lives (Rodenberg, 2009). Their work is more directly related to the environment as their main activities include fetching water and bringing wood for household purposes (FAO, 2011, ch. 2), tasks that are also related to their main diseases (BRIDGE, 2008; Rodenberg 2009, 29). Moreover, cultural norms related to gender sometimes limit the ability of women to make quick decisions on whether to move to safer ground in disaster situations before it is too late. In the same manner, they are not taught to swim or climb trees, endangering their likelihood of surviving in case of natural disaster (Araujo & Pearl, 2007). Another study showed in the case of Ethiopia that when climate change leads to shortages of food or water, social norms may lead to greater malnutrition among girls and women because of expectations that women are to eat only after they have fed their families, which often means there is little left over for them (Pelter & Capraro, 2015). Finally, women have less access to land property and resources. In overall terms, climate change exacerbates the existing economic and social gender disparities (Rodenberg, 2009, 26-30; GCCASP, 2012).

8 However, paradoxically, it has at the same time been noticed that women have unique knowledge and skills related to their environment. Women are important food producers and providers, and because of this central role in agriculture (FAO, 2011, ch. 2), they are

major agents of social change. Their knowledge of natural resources and environment (e.g., potable water sources, soils, seeds and animal reproduction) can help bring about a more effective and sustainable response to climate change (IUCN/UNDP/GGCA, 2009: 122). This applies both to work that is already being undertaken by women and to activities in which women could assume a leading role. In developing countries, for instance, women frequently play a major role in the reforestation and afforestation of cleared land and in forest conservation (Bäthge, 2010: 4; IUCN/UNDP/GGCA, 2009: 155). In the same manner, the use of efficient energy systems at the household level (e.g., special cooking stoves and ovens) could reduce emissions and harness the potential of women as agents for mitigation measures (IUCN/UNDP/GGCA, 2009: 159). For instance, the International Food Policy Research Institute (IFPRI) combined two aspects of its activities, involving the gender approach and climate change, in developing the project "Enhancing Women's Assets to Manage Risk under Climate Change: Potential for Group-Based Approaches", which was carried out between March 2011 and September 2014. Within this project, a specific policy note on Ethiopia was drawn up; it showed that when women are given access to climate information, households are more likely to better adapt themselves to climate change (Berga, 2014a; 2014b; GCCASP, 2012). Therefore including women and a gendered approach to climate change is deeply relevant as the challenges faced need such an approach in order to achieve sustainable success (Bäthge, 2010: 11-16).

9 However, it must be pointed out that the problems of women's conditions and gender equality have not improve much over the past 10 years; the same problems continue to be raised by international organizations. Only a few of these problems have shown any change since the launch of the "Millennium Goals" in 2007. The evaluation of these goals by the UN Economic Commission in 2014 specifies that the majority have not been achieved in matters of gender issues, notably with regard to Goal 1 (eradicating extreme poverty and hunger), Goal 3 (promoting gender equality and empowering women), Goal 7 (ensuring environmental sustainability) and Goal 8 (developing a global partnership for development). Moreover, in 2014, the conclusions and recommendations of the report continued to be at the same stage as in the UNDP report of 2007. Moreover, several indicators do not provide sufficient gendered information that can help at empowering women.

10 Reports underline the fact that women and girls are disproportionately affected by natural disasters while at the same time they play a vital role in disaster risk reduction, and recovery. The need to enhance women's access, capacities and opportunities to participate in preventing and responding to disasters is therefore recognized. In parallel, climate change poses a challenge to the achievement of sustainable development where the family is believed to be a contributor to such development. Finally, the Commission concluded by stating that insufficient priority given to gender issues and significant underinvestment in gender equality and the empowerment of women continue to limit progress on the "Millennium Development Goals" for girls and women of all ages (UN Economic and Social Council, 2014; UNDP 2014).

Table : Women, gender issues and climate change

Year	Program and framework	Details

2010-...	UN "Framework Convention for Climate Change" (COP 16, 18, etc.)	COP 16: The "Cancun Agreement" is the first global climate change policy to include multiple references to gender equality.
October 11-12, 2010	"Africa Regional Dialogue on Forest, Governance and Climate Change" in Addis Ababa (Ethiopia)	All stakeholders should facilitate the effective participation and representation of women in decision-making.
2012	"International Day for Disaster Reduction" celebration choosing the theme of "Women and Girl- the (in)visible Force of resilience"	The government of Ethiopia initiated the "Climate Resilient Green Economy" (CRGE) initiative.
2014-2017	Second UNDP gender equality strategy	Outcome 1e (UNDP will support partner efforts to increase women's access to and ownership and management of ecosystem goods and services, including through climate finance) and 1f (UNDP will support governments to ensure that women can access affordable and clean energy). Output 4.5: Measures in place to increase women's access to environmental goods and services (including climate finance).
June 26 2014	CAHOSCC: "Committee of African Heads of State and Government on Climate Change"	Resolve to adopt 'Women and Gender Program on Climate Change".

Sources: UNISDR, 2012; UNDP, 2014; AU, 2014a ; see http://www.efdinitiative.org.

11 In considering the links between climate changes issues, the women and gender approach and financial resources, the question of financial opportunism has to be raised. Indeed, the current architecture of climate finance involves numerous private and public players, as there are currently over 50 international public funds, 45 carbon markets and 6,000 private equity funds providing climate change finance. Nevertheless, given various barriers and limitations, including low institutional and technological capacity, much of Africa has continuing problems in accessing these climate finance structures. In July 2012, the entire African continent had managed to attract only a meager 2.07% of "Clean Development Mechanism" (CDM) projects worldwide: out of the 4,389 registered CDM projects, only 91 went to Africa. Thus far, most CDM funding had tended to overlook small-scale projects that would benefit women (Senay Habteseyon, 2012). In June 2014, in Malabo, the President Kikwete of Tanzania declared that Africa needs more than 15 billion US dollars per year to fight against climate change and that this amount keeps on rising (up to 17 billion US dollars projected for 2030) (AU, 2014). In parallel, the "Funds for African Women" launched in 2010 by the AU is still seeking partners in addition to the contribution from member states (1% of the fund). The AU expects additional resources

from the African private sector, the African diaspora and African philanthropists (AU, 2013b). Considering the low level of financial support, the slow evolution of mentality regarding women's considerations and gender mainstreaming, as well as the fact that the issues regarding the environment crosschecked the same agenda as did women's issues, the budget allocated to climate change could be a financial solution for women's issues as well.

12 Promoting the integration of a gender perspective into environmental and climate change policies could provide adequate resources and access to financial credit. It could ensure women's full and equal participation in decision-making at all levels while integrating their specific needs (as for instance in water and reforestation projects). It could also ensure sustainable management of natural resources through women's empowerment and access to information. It is now recognized that involving women and men equitably in climate finance mechanisms would increase the impact and benefits of all programs. It has been demonstrated that women's empowerment leads to gains in productivity, in environmental sustainability and in confronting the ill effects of climate change. And yet, many finance programs and strategies continue to overlook typical women's activities that could count as adaptation and mitigation (such as tree planting).

13 Over the last five years, and especially since 2012, projects have been built in Ethiopia following the two axes of gender and climate, developing innovative actions in a macro-approach that crosschecked climate dangers and gender issues (GCCASP, 2012). Agriculture is the key sector of Ethiopia's economy, and here climate change issues and gender equality need to go together. Indeed, Ethiopia's economic production is characterized by its low intensity, low productivity and high susceptibility to climate variability and shocks (drought, floods, etc.) (*Ethiopia Weekly Humanitarian Bulletin*, 2015). Thus there is a third axis that must be considered alongside the two axes of gender and climate, and this is economic development. Since a link was made between these three issues, Ethiopia has slowly increased its benefit from international financial resources allocated to development, to some extent channeling this funding to climate and gender issues (Zewdu et al., 2014). This process started with programs like IPMS Ethiopia 2004-2012 ("Improving the Productivity and Market Success of Ethiopian Farmers") which used funds from the Canadian International Development Agency (CIDA) to improve the productivity of Ethiopian farmers and focused on gender mainstreaming, at the same time producing 27 research papers on women and gender related to agriculture and climate (ILRI, 2013).

14 In 2012-2013, with $23.2 million from the Canada Fund for African Climate Resilience, Canada provided support to smallholder Ethiopian farmers to help deal with climate change. Further projects have proposed to use the carbon finance to help the poorest and most marginalized people, where women represent the two-thirds of the population. Additional programs also plan to train women and men jointly in agricultural development (in Ethiopia 85% of women live in rural areas), and to promote equal access to credit and information. For example, the NGO CARE and its specific program "Poverty, Environment and Climate Change Network" (PECCN) used climate-oriented financing to improve microcredit given to Darara women, and training them in haymaking. It aims at empowering women and educates them to confront the problem of drought (CARE, 2013). Projects have been adapted to local conditions by providing mules and proper information on seeds that will be responsive to climate change while preserving the local biodiversity and expanding business opportunities. For example, the Gurmuu foundation

and the Swiss associations “Bread for All” and HEKS EPER (Swiss Church Aid) used funds specifically allocated to climate and development in order to plant tree and provide seeds in the Guduru region in order to decrease poverty, and develop the knowledge of soil management while empowering women (Keller, 2009; Künzler, 2010). The benefits of the actions based on local peoples’ experiences, knowledge and way of living have amply proven themselves.

15 Finally, regional research centers and activities have been promoted that have gender-based approach (Ethiopia Climate Innovation Center [CIC], ILLRI-ETHIOPIA, IFPRI, PHE Ethiopia Consortium, Horn of Africa Center, etc.). In the framework of its “Climate Technology Programme” (CTP), the United Kingdom supported in 2013 the creation of a national Climate Innovation Centre (CIC) to support the development and growth of local innovation capabilities and businesses in Ethiopia (9£m between UK and Norway). By 2023, the global program expects to create 14 000 “green jobs” with at least 30% for women. Within the GGCA, Finland sponsored a project starting in 2008 called “Gender Responsive Climate Change Initiatives and Decision-Making”. The fourth and last phase of the project is currently underway and will last two years (July 2014 - June 2016); the support will be 2.6 million euros, at roughly the same level as previous phases and will involve Ethiopia. In January 2015, Christian Aid and partners began work in Ethiopia to implement the “Building Resilience and Adaptation to Climate Extremes and Disasters Programme” (BRACED) of the UK Department for International Development (Pelter & Capraro, 2015, 2015). These are some examples of what has been achieved in bringing together the two agendas. Finally, the schedules of these achievements, and the increasing number of programs and projects launched since 2012 and that are still to begin, show that focusing on the intersection of climate danger, development aid and gender issues may lead to a real change of mentality towards women within the society, in developing countries at large and in Ethiopia in particular. However, much has to be done in order to achieve the final goals of both climate and gender concerns in Ethiopia and worldwide, as a gender gap in climate decision-making still exists at every level (Pelter & Capraro, 2015).

List of abbreviations

16 AU: African Union

17 CDM: Clean Development Mechanism

18 FAO: Food and Agriculture Organization of the United Nations

19 GBM: Green Belt Movement

20 GGCA: Global Gender and Climate Alliance

21 GCCASP: African Gender, Climate Change and Agriculture Support Program

22 GTZ: Deutsche Gesellschaft für Technische Zusammenarbeit GmbH

23 ICT: Information and Communication Technologies

24 IFPRI: International Food Policy Research Institute

25 IPCC: International Panel on Climate Change

26 IUCN: International Union for Conservation of Nature

27 UNDP: United Nations Development Programme

28 UNFCCC: United Nations Framework Convention on Climate Change

29 UNISDR: United Nations Office for Disaster Risk Reduction

30 UN-SWAP: UN System-Wide Action Plan

31 WEDO: Women's Environment and Development Organization

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INDEX

Mots-clés: climat, femmes, genre, programmes internationaux, développement
Keywords: climate, women, gender, international programs, development

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Indigenous Cosmological Paradigms for Popularizing Ecological Ethics in the Ethiopian Context

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1 An editorial in a recent edition of *Addis Standard* with the bold title "Behind the Smokescreen..." stated that: "Aside from the much repeated boisterous "Ethiopia Rising" narrative, the government should [...] use its excessive access to media networks to inform citizens on looming droughts and mobilize support to help those suffering from them" (Editorial Staff, 2015: 8). The ecological discourse in Ethiopia has become part of the "Ethiopia Rising" narrative. Newspaper headlines proudly announce: "Electric Power Groundbreaking Agreement to Buy Geothermal Energy" (Abdi, 2015a: 9), "Rural Electrification Increases Contributions to Green Economy" (Abdi, 2015b: 10), and "On Green Energy, Ethiopia Leaves U.S. in the Dust" (Cole, 2015: 30). The last article asserted that: "On the issues of green energy and climate change, Ethiopia has announced initiatives that put the United States to shame" (Cole, 2015: 30).

2 However, behind the robustly positive "Ethiopia Rising" narrative of commitment to "Green Development", the question remains what impact this is having on the general public not only the elite but also at grass roots level. The Goethe Institute in Addis Ababa organized an exhibition entitled "Examples to Follow: Expeditions in Aesthetics and Sustainability" (4-24 May, 2012); more recently a group of Ethiopian artists mounted a green exhibition at the National Museum. Such exhibitions seek to make a link between aesthetics and ecology, and to reach a wider public with an ecological message. They are admirable initiatives, which cause people to think and reflect. However, their public impact is limited.

3 Meanwhile, ecological awareness requires a long-term view, involving investment in the future. It entails an ascetic willingness to give up short-term time financial gratification for the future benefit of the planet and mankind as a whole. Such a message is difficult to "sell" in the context of developing countries, where technological development is just beginning to impact the lives of the mass population. Rapid economic development is

prioritized and everything that could be an impediment ignored. Ecological discourse inevitably becomes a fashion or luxury, associated with the urban elite. Ordinary countryside dwellers resent curbs on their ability to exploit the natural environment, and associate ecological discourse with foreign alien narratives. This creates a huge gap between the official governmental 'Green Development' discourse associated with the "Ethiopia Rising" narrative and the reality of life in the industrial suburbs and rural areas of Ethiopia.

4 Currently climate change is exacerbating an ongoing process of ecological degradation, which has ravaged much of Ethiopia. Lack of forests leads to erosion and inhibits cloud cover, thus further aggravating climatic conditions and producing an ongoing vicious circle. Ethiopia has already lost aspects of natural resources retained elsewhere in Africa. Merulli Pai, Professor of Wildlife Conservation at Arba Minch University, commented that: "The large predators have become extinct in Ethiopia and many of the large herbivores" (M. Pai, pers. comm., 2015) thus diminishing the wildlife tourist potential of the country (others claim that a few lions and other predators survive). On 9 August, 2010, Mr. Ban Ki-moon, the UN Secretary-General, launched a High-level Panel on Global Sustainability (GSP) stating: "Increasing strains and crises [...] point to reaching, and increasingly overstepping, planetary boundaries [...] [we] continue to deal with individual symptoms rather than the causes and their interrelationships" (Folke & Gunderson, 2010). He emphasized the need for a paradigm shift which addresses root causes. An Environmental Risks and Opportunities (ERO) Summit in Djibouti (2-4 May 2015) called for "extensive Climate Change Resilience and Adaptation – trimming dialogues to specific regional situations and needs" (Capital – Editor, 2014: 26).

5 There are attempts at intervention, but they are not really achieving the desired results: "Despite decades of research and development projects, concerned with mitigating the consequences of land degradation and soil erosion, these two negative forms of local environmental change continue to pose major challenges to African agriculture and livestock producers... the maintenance of a viable life is no longer a function of meeting socio-economic needs, but maintaining a sustainable environment that can generate both continuity and schism... [Meanwhile] there is a grim realization that beyond global environmental problem areas there are always victims who suffer the most. [This means that] at a larger synthesis, the consequences of climate change in the developing countries are more serious than we have ever thought and its consequences on other environmental problems such as food security, desertification, wetland disappearance and biodiversity loss, among others should not be underestimated.... of particular relevance is the negative consequences of global environmental change for the local environments as well as the social political and environmental change they produce," (Salih, 2001: 6 &11.).

6 Cosmological ideas have determined how people relate to and respect the environment. They have constituted a store of indigenous knowledge including sanctions related to moral and religious codes, producing a frame of reference guiding society and individuals in their relations to each other and the world around them. Rapid industrialization, secularization and globalization have undermined and marginalized them. "With the passage of time the environment which had been considered sacred and alive in the remote past was no longer viewed as such. As a result of surplus production, perceptions and attitudes of people towards the environment gradually changed, economic advantages became more and more important than environmental considerations. When

environmental considerations were pushed to the background, human beings stopped being friendly towards the environment... [Meanwhile] a society's environment is made up of natural processes (e.g. air, water, and land) biological processes (animal and plant life) and socio-cultural processes (economy beliefs, values and attitudes) (Axen, Tesfay Mulugeta.& Wolde Mulu, 1995: 4 & 6). It is precisely the aspect of beliefs, values and attitudes which is often ignored in the ecological/climate change discourse but in this article constitutes the focus of attention.

7 Researchers note that the positive or negative feedback from the human system directly determines the success or failure of projects: "The ecologist's worldview, when combined with a profound respect for human society and human institutions, can be used to find ways to achieve harmony between humans and the environment, and provides examples to inspire others" (Zheng & Wang, 2014: 35). Yet Ethiopia remains dominated by deeply religious and traditional sentiments even among the youth. Thus cosmological ideas and indigenous philosophies could constitute the most natural way of undergirding an ecological discourse which ordinary Ethiopians could "make their own" and genuinely "own".

8 Scholars write that: "During the course of African history, complex economic and technological developments have unleashed unprecedented social and environmental transformation. a generally accepted conclusion is that environmental alienation has contributed to the distortion of local ecosystems and economies, thus denying local communities the right to eke out their living from a productive and healthy environment. The problem is not the often-neglected local dimension of environmental change, but one of impaired society-environmental relations that have simultaneously had an impact on ecosystem and economic sustainability. However, familiar concerns with the non-sustainability of top-down policies imposed on local environmental managers have not gone away. Despite at least three decades of popular participation in local resource management, global conventions and national pledges have not been matched by practice and words are still louder than actions.... Furthermore, the global environmental ethics that have generated tens of thousands of conferences, conventions, treaties, laws and socio-economic instruments are yet to be translated into workable local level environmental interventions," (Salih, 2001: 1&2). In other words, local community involvement in the ecological/climate change discourse is essential, but not facilitated by current policies.

9 In the introduction to his recent encyclical on the environment *Laudato Si', mi' Signore* – "Praise be to You, my Lord", Pope Francis quotes from the beautiful canticle of Saint Francis of Assisi which reminds us that our common home is like a sister with whom we share our life and a beautiful mother who opens her arms to embrace us (Francis, 2015: 1).

10 As noted above, protecting the biosphere could benefit from a certain attitude of "asceticism" i.e. putting the long-term good of mankind above short term economic benefits. Economic progress is largely founded on nature's capacity for production but rarely on resilience and renewal. Dynamic and complex social-ecological systems require strategies that build resilience rather than attempt to exert control for optimal production and short-term gain. "Mustering social innovation and ingenuity for social-ecological transformations away from destructive pathways to sustainable ones creates exciting opportunities for societal development in tune with the biosphere. The renaissance reconnecting human actors to the biosphere links with the realization that

social-ecological systems are dynamic, connected in complex webs of interactions subject to gradual and abrupt changes" (Folke & Gunderson, 2012: 55).

11 Instead of force, a genuine Ethiopian ecological discourse requires ground-roots mobilization. Inspiration can be gained from "life ways [...] indigenous traditions of alternative visions and possibilities that exist among peoples who have imagined themselves more intimately into their worlds" (Grim, 2001: lvi). "Religion is a *sine qua non* of culture [...] [and] nothing can match the paradoxical – both restraining and empowering – potential of religious narratives and their endurance. Re-thinking globalization [means] tackling the inevitable 'revenge of the sacred in the secular culture.' Forging positive globalization is a complex task which involves not just rethinking [...] environmental policies, but enabling [coherent] master narratives" (Witoszek, 2006: 280). Saint John Paul II called for "a global ecological conversion", noting that little effort had been made to "safeguard the moral conditions for an authentic human ecology". His successor Pope Benedict XVI continued that "the deterioration of nature is closely connected to the culture which shapes human coexistence. The misuse of creation begins when we no longer recognize any higher instance than ourselves, when we see nothing else but ourselves" (Francis, 2015: 13).

12 There results a search to locate the possibility of a renewed relationship between the enlightenment concept of reason and the "others" of reason, including faith. "Key ideas like Derrida's deconstruction, Levinas's the 'Saying and the Said', and Irigaray's new ontology point theology towards a critique of autonomy and the search for a yet-to-be-glimpsed new relationship with non-human nature" (Reader, 2004: 221).

13 Ethiopian philosophers such as Massay Kebede emphasize the importance of engaging enlightenment concepts with indigenous thought; religion, as part of culture, mediates between man and his environment to ensure its security (Milton, 1996: 33). Spirituality potentially restores relationship and responsibility. "Environmental ethicists may alert indigenous people to the long-range effects of environmental degradation, although dominant western paradigms isolate humans from nature, exacerbating ecological problems" (Workneh Kelbesa, 2003:63). One answer is to adopt the notion of ethnoscapes: Understanding globalization requires the elaboration of a socio-cultural concept of space and place, recognizing how "religious traditions have long regarded the land itself as a subject with autonomous power and intrinsic value. All religions [express] a foundational code stating that life is a gift that has been given in a cosmic space and in local environments" (Bergman, 2007: 332).

14 An Ethiopian writer on ecological issues states: "The government must involve all development activities, [which should be] generated by the beneficiaries themselves. By bringing ourselves together let us bequeath to our children, our children's children and so on nature's rich legacy, not the bitter lament of poverty and destitution" (Tedla Shibru, 2005: 29).

15 The current Federal Government policy of Ethiopia reflects such ideas, the EPE of 1997 emphasizing the involvement of local communities and indicating the relevance of decentralization of power and collaboration between sectorial interests (FDRE, 1997: 17). Under such circumstances it is particularly important to create an "enabling environment" by mobilizing and motivating the public so that they engage in interlinked and common actions.

16 Yet, the ability to intervene effectively at local level is hampered by ongoing circumstances: "Although, global trends are legitimate areas of enquiry, the obsession with global environmental change has not been matched with equal interest in local environmental change and its consequences on society. Global environmental governance and institutions are still dominated by global economic powers that have found it increasingly difficult to deal with the multitude and varieties of local realities unleashed by global environmental change... hence problem avoidance and the relegation to oblivion of the more problematic parts (local) of the global equation have become common practice. Understandably local communities cannot put their faith in environmental policies and plans imposed on them by global or national institutions that often deprive them of access and control over their local environment, compliance with local norms is more important and more pervasive than compliance with state policies and state norms and values. The gulf between the two tells a story of a mounting tension between state illegitimacy and local self-assertion. [At the same time] duality can easily be transformed into hostility and conflict, without local acceptance, national environmental policies are doomed to failure. The concern for good governance in politics has also not been matched with an equally pressing need for good local governance and institutions capable of carrying out some of the local implementations of global and national environmental policies. [Thus] local communities' institutions and resources management systems [can be regarded as] vehicles for internalizing empowerment, participation and accountability ethos in society," (Salih, 2001:12.)

Ecology and Indigenous Religious Thinking in Ethiopia

17 Traditional religious texts and cultural practices constitute an untapped and disregarded resource for ecological thinking. Despite efforts to involve religious authorities in reforestation campaigns, no attempt has been made to systematically and holistically use indigenous thought to promote i.e. indigenous eco-theologies, or indigenous ecological ethics systems. .... While Ethiopia suffers from critical environmental degradation, "social mechanisms, which negotiate the interests of different groups with the demands [concerning] ecological challenges are critically lacking. Environmental programs will never succeed as long as they are implemented in the context of a structure which the peasants do not experience as their own" (Pausewang, 2002: 9). We need to "recognize the global need to empower, strengthen and build the capacity of indigenous peoples and local communities to equip them with the necessary knowledge they require to meaningfully advocate for their own cause" (WSSD Secretariat, 2008: 29). How can the vision of sustainable development be made attractive? Perhaps "the current, religious revival in non-European countries is a possible ally of positive globalization, [providing] the solid ground [for] reclaiming the humanist project" (Witoszek, 2006: 268).

18 The Ethiopian Churches are engaged in practical ecological projects, yet has given little attention to developing an indigenous ecological theology. Relations with nature figure prominently in the monastic spirituality at the heart of the Ethiopian Orthodox Church; monastic rules prescribe respect for nature and the protection of all living beings within church or monastery precincts. In contrast, modernizing technological society creates an organized, compressed, no longer God-given, rational human construction: "The marginalistion of spatiality in western constructions of nature and reality ultimately feeds into Leibniz' well-known polarization of time over space that dominates Western

world views. [Consequently understanding indigenous cosmologies] moves the theme of space, place and surrounding from the margins to the centre of Eco-Theological studies" (Bergman, 2007: 326). Traditionally Ethiopians emphasize space. Sacred buildings were often hidden in the womb of the earth (like the rock-hewn churches of Lalibela), being built on or into features of the natural environment (Pankhurst, 1972: 17). An important text known as Dirsane Uriel describes the visit of the Holy Family to Ethiopia, and how the Archangel Uriel caught in a chalice of light the blood of Christ and sprinkled it out over the land of Ethiopia, which became the *rist-gult* (the landed property) of Our Lady (Gebre-Selassie Tesfa 1985: 34). Waldebba monastery and other holy places were established along the itinerary of the Holy Family. Locations are known according to their *tabots* (arks of the covenant), which are "planted" and grow organically in the landscape. "Sacred architecture holds the clue to understanding a culture from the inside, assisting in finding the third path, open to nature, culture and the spirit's life-giving artifacts" (Bergman, 2007: 345) see also Taddesse Tamrat 1984: 196 &197.

19 Traditional land distribution (*rist/gult*) was integrated with obligations associated with the continual round of worship and celebration of festivals; divine worship sanctified the cosmic order, bringing fertility and prosperity (Taddesse Tamrat 1984: 197). Dirsane Uriel is recited in churches on the 22nd of every month, and the Archangel Uriel has cosmic significance being associated with the powers of the earth and ecology. The Book of Enoch, preserved in its entirety only in the Ethiopian Apocrypha, features two special themes: the cosmic struggle between good and evil (angels and demons), and the concept of covenant (Murray, 1992: 36). Ethiopians stretch the tenets of their Christianity to include the experience of the surrounding physical world in a particularly "African" manner, filling the space around them with spirits and relating to the environment and country in terms of their concepts of sin and God's covenant of mercy.

20 Orthodox Christians relate to the natural world in a holistic manner, favoring respect and veneration of nature. Both the story of creation and the descent of the Ethiopians from the chosen people of God define and give a sense of stability to the country. Use of the environment is regulated by restrictions about observing holy days, holy grounds and venerated sites (Tsehai Berhanu, 1994: 155). Church grounds within a certain radius are considered holy; even wood or leaves are not cut. The huge grounds of churches and monasteries afford shelter to wild animals and rare monkeys, due to the inherent holiness of the grounds. The spread of churches has thus imposed a symbolism similar to that of the Axum Maryam-Tsion on the whole country. Ethiopia herself is literally considered holy, an environment to be protected, and *tabots* constitute important symbols of social life and activity. Interrelation between the physical environment and God's symbolic presence is reflected in attitudes towards severe climatic conditions. Environmental difficulties are perceived as God's punishment, *egziota* – rainmaking – is an affirmation of the physical inter-relatedness between spirituality, environment and God.

21 Ethiopians are proud of their divinely instituted cultural traditions. Ethiopia preserved a unique, unadulterated and pure African culture, accepting the *hige libuna* – intuitive law or fear of God in the heart (Acts 28:2b) (Dejaney, 1998: 21). We can see in "Ethiopia an exciting example of non-Hellenized Semitic Christianity as well as the manifestation of the peculiar Jewish genius of religious assimilation without degradation, characteristic of the Hebrew Bible" (Heinrich 1991: 179). The Eastern Fathers and ascetics, despite the influence of Hellenic dualism, stayed faithful to the biblical view of the human being as a unity which God radically transcends and can entirely transfigure. An abiding task of the

Eastern Orthodox tradition is maintaining the patristic doctrine of deification (*theosis*), an overarching principle permeating all of Eastern theology and spirituality (Karkkainen, 2001: 45).

Monastic Spirituality (Asceticism) and Ecology

22 Orthodox monasticism is the central institution of the Church, and has consolidated its hold on administrative power. Youth groups, Sunday Schools and vesper preaching programs have popularized monastic spirituality among the laity. Each monastery in Ethiopia has a *kidan* or covenant, mentioned in its deeds of establishment, documenting the special promise given by Christ to its founding saint. Often this includes some tangible proof of sanctity, such as the statement that bodies buried in the holy spot will not decompose (Abune Melketsedek monastery, Northern Shoa). Another common physical proof of sanctity is the presence of healing springs. Churches and monasteries create a sacred topography, making their sacred power accessible to the faithful. Pilgrimage became enormously popular despite repression under Communism; tens of thousands attend the most important pilgrimage festivities such as that at Kulubi Gabriel monastery. The covenant or *kidan* constituted the legitimation or symbolic form maintaining power structures, allowing them to persist and reproduce inter-generationally. Constituting a kind of pact entered into between God and the saint at the completion of his martyrdom or monastic exploits, it expresses divine assistance both in heaven and on earth to those who have made offerings, observed the saint's day, prepared feasts and gone on pilgrimage. The *kidan* was a divine land grant on which the clergy based their claims to spiritual leadership and the economic support of the local population (Taddesse Tamrat, 1984: 196).

23 Ethiopian monasticism is characterized by a type of "liminality", which is associated with nature. The concept of monastic "desert" means something different from the preferred habitat of the temperate highlands; it could be gorges, mountain tops, border areas or disease-ridden lake islands (Bakker, 1990: 44). The decisive factor for Ethiopian monastic topography is the search for the sacred, the River Giyon (Nile) and highland Ethiopia are the primordial landscape, comparable only to the heavenly Jerusalem. Monasteries and churches are part of the sacred landscape, places where the action of a saint or believers' visions enabled the 'discovery' of some aspect of the divine, sealed by a covenant and a source of grace to visitors and inhabitants. Like Irish monks, Ethiopian holy men sought out places where heaven met earth, so that they might inhabit them and draw out their spiritual aura. Consequently, holy places were integrated into the natural milieu. Whereas Greek or Russian monasteries became cities in the desert, Ethiopian monks chose rather to preserve the nature of the wilderness in which they dwelled (Persoon & Jezek, 2014: 44).

24 In certain monasteries such as Waldebba and Zuqwala we have detailed accounts of the struggles endured by the monks to maintain the traditional rule of the monastery and protect the natural environment against intruders. In the case of Waldebba this concerned especially soldiers who during the Communist period wanted to hunt the wild animals and disturb the natural life in other ways. Waldebba is considered "a virgin land for virgins", and consequently no effort was spared to prevent its violation. The monks fasted, prayed and carried sacred books in procession during intercessory prayers. In the case of Zuqwala it was a case of the families of the former laborers of the monastery

demanding increased rights, and disregarding the rules maintaining the fragile ecological balance on the holy mountain. The monks struggled for years to have the rules re-instated and thus to protect both the sanctity of the site and its environmental equilibrium (Persoon, 2005: 209).

25 Immersion in nature was represented by the strong troglodyte tradition in Ethiopia. Numerous pious monks lived in caves, often the sites of miracles. Abuna Habta Maryam (in the gorge beyond Dabra Libanos) is a recent example of a prominent cave monastery. Monastic layout was normally determined by the natural topography of the site and the location of its sacred features. Indigenous materials integrated monasteries into the local topography. The boundaries of Ethiopian monasteries were marked by natural features having ritual significance, such as large rocks, piles of stones or trees. Monastic phenomenology articulates an essential search for unity motivating the religious conscience, reminiscent of the concept of non-duality in Advaita Vedanta (Ganguly, 1995: 2). "Euro-linear values seek to predict and control, in contrast Afro-circular views seek to interpret and understand" (Asante, 1987: 18).

26 In the Orthodox Church matter is not only sanctified, but is used as a means for man's salvation. The monk's path of asceticism and repentance helps contemporary man to transfigure the creation within and around him with an understanding of the Eucharistic use of the world, inspired by the divine liturgy and the life of the saints and to reconciliation of man with the environment (Theoxeni, 1998:71). The circle is an important form in Ethiopian cosmology, reflecting traditional Church architecture and the arrangement of certain monasteries. It reminds us of the monastery's vocation described in founding charters as being a second paradise, the place where the alienation which came with sin is overcome. It suggests the recurring cycle of the liturgical year, with its emphasis on conversion - *metanoia*, and resurrection, (*metanoia means conversion*) the basis of an ecological way of living. The voluntary poverty of the monks in Mahbere Selassie (Persoon, 1997), and their willingness to practice literally a rule forbidding private property, are a sign of embracing asceticism, and calling the wider population to repentance. Likewise, the degradation of the earth reveals a moral dimension, the result of man's sinfulness, our human collective sinfulness. It calls for a response through the challenge to practice voluntary self-divestiture, recalling the great saints and ascetics of early Christianity. This could be described as the need for an eco-asceticism, voluntary self-denial, freeing oneself from the technologies that destroy God's good earth.

Conclusion

27 At a time of widespread religious adherence among the youth of Ethiopia, religious resources need to be harnessed to further ecological aims. The Ethiopian faithful of different persuasions should be mobilized to save their country from an ecological doomsday. Change can be brought forward with a twin strategy, creating new alliances on all the different levels of civil society, and by engaging in different economic projects. The monastic spirituality at the heart of the Ethiopian Orthodox Church is inherently ecological, and has unused potential for the development of indigenous ecological ethics. The ancient practice of pilgrimage could be understood as a ritual encounter with the natural world, and could be used for stimulating ecological awareness. Ethiopian Orthodox youth movements and para-church organizations constitute a network which could be utilized for disseminating ecologically friendly ideas.

28 Meanwhile, at an official level, "climate change research has been suffocated by scientific polemic about its eminence or remote possibility [but] the key answer to this question is to go back to basics in a genuine search for methodologies capable of recognizing the unity of the social and natural world" (Salih, 2001: 216). There has been progress but not without inherent shortcomings. "The post 1991-period has also brought about changes in institutional mechanisms. The most important development is the establishment of the Environmental Protection Authority (EPA) as a Federal Agency. [However] it remains to be seen whether legal instruments without socio-economic incentives, institutional integration and a genuine people's participation, will satisfy the requirement for sustainable development," (Salih & Shibru Tedla, 1999: 39). Environmental and climate change discourse in Ethiopia obviously needs to be reformulated to be effective at local level where it can have the most impact. It needs to reconnect with indigenous ideologies and ways of thinking, and in this respect cosmologies, theologies and above all spirituality have a remarkable potential which we cannot afford to disregard. This facilitates engaging with traditional civil society, and thus bridging the gap between official institutions and the wider public, especially the youth who are important for influencing future generations.

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INDEX

Mots-clés: écologie, religion, christianisme éthiopien, environnement, monachisme
Keywords: ecology, Ethiopian Christianity, environment, monasticism

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