To: students 1ma Geography, 1ma Physical Land Resources

Master thesis topics

*Masterproefonderwerpen*

Prof. Dr. Jan Nyssen

(2017-2018)
1. Topographic rain zones and regional rain shadows related to mountain massifs in the Ethiopian highlands

Promoter: Prof. Jan Nyssen  
Co-Promoter: Prof. Piet Termonia  
Advisors: Dr. Miro Jacob and Etefa Guyassa (UGent Department of Geography)  
Note: Fieldwork in Ethiopia is optional for this master thesis.

In mountainous countries mapping of annual rainfall depth often done using interpolations that involve longitude, latitude and possibly elevation of meteorological stations. Such an approach does not allow to account for dominant wind directions and rain shadow. For instance, in Ethiopia, slope aspect has been demonstrated to be an important explanatory factor of rainfall depth (Nyssen et al., 2005). On rainfall maps at different scales, the major massifs appear to induce topographic rain on the windward side, and rain shadow on the leeward side. For instance it has been demonstrated that the Semien mountains (4560 m) throw a rain shadow on its northern slopes (Puff & Nemomissa, 2001, Fig. 3B) that is believed to extend hundreds of km further to the NNW (Feoli et al., 2002; Deyassa et al. 2014).

Also at local scale relatively minor massifs generate a similar effect. The Dogu’a Tembien massif (photo), under conditions of dominant southwesterlies in the rainy season, generates a topographic rain zone near Abi Adi and Hagere Selam, and less rain (including frequent catastrophic droughts) in the Wukro-Senkata area.

The Dogu’a Tembien massif, seen from the West. Difference in elevation between the lowlands in front and the crestlines is 1200-1400 m.
Topography (left) and annual rainfall (right) in Geba catchment. Wind direction during the rainy season is from the SW. The high rainfall around Abi Adi is thought to be largely of orographic nature, induced by the Dogu’a Tembien massif around Hagere Selam. A rain shadow occurs then in the Senkata-Wukro area (Etefa et al., 2016). Dots are monitoring sites for land cover since the 1930s.

Using station data and the state-of-the-art ALADIN climate model, as well as the expertise available at the RMI, the student will study the annual rainfall distribution in northern Ethiopia in relation to global circulation, orographic forcing, and föhn effects. Inputs will also be provided through an ongoing MSc research on “Rainfall and drought modelling in Ethiopia using the ALADIN model” (Sander Van Vooren, Dept. Geography, UGent).

References
2. Environmental impacts of export crops: mapping the effects of khat (*Catha edulis*) and cut flower production on the water balance in Ethiopia

Promoter: Prof. Jan Nyssen  
Co-Promoter: Dr. Enyew Adgo, Bahir Dar University, Ethiopia  
Local advisor: Etefa Guyassa (UGent Department of Geography, and Mekelle University, Ethiopia)

Note: Fieldwork in Ethiopia is optional for this master thesis.

Khat (*Catha edulis*) is a mild narcotic that is widely produced in Ethiopia for export to countries along the Red Sea and the Gulf of Aden and for local consumption (at high social cost – Teni et al., 2015). It is a permanent crop (bush or small tree), the water consumption of which has been studied (Al-Hebshi & Skaug, 2005; Gebere et al., 2016), but its spatial distribution has never been mapped. Cut flowers, grown under plastic greenhouses, are also a major export product of Ethiopia, and have been blamed for negatively impacting the country’s water resources (Sahle & Potting, 2013; Breu et al., 2016). Yet, it remains to be analysed whether this perception is correct or if the irrigated narcotic is not a much higher water consumer. Mapping spatial distribution of both irrigated export crops, will also contribute to policy decisions concerning such crops.

*Khat plantation near Dire Dawa, Ethiopia (Photo: Simon Roughneen)*

The student will (i) map khat areas and flower greenhouses from Landsat imagery, using GCPs provided by the promoters; (ii) do a literature review on water consumption by both crops; (iii) map water abstraction by both crops; and (iv) calculate the share that is abstracted from Ethiopia’s major rivers by production of these crops in their basins.

The study can be done through desktop analysis. Additional fieldwork in Ethiopia is also possible (GCP recording for both crops; irrigation application rates). See practical fieldwork information, as presented with the other MSc topics for Ethiopia.

**References:**


3. A 3D representation of the late Tertiary clay-with-flint peneplains of E Belgium and N France/SE England: what does it learn us about neotectonics and current valley asymmetries?

Driedimensionele voorstelling van schiervlaktes op vuursteeneluvium in Oost-België, Noord-Frankrijk en Zuidoost Engeland; wat leert het ons over neotektoniek en asymmetrische valleien?

Promoter: Prof. Jan Nyssen

Het voorkomen van vuursteeneluvium is een getuige van schiervlaktes die ontstonden tijdens het Tertiair op kalksteenafzettingen uit het Krijt. Ze komen voor in het Oosten van het land, maar ook in Noord Frankrijk en Zuidoost Engeland. Bij Valkenburg (NL) komt het vuursteeneluvium voor op een hoogte van 150 m, maar een honderdtal km ten Zuiden, zijn er resten van de formatie op de toppen van de Hoge Venen. De schiervlakte zit dus niet meer horizontaal. Aan de hand van geologische kaarten, ondersteund door terreinobservaties zal de student de afzettingen precies in kaart brengen, en daarna een driedimensionele voorstelling van de vlaktes met hun huidige hellingsgradient uitwerken. Dit wordt dan verder gelinkt aan de voorkomende neotektoniek van het Ardens massief. Ook zal de student onderzoeken of de huidige helling van het schiervlak een band vertoont met het mogelijke voorkomen van asymmetrische valleien.

Een voorbeeld:

http://www.hertsgeolsoc.ology.org.uk/IntroToHertsGeology.htm

Voor Zuid-Nederland en Oost-België, zie zeker het werk van Felder en de vele referenties erin, alsook een kaart van het voorkomen van vuursteeneluvium.
4. Reconstruction of the geometry of the ferricrete (Diestiaan ijzerzandsteen) palaeosurface; evidence for a sudden regression related to the Zanclean Event?

Reconstructie van de geometrie van het schiervlak op de Diestiaan ijzerzandsteen; aanwijzingen voor een plotse regressie in verband met de Zancleanse vloed?

Promoter: Prof. Jan Nyssen

De student zal de theorieën van Gullentops (1957) en Vandenberghe et al. (2014) confronteren met de realiteit van het hypervlak doorheen de Diestiaan ijzerzandsteen afzettingen.

Gullentops: “Na het Diestiaan: Zanclean flood → snelle daling van niveau van oceanen → zandbanken onttbloot → precipitatie van Fe onder tropische omstandigheden”

Vandenberghe et al., 2014: “Valleibodems waarin ferricrete precipitatie plaatsvond, en daarna erosie en reliëfinversie”

Aan de hand van geologische kaarten, ondersteund door terreinobservaties zal de student de Diestiaan ijzerzandsteen afzettingen precies in kaart brengen, en daarna een driedimensionele voorstelling van de afzetting met hun huidige hoogteligging uitwerken.

Als dit een horizontaal vlak is of was tijdens de periode van de Zancleanse vloed, is dat een argument dat de theorieën van Gullentops kan bevestigen. Als de geometrie van de afzettingen eerder overeenkomt met een dendrietisch rivierpatroon, pleit dat voor Vandenberghe et al.


5. Scientific communication on soil erosion control to smallholder farmers in developing countries: a meta-study of pathways (oral, written, media), approaches and actors involved

Promoter: Prof. Jan Nyssen
Advisor: Hailemariam Meaza (UGent Department of Geography, and Mekelle University, Ethiopia)

Extension, or distribution of scientific knowledge to the farmers in Africa and Ethiopia in particular, goes through a long formal and structured extension system.

However, over the centuries farmers have shared their knowledge what allowed the spreading of innovations. For instance, the miguemas or shilshalo technique for sorghum leads to strongly improved yields and was developed many centuries ago, and spread all over the Horn of Africa and Yemen (Nyssen et al., 2011). Throughout Ethiopia, when farmers grow sorghum or maize, they use the marasha or ard plough to create contour furrows within the standing crop during the (second) weeding operation (Gebreyesus Brhane et al., 2006). The technique has been documented also in Yemen (Bédoucha, 1986; Varisco, 2004). Besides weeding and plant thinning, the aim of the practice (miguemas in Tigrinya, shilshalo in Amharic and south Tigray; Table 1) is to enhance runoff capture, particularly in semi-arid areas. In our target area, and despite the existence of very heavy rains in August when shilshalo is practiced (Nyssen et al., 2005), the furrows are made along the contour and are slightly curved upwards at both ends of the farmland to enhance the water harvesting effect. In addition, plant physiologists pointed to the sorghum crop root pruning that takes place and which enhances root growth (Blum, 2004; Blum et al., 1977; Rajaram et al., 1991).

![Shilshalo ploughing as practiced on sorghum, some weeks after emergence in the May Zegzeg catchment. In one tillage operation, weeding, thinning and root pruning is done; the furrows also decrease runoff and enhance infiltration.](image)

In Ethiopia, the structural extension system also allowed many advances such as soil and water conservation or improved seed varieties, or milk production. But in the same time it is carried out in a top-down approach, imposing sometimes priorities that are not necessarily the farmer’s priorities, such as fertiliser use when soils are fertile, or when rainfall is uncertain, or biofuel plantations without market.
Jatropha was introduced as a biofuel plant through the extension system in Tigray, Ethiopia. The plants grow vigorously, produce high yields, but there is no factory to process it and no market for it.

Extensionists or Development Agents also try to force results (in order to increase their own chance for promotion) by bartering a package against benefits for the farmers such as work opportunity or food aid (see Segers et al., 2008). Farmers’ days are organised but to what extent do they address only model farmers, and does the information really trickle down to society?

A farmers’ day typically consists of a joint visit of places were innovations were successfully implemented.

Recently, theories have been developed that give much more focus to farmer-to-farmer extension. How and to what extent are such methods really implemented in the field, and what is then the (reduced) role of the scientist and the extensionist? Is farmer-to-farmer only working through oral communication, or is there the necessity of a written support? Could the 17th-20th centuries’ almanacs in Europe stand as an example for written support of agricultural extension (Bollème, 1975; Gaspard, 1986)?

This requires a detailed and thorough literature study contrasting theories and cases, both for ancient and recent spread of innovations in agriculture and land management.

References


6. **Quantification of the water balance and scenarios for water use at historical water mills – case of the Van den Borresmolen in Strijpen (Belgium)**

*Begroting van de waterbalans en scenario’s voor waterbeheer bij historische watermolens – de Van den Borresmolen te Strijpen (België)*

Promoter: Prof. Jan Nyssen
Advisor: Ir. Simon De Boever

Historische watermolens berusten op top-technologie die dateert van het proto-industriële tijdperk. Deze studie zal bijdragen tot het begrijpen van de hydrologische principes die gevolgd werden om het waterverbruik te optimaliseren bij bovenslagmolens bij rivieren met een klein en onregelmatig debiet.

De studie zal uitgevoerd worden bij de nog werkende Van den Borresmolen te Strijpen, “een van de weinige ongeschonden watermolensites in Oost Vlaanderen.”


De situatie rondom de molen: links (de Ferraris, 1771-1778); rechts in 2007 (NGI).

Schema van het hydrologisch systeem rond de Van den Borresmolen (verticale coupe, niet op schaal). Dit zal gebruikt worden om de conceptuele hydrologische balans op te stellen.

Grafisme: Hanne Hendrickx.
Het onderzoek zal bestaan uit het opstellen van een conceptuele hydrologische balans voor verschillende situaties (werkende molen, wateropslag, hoge debietsituatie), en het opmeten van verschillende termen ervan (debieten, neerslag, wateropslag), en modelleren/afleiden van andere (subsurface flow, evapotranspiratie).

Ook zal het effect van verschillende alternatieve scenario’s berekend worden:
- Vergroten van de molenvijver (en dus vergroten van opslagcapaciteit)
- Aanleg van een vistrap (en bypass)
- Bijkomend gebruik van molenvijver als stormbekken (vermindering van opslagcapaciteit)

Het toegepaste nut is het verhogen van groene energieproductie door de watermolen. Voor dit onderzoek is een goede samenwerking opgezet met de molenaar, Ir. Simon De Boever.
7. Regional geomorphology of the Keiwelbach catchment (GDL)

Promoter: Prof. Dr. Jan Nyssen
Co-promoters: Prof. Dr. Eric Cammeraat (UVA Amsterdam); Dr. Christophe Hissler (Centre de Recherche Public - Gabriel Lippmann, Luxembourg)
Advisors: Ing. Jérôme Juilleret (Centre de Recherche Public - Gabriel Lippmann, Luxembourg), Ing. Simone Marx (Ministère de l’Agriculture et de la Viticulture, Luxembourg)

The Keiwelbach catchment (outlet at 49.84944°N, 6.232631°E) in Luxembourg’s Gutland is one of the areas where geomorphological mapping may contribute to the understanding of topography and hydrological response. The catchment is located on Keuper marl and mainly under forest and cultivation land. The soil erosion and hydrological processes in the region have been well studied (Fig. 1 and Fig. 2.)

Table I. (Imeson and Vis, 1984)

<table>
<thead>
<tr>
<th>Year</th>
<th>Precipitation (mm)</th>
<th>Keiwelbach Runoff (mm)</th>
<th>Keiwelbach Suspension (kg ha⁻¹)</th>
<th>Solution kg ha⁻¹</th>
<th>Mosergiecht Runoff (mm)</th>
<th>Mosergiecht Suspension (kg ha⁻¹)</th>
<th>Solution kg ha⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>1978</td>
<td>773</td>
<td>223</td>
<td>299</td>
<td>802</td>
<td>256</td>
<td>1110</td>
<td>1106</td>
</tr>
<tr>
<td>1979</td>
<td>1016</td>
<td>285</td>
<td>376</td>
<td>1014</td>
<td>316</td>
<td>1960</td>
<td>1500</td>
</tr>
<tr>
<td>1980</td>
<td>946</td>
<td>246</td>
<td>347</td>
<td>1023</td>
<td>278</td>
<td>1800</td>
<td>1340</td>
</tr>
</tbody>
</table>

Figure 1. (Cammeraat, 2002)

The hydrological response of the two main subcatchments (Schroedeschaff R. also called Upper Keiwelsbach, and Mosergiecht) is known. High storm runoff coefficients in the forested Upper Keiwellbach subcatchment (Fig. 1 and Table 1) are to be correlated to the clayey nature of the soil under the forest (Imeson and Vis, 1984; Cammeraat 2002). The question remains whether this is due to the impact of soil fauna on forest soils as stated by Cammeraat & Kooijman (2009), or whether it is due to the intrinsic nature of the parent material, as the soil map of the region tends to indicate (Fig. 3). In the latter case, it is assumed that forests would have been maintained in this region because the fluctuating perched water tables made the land not suitable for cropping.

In this and nearby regions, gullies occurring under forest have been related to the presence of the high water table (Imeson & Vis, 1984); yet, the human impact must also be considered. Anecdotal evidence tends to indicate that footpaths, drainage ditches and bridges may also have enhanced runoff concentration. Sediment infill, evidencing a gully cut-and-fill cycle, can
further be observed in a profile pit, pointing to land-use-related changes in geomorphic processes and their rates.

Three profile pits have been opened in the catchment that will allow the student to do the necessary profile descriptions and soil analyses (texture, relevant soil chemical parameters).

In order to provide answers to these research questions, the student will prepare a detailed geomorphological map of the catchment (Degraaff et al., 1987; Gustavsson et al., 2006), in line with the expertise of the physical geography research group (Anrys et al., 2014; Frankl et al., 2010; Poppe et al., 2013). Field observations and a wide set of relevant existing literature will provide the necessary information. Soil types and landforms will be related to lithology, topography and land cover through time.

As the research will be done in cooperation with our Luxembourg colleagues, the thesis will have to contain an extended summary in English or French, or possibly be written in either of these languages.

Fig. 2. (Duijsings, 1987)

![Fig. 2. Detailed sediment budget of the forested Schrondswilerbach catchment over 1979–81. All values are in kg ha⁻¹ yr⁻¹. (Reproduced from Duijsings JIBM, A sediment budget for a forested catchment in Luxembourg and its implications for channel development, Earth Surface Processes and Landforms, 1987, 12: 173–184, by permission of John Wiley & Sons, Ltd.]

Fig. 3. Part of GDL soil map (2010, prepared at 1:25 000). Dark shades: forest.

References
Cammeraat, E. 2002
http://www.geoportal.lu/Portail/

A longer list of references of all earlier geomorphological research in the study area is available.
8. River channel response to land cover changes in the Ethiopian Highlands since the 1930s

Promoter: Prof. dr. J. Nyssen  
Co-promoters: Dr. Sil Lanckriet, Dr. Tesfaalem Gebreyohannes (Mekelle University)

Context
The dynamics of streams, and related flooding, are strongly governed by the characteristics of discharge and sediment supply to their channels which in turn are controlled by the geological, geomorphological, hydrological, climatic and vegetal characteristics of their catchments [1-4]. In contrast to the geological and geomorphological factors, climatic variability and land cover changes were shown to induce changes in stream channels over short timescales in northern Ethiopia [5]. Eleven streams on the western Rift Valley escarpment of Ethiopia have already been studied to understand how mountain streams have reacted to land cover changes over the last eight decades. In the 1970s and 1980s, peak discharge and the size of bed load supply increased. Consequently, stream channels increased in width, straightened and braided. After reforestation starting from 1986, the channels have narrowed, the braided pattern was abandoned in favour of a single thread, and boulder bars and channels were stabilized by vegetation. Hence, it was demonstrated that reforestation of steep mountain catchments can give quick response in reducing discharge and sediment supply to the streams and thereby curb associated flooding calamities [5]. This study by Tesfaalem Ghebreyohannes at Ghent University was the first to use the aerial photographs (APs) of Ethiopia realised in the 1930s. The Italian Military Geographical Institute has photographed large parts of Ethiopia in the 1930s, to prepare and sustain its war activities, and to establish infrastructure in that country [9]. The nearly complete archive of this aerial photography was re-discovered by the promoters in the Ethiopian Mapping Agency (EMA) building in Addis Ababa [9] and is at hand.

The pre-eminent evidence of geomorphic activity in a mountainous landscape that can be retrieved from APs is river morphology. Several researches have shown the strong relationship between changes in vegetation cover of catchments and stream geomorphology. Deforestation-induced increase in sediment supply causes channel widening, bank erosion and increase in flood risk whereas reforestation is associated with reduction in runoff and sediment supply and thereby narrowing channels, stabilization of bars, incision, changes from braided to meandering patterns and new terrace levels [2, 4, 54-59]. In Ethiopia, such phenomena have been described [10, 60] (Fig. 3) and studied in detail by the promoters in a study area along the Rift Valley escarpment [5, 22, 38]. The MSc thesis student will study the changes at a regional scale and in the long term, in contrast to earlier studies that were limited in time or spatial extent.
Fig. 1. Suluh River near May Tiwaru (13.7524°N, 39.5065°E), in 1936 (Italian aerial photograph) and 2014 (Google Earth) [10]. The river channel has widened and gravel bars appeared. Such changes will be quantified along several rivers draining the Ethiopian highlands and correlated to land cover changes. Width of scene: approx. 650 m.

Fig. 2. Confluence of May Zegzeg river (at left) that drains a protected catchment [61, 62] and Tsigaba river (at right) from a catchment with less vegetation cover. The sediment deposits at the confluence (13.6141°N, 39.2263°E) can be clearly linked to the river that drains the unprotected Tsigaba catchment. Image: Google Earth; width of scene: approx. 500 m.
Study methodology

1. Selection of suitable rivers. River channels over the whole study area will be systematically screened for the occurrence of gravel bars, both in the 1930s and currently (Fig. 1; Fig. 2). To be done during the preliminary study, based on screening of the already relocated APs.

2. Mapping changes to river channels. For selected subsets, the current spatial extent will be measured in the field and on APs; similarly channel width will be measured at regular intervals (100 m) using APs. In floodplains, the sinuosity will also be measured for both periods. Temporal changes to these parameters will allow characterising and mapping the changes to stream channel morphology.

3. Interpretation of landscape dynamics. Changes in channel characteristics will be correlated to changes in land use and cover in the upper catchments.

4. Detailed case studies to be carried out for rivers with contrasted bed load (Fig. 2).

References

5. Tesfaalem Gebreyohannes, Mountain stream dynamics as impacted by rainfall variability and land cover change in the western Rift Valley escarpment of northern Ethiopia. PhD thesis. 2015, Ghent: Department of Geography, Ghent University.

FOR FIELDWORK

During the fieldwork, the MSc student will stay in small towns to the S and W of Mekelle; one translator/field assistant will work permanently with him/her.

Some important points for students to consider before declaring an interest:
- The thesis will have to be written in English.
- Fieldwork period: 2 months between early July and late September 2017. This implies that the student needs to make sure he/she will not have to take exams in August/September!
- Environment for the fieldwork: cool tropical climate (June/September is the rainy season), keep in mind that you will work in the mountains; other culture, totally different food, other norms for comfort; often no electricity; telecommunication is difficult; only a few busses per
day; the student will often move on foot (mountains; heavy rains possible in the afternoon). But also: friendly, dynamic people and breathtaking landscapes, and a unique experience.
- Before departure, practical guidelines and information sessions will be provided
- Assistance by promoters during start-up; possibly other UGent Master students will be in the region.
- Profile of the student: should be prepared to live and work with local farmers, technicians and authorities; strong sense of autonomy and adaptability; conversational English.
- For European students, partial funding for the travel costs can possibly be obtained through a “reisbeurs naar ontwikkelingslanden” (deadlines 12 December, or April-May), see http://www.ugent.be/nl/onderzoek/financiering/ontwikkelingssamenwerking/beursmogelijkheden/vlaamsestudenten/vlstudenten.htm#vlaamse-reisbeurzen http://www.vliruos.be/media/6444173/student_oproep_reisbeurzen_2017_finaal.pdf
If you have practical queries about living and working in Ethiopia, you may want to get in touch with students or researchers who recently did their thesis in Northern Ethiopia:
- Dr. Sil Lanckriet (sil.lanckriet@ugent.be)
- Dr. Amaury Frankl (amaury.frankl@ugent.be)
- Hanne Hendrickx (hanne.hendrickx@ugent.be)
- Sofie Annys (Sofie.Annys@ugent.be)
- Dr. Miro Jacob (miro.jacob@ugent.be)
Your local counterpart will be Dr. Tesfaalem Gebreyohannes tesfitga@gmail.com
9. The impacts of flash floods of dryland rivers on agricultural systems in the Raya graben (Ethiopia)

Promoter: Prof. dr. J. Nyssen
Co-promoter: Dr. Biadgilgn Demissie (Mekelle University)
Advisor: Hailemariam Meaza (UGent Department of Geography, and Mekelle University)

Introduction
Despite widespread problems of water scarcity, one of the main consequences of climate change is an increase in global incidences of intense precipitation events, in return causing an increased and intense flooding including in the arid and semi-arid regions of the world (Trenberth et al., 2007; Kundzewicz and Kaczmarek, 2000). Arid and semi-arid regions are particularly vulnerable to this change in climate. Additionally, the highly nonlinear and flashy nature of the runoff in these dry regions makes predictions of the impact on agricultural systems difficult. Extreme rainfall events and the resulting floods usually could cause significant damage to agriculture, ecology and infrastructure, disruption to human activities, injuries and loss of lives.

There is high recurrence of flood events in the marginal grabens of the Ethiopian Rift Valley which are the main causes of agricultural failures and land loss, and life and housing loss. Scientific information about the nature of flood risks on agricultural land and life are important for proper planning of land use/cover in the study area. But less attention is given to the impacts the flashy floods are inflicting in the farming systems and other land use/cover in the graben floor. The purpose of this MSc thesis is therefore to assess and analyze the impacts that these flashy floods are imposing on the agricultural activities, land use/cover and settlement in the graben floor.

Objectives
The general objective of this MSc research is to investigate the impacts of the flash floods of the braided rivers in Raya Graben on the farming activities, land use/cover and settlement. The specific objectives are: (i) analyze the vegetation biomass change of the crops around the rivers, (ii) analyze the land use/cover changes around the rivers, and (iii) quantify the changes in biomass and land uses/cover and estimate the productivity

Methodology
The impacts of the flashy floods on agricultural production can be quantified and mapped using satellite images and aerial photos. The Landsat imageries and/or MODIS NDVI will be used to see the changes in biomass and estimate the productivity of the farmlands along/around the braided rivers. High and/or medium resolution imageries will be used to detect the changes in land use/cover around the braided rivers. The remote sensing methods can be supported with interviews, focus group discussions with the peasants and terrestrial photographs for qualitative analysis and ground truthing. As per the need some documents related to production in the study area will also be collected from the agricultural offices in the study area. For data organization and analysis, GIS and RS software can be used (such as ArcGIS10, ERDAS Imagine 9.1, IDRISI Selva, ILWIS and ENVI).

Expected output
The outputs of the MSc research will be quantified results and maps of the changes in the productivity of the farmlands. This will give insight into how the flashy dry land rivers are imposing impacts on the productivity of the farming systems in the graben floor.
Figure 1: Images of the study area showing how the rivers are braided (upper) and their impacts on farmlands and other land uses/covers (lower).

References and recommended readings
FOR FIELDWORK

During the fieldwork, the MSc student will stay in Alamata, Meholi and/or Kobo towns or villages around them; one translator/field assistant will work permanently with him/her.

Some important points for students to consider before declaring an interest:
- The thesis will have to contain an extended summary in English or possibly be written in English.
- Fieldwork period: 2 months between early July and late September 2017. This implies that the student needs to make sure he/she will not have to take exams in August/September!
- Environment for the fieldwork: cool tropical climate (June/September is the rainy season), keep in mind that you will work in the mountains; other culture, totally different food, other norms for comfort; often no electricity; telecommunication is difficult; only a few busses per day; the student will often move on foot (relatively level terrain, sometimes long distances; heavy rains possible in the afternoon). But also: friendly, dynamic people and breathtaking landscapes, and a unique experience.
- Before departure, practical guidelines and information sessions will be provided
- Biadgilgn Demissie will help you starting up; possibly other Belgian Master students will be in the region.
- Profile of the student: should be prepared to live and work with local farmers, technicians and authorities; strong sense of autonomy and adaptability; conversational English.
- For European students, partial funding for the travel costs can possibly be obtained through a “reisbeurs naar ontwikkelingslanden” (deadlines 12 December, or April-May), see http://www.ugent.be/nl/onderzoek/financiering/ontwikkelingssamenwerking/beursmogelijkheden/laamsestudenten/vlstudenten.html#vlaamse-reisbeurzen

If you have practical queries about living and working in Ethiopia, you may want to get in touch with students or researchers who recently did their thesis in Northern Ethiopia:
- Dr. Sil Lanckriet (sil.lanckriet@ugent.be)
- Dr. Amaury Frankl (amaury.frankl@ugent.be)
- Hanne Hendrickx (hanne.hendrickx@ugent.be)
- Sofie Annys (Sofie.Annys@ugent.be)
- Dr. Miro Jacob (miro.jacob@ugent.be)

Your local counterpart will be Dr. Biadgilgn Demissie (Biadgilgn.Demissie@Ugent.be)
10. Land use changes since the 1930s in Tigray, Ethiopia, using a unique set of aerial and terrestrial photographs

Promoters: Prof. Jan Nyssen, Dr. Amaury Frankl (UGent)
Local advisor: Etefa Guyassa (UGent, Vakgroep Geografie; Mekelle University, Ethiopia)

UGent’s department of Geography is in possession of a unique photographic dataset concerning the northern part of Ethiopia, what will allow to do land use change studies.

**Fig. 1.** An example of a set of four photographs comprising – from left to right – high oblique; low oblique; near-vertical; and low oblique exposures in a fan configuration covering an area east of Quiha in Northern Ethiopia. Date: 1935-12-16; Photo number Mai Dolo 11-2-37; centre of the vertical photo at 13.46574°N, 39.59906°E. © EMA. Width of the conformably oriented fan configuration is 36 cm on hardboard tile and 6.24 km on the terrain. Permanent farmland boundaries are clearly visible, as well as bushland that occupies structurally determined scarps. Bright dots correspond to threshing floors. (Nyssen et al., 2016)

1. Aerial photographs
The aerial photographs (APs) acquired in the period of the Italian occupation of Ethiopia (1935-1941) have recently been discovered, scanned and organised (REF phot rec). In total, the archive comprises approximately 34,000 individual photographs, made up of 8281 discrete assemblages, each comprising four adjacent photographs. An individual group or set of four photographs comprises a vertical (nadir-pointing) photograph, flanked by two low-oblique photographs and a single high-oblique photograph, which is present alternatively at left and right (Fig. 1). All four photographs had been exposed simultaneously in a fan configuration in the cross-track direction (perpendicular to the flight line) to ensure the widest possible angular coverage of the terrain. The vertical and oblique photographs of each successive set of four photographs overlap on the previous set by approximately 60% in the along-track direction, to ensure stereo-coverage of the terrain. The format size of each individual photograph in the archive is 10 cm x 15 cm, though many oblique photographs were slightly cropped on their borders to minimise the seam with the nadir-pointing photographs. All the photographs in the archive have been transformed into digital form at the EMA offices in Addis Ababa using a Plustek A3 scanner (Optic Pro A320) with a resolution of 600 dpi (Nyssen et al., 2016). Moreover, the scanned photographs have been carefully organised into a searchable inventory (Fig. 2).

Up-to-date technology needs to be used for restitution of the imagery, particularly orthorectification. Especially the vertical and low oblique photographs in the sets are of prime value for the construction of orthophotographs of Ethiopia in the early 20th Century.
Using image-based modelling software with Structure from Motion and MultiView Stereo (SfM-MVS) procedures implemented, workflows for development of such ortho-mosaics have been developed (Frankl et al., 2014), although the high oblique photographs appeared unsuitable for sake of insufficient overlap. As the archive consists of both oblique and vertical aerial photographs, covering areas of approx. 4 km², methods of image-based modelling can be used for the ortho-rectification. An example of the 1936 ortho-mosaic can be accessed here: http://geoweb.ugent.be/download/physical-geography/research/environment-ethiopia/Suluh.kmz

More recent aerial photographs (1964, 1994), as well as highly detailed recent Google Maps imagery are also at hand.

Fig. 2. Location of 1987 relocated aerial photographs of the late 1930s, on 48 different flight lines. Each dot represents the centre of the vertical photograph within an assemblage of four photographs. The study area is located in the Northern highlands, (Nyssen et al., 2016)

2. Terrestrial photographs

Observational studies of land cover in Ethiopia date to the 1960s at the earliest, the age of the oldest available aerial photographs. The recent rediscovery of large sets of historical terrestrial photographs (Nyssen et al., 2010) allows for this research to now extend back to in time. To date, these historical photographs have been used to study certain time periods, based on interpretation of land used changes observed on the photos (Nyssen et al., 2008, 2009, 2014). This study intends to go a step further.

Particularly, a large set of repeated ground photographs, representing the Ethiopian landscapes at the time of Italian occupation, are available (Fig. 3).

Methodology

The study will consist of a land use change study since the 1930s, in which the interpretation of the historical aerial photographs will be enhanced by ground truthing using the terrestrial photographs. A study area will be selected where there is a dense coverage of historical terrestrial photographs. The study will comprise the following activities

- Ground truthing of ancient land uses, using terrestrial photographs, in line with methods developed by Meire et al. (2013) and de Műelenaere et al. (2014)
- Field observations and interviews allowing to understand and map drivers for the changes
- Preparation of orthomosaics based on the historical aerial photographs, following the method of Frankl et al. (2014)
- LUC change interpretation, mapping and analysis

Fig. 3 Example of one of the many repeated photographs, with interpretation: The remnant Juniperus trees in the late 1930s are evidence of a vegetation optimum. In the period thereafter, nearly all of the woody vegetation in the undulating lands in the foreground was cleared and farmlands were established, including strip lynchets. On the scree slopes at the foot of the escarpment, the tree cover was approximately the same in both years, and the far mountains were reforested in the 1980s as mixed Juniperus-Eucalyptus forests. Although the entire area was open-access in the 1930s, the land use system has since been reorganized with clearly demarcated crop and forest lands. Archival photograph © G. Merla; 2009 photograph © J. Nyssen. (Nyssen et al., 2014)

References
FOR FIELDWORK
During the fieldwork, the MSc student will stay in villages around Mekelle, and particularly in rural areas within Tigray; one translator/field assistant will work permanently with him/her. Some important points for students to consider before declaring an interest:
- The thesis will have to contain an extended summary in English or possibly be written in English.
- Fieldwork period: 2 months between early July and late September 2017. This implies that the student needs to make sure he/she will not have to take exams in August/September!
- Environment for the fieldwork: cool tropical climate (June/September is the rainy season), keep in mind that you will work in the mountains; other culture, totally different food, other norms for comfort; often no electricity; telecommunication is difficult; only a few busses per day; the student will often move on foot (mountains; heavy rains possible in the afternoon). But also: friendly, dynamic people and breathtaking landscapes, and a unique experience.
- Before departure, practical guidelines and information sessions will be provided
- One experienced UGent researcher will help you starting up; possibly other Belgian Master students will be in the region.
- Profile of the student: should be prepared to live and work with local farmers, technicians and authorities; strong sense of autonomy and adaptability; conversational English.
- For European students, partial funding for the travel costs can possibly be obtained through a “reisbeurs naar ontwikkelingslanden” (deadlines 12 December, or April-May), see http://www.ugent.be/nl/onderzoek/financiering/ontwikkelingssamenwerking/beursmogelijkheden/vlaamsestudenten/vlstudenten.htm#vlaamse-reisbeurzen

If you have practical queries about living and working in Ethiopia, you may want to get in touch with students or researchers who recently did their thesis in Northern Ethiopia:
- Dr. Sil Lanckriet (sil.lanckriet@ugent.be)
- Dr. Amaury Frankl (amaury.frankl@ugent.be)
- Hanne Hendrickx (hanne.hendrickx@ugent.be)
- Sofie Annys (Sofie.Annys@ugent.be)
- Dr. Miro Jacob (miro.jacob@ugent.be)

Your local counterpart will be MSc. Etefa Guyassa EtefaGuyassa.Dinssa@UGent.be
11. Mapping and characterization of gullies with and without check dams using remote sensing and ground survey, Northern Ethiopia

Promoter: Prof. Dr. Jan Nyssen
Coach: MSc Etefa Guyassa (Mekelle University and Ghent University)

Gully formation is the indication of extreme land degradation processes resulted from different human activities especially associated to agricultural expansion and lack of sustainable land management. Gullies have various on-site and off-site environmental and social impacts. Studies on gully dynamics have indicated that the development of gullies increased in Northern Ethiopia during the second half of 20th century. But implementation of extensive land management interventions started since late 20th century in the region, what has decreased the rate of gully developments. Check dam is one of the major soil and water conservation techniques used in areas where gully formation is a problem. This technology is believed to have significant effects on gully stabilization. The construction of check dams in gullies affects the hydrological behaviour of catchments by changing the characteristics of gullies such as channel bed roughness/cover, slope gradient, and width. Despite their widespread implementation the effects of check dams on the water balance at catchment scale are not well understood. This requires the knowledge of the density of check dams and their impact on the roughness and other characteristics of gullies. Hence, quantification, mapping and characterization of check dams is required to evaluate the effects of check dams on runoff in gullies and catchment hydrological behaviour which will further help to design appropriate developmental schemes such as dam construction. The objectives of this study are (1) mapping the gullies with and without check dams in Geba catchment; (2) characterization of selected gullies with and without check dam; (3) extrapolation of the hydrological effects measured in a few gullies to the wider catchment.

Methodology: Check dams constructed in gullies will be detected by using high resolution satellite image supplemented by ground survey. Then selected gullies will be characterized for the roughness, vegetation cover, soil, sedimentation, lithology, slope, cross-section, check dam type, age, standards and maintenance. Hydrological models will be applied to calculate the effect of the dams at catchment and subbasin scale (approx. 10-1000 km²).

Current expertise of the promoters with regard to gully systems in the study area


FOR FIELDWORK

During the fieldwork, the MSc student will stay in the market town Hagere Selam; one translator/field assistant will work permanently with him/her.

Some important points for students to consider before declaring an interest:

- The thesis will have to be written in English.
- Fieldwork period: 2 months between early July and late September 2017. This implies that the student needs to make sure he/she will not have to take exams in August/September!
- Environment for the fieldwork: cool tropical climate (June/September is the rainy season), keep in mind that you will work in the mountains; other culture, totally different food, other norms for comfort; often no electricity; telecommunication is difficult; only a few busses per day; the student will often move on foot (mountains; heavy rains possible in the afternoon). But also: friendly, dynamic people and breathtaking landscapes, and a unique experience.
- Before departure, practical guidelines and information sessions will be provided
- Assistance by promoters during start-up; possibly other UGent Master students will be in the region.
- Profile of the student: should be prepared to live and work with local farmers, technicians and authorities; strong sense of autonomy and adaptability; conversational English.
- For European students, partial funding for the travel costs can possibly be obtained through a “reisbeurs naar ontwikkelingslanden” (deadlines 12 December, or April-May), see http://www.ugent.be/nl/onderzoek/financiering/ontwikkelingssamenwerking/beursmogelijkheden/vlaamsestudenten/vlstudenten.htm#vlaamse-reisbeurzen

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- Sofie Annys (Sofie.Annys@ugent.be)
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Your local counterpart will be MSc Etefa Guyassa EtefaGuyassa.Dinssa@UGent.be
12. Hydrological balance of forests on a foggy escarpment along Ethiopia’s Rift Valley

Promoters: Prof. Dr. Jan Nyssen, Dr. Amaury Frankl
Coach: MSc Hailemariam Meaza (Mekelle University and Ghent University), MSc Sofie Annys (Department of Geography, Ghent University).

The western escarpment of the Ethiopian Rift Valley is subject to eastern air circulations during winter and spring small rainy season. Forced ascendance of air masses provokes condensation, cloud formation and possibly rain. Much precipitation is however generated by the occurrence of beard lichen on trees, particularly on Juniperus procera. “Generally, the rainfall along this part of the Rift Valley is marginal for the growth of true forest, but similar to the Afromontane forests in the Bale and Simien mountains, fairly large quantities of moisture are collected by the forest by trapping clouds or mists which frequently build up along the escarpment. Epiphytic plants typical for cloud forests such as old man’s-beard lichen (Usnea spp.) and orchids (for example Polystachya benettiana) can still be found in the forests” (Aerts et al., 2006). Also in the main rainy season the bearded lichen have been observed to generate continuous dripping under the trees.

In other places, the forests have been removed, or replaced with plantations of exotics such as Eucalyptus sp., or Cupressus lusitanica.

The dominant woody vegetation cover along the escarpment was already mapped in detail by Annys et al. (2016).

The student will study the spatial distribution of Usnea spp. in relation to the distribution of its host trees, and measure the precipitation (direct rainfall, throughfall, trapped mist), and possibly stemflow, in several forests along the escarpment of the Ethiopian Rift Valley between Maychew and Alamata (Tigray, Northern Ethiopia), in line with procedures that have already been implemented in the Ethiopian highlands (Obsu et al., 2016). Before and after the student’s fieldwork period, additional data will be collected by local workers in his/her absence.

Partitioned rainfall will then be mapped, as well as its contribution to the water balance of different ecotones.
Woody vegetation cover at dominant species level in the study area in 2014 (Annys et al., 2016). The map exists at high resolution and will be availed to the student.

A manual rain gauge to measure throughfall in a forest in Ethiopia (Obsu et al., 2016). Dozens of such plastic bottles will be used per site.

References


**FOR FIELDWORK**
During the fieldwork, the MSc student will stay in the towns of Korem and Alamata; one translator/field assistant will work permanently with him/her.

Some important points for students to consider before declaring an interest:
- The thesis will have to be written in English.
- Fieldwork period: 2 months between early July and late September 2017. This implies that the student needs to make sure he/she will not have to take exams in August/September!
- Environment for the fieldwork: cool tropical climate (June/September is the rainy season), keep in mind that you will work in the mountains; other culture, totally different food, other norms for comfort; often no electricity; telecommunication is difficult; only a few busses per day; the student will often move on foot (mountains; heavy rains possible in the afternoon). But also: friendly, dynamic people and breathtaking landscapes, and a unique experience.
- Before departure, practical guidelines and information sessions will be provided
- Assistance by promoters during start-up; possibly other UGent Master students will be in the region.
- Profile of the student: should be prepared to live and work with local farmers, technicians and authorities; strong sense of autonomy and adaptability; conversational English.
- For European students, partial funding for the travel costs can possibly be obtained through a “reisbeurs naar ontwikkelingslanden” (deadlines 12 December, or April-May), see http://www.ugent.be/nl/onderzoek/financiering/ontwikkelingssamenwerking/beursmogelijkhedenvlaamsestudenten/vlstudenten.htm#vlaamse-reisbeurzen

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- Sofie Annys (Sofie.Annys@ugent.be)
- Dr. Miro Jacob (miro.jacob@ugent.be)

Your local counterpart will be MSc Hailemariam Meaza HailemariamMeaza.Gebregergs@UGent.be
13. Contemporary and historical rates of floodplain sedimentation in Lake Tana basin (Ethiopia)

Promoter: Prof. Dr. Jan Nyssen
Coach: MSc Hanibal Lemma (Bahir Dar University and Ghent University)

Introduction
In the Lake Tana Basin (LTB), extensive lacustrine plains were created when the Lake Tana reached its maximum extent (Poppe et al., 2013; Vijverberg et al., 2009). Terraces and river deltas in the basin suggest that the lake extent decreased; the current lake area is 3074 km² as compared to the ancient extent of 6514 km² (Poppe et al., 2013; Rzó ska, 1976). However, parts of these lacustrine plains (once it was the bed of Lake Tana) adjacent to the rivers and the lake are subjected to periodic flooding and sediment deposition, and form a wide area of floodplains. Those floodplains can buffer the transport of sediment as it is mobilized from the upstream parts of the catchment. Sedimentation on the river floodplains during overbank floods can result in significant reduction of the suspended sediment load transported by a river and can thus represent an important component of the catchment sediment budget (Walling & Owens, 2003). The storage effects of floodplains may, therefore, complicate the interpretation of downstream sediment yields in terms of upstream sediment mobilization by attenuating the record of sediment delivery from hillslopes and sediment transfers within the upstream drainage basin (Walling et al., 1998).

Although it is generally recognized that floodplain systems may provide an important sink for suspended sediment during periods of inundation, this role has attracted little attention in previous sediment budget studies in LTB (Maes, 2012; Engida, 2010; SMEC, 2008). However, Hanibal et al. (2015) estimated that the conveyance losses associated with overbank deposition over the floodplains was on average 32% of the total sediment from the upstream hilly catchment.

Floods and sedimentation along the Gumara floodplain in LTB

Understanding the significance of floodplain conveyance losses to sediment budget is important if sediment yield data are to be used to interpret on-site rates of soil loss and the implementation of soil conservation measures is to be meaningfully assessed (Walling et al., 2001). Hence, the main purpose of the study is to quantify rate of floodplain deposition in order to understand the process associated with the delivery of fine sediment through the catchment system.
Methodology
Field measurements of water and sediment discharge will be combined to estimate rates of transport and the fate of water and sediment along the river reach.
- Monitoring SSC during peak flood events as well as along the river reach
- Floor tiles as sediment trap in different land uses and different locations perpendicularly to the river
- Use of radionuclides ($^{137}$Cs or $^{210}$Pb) and study of anthropogenic soil horizons (around residence area) to assess historical deposition

References

FOR FIELDWORK
During the fieldwork, the MSc student will stay in Bahir Dar and small towns such as Woreta or Wanzaye; one translator/field assistant will work permanently with him/her. Some important points for students to consider before declaring an interest:
- The thesis will have to be written in English.
- Fieldwork period: 2 months between early July and late September 2017. This implies that the student needs to make sure he/she will not have to take exams in August/September!
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- Sofie Annys (Sofie.Annys@ugent.be)
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14. Gully erosion rates and efficiency of gully control measures worldwide

Promoters: Dr. Amaury Frankl and Prof. Dr. Jan Nyssen

“Physical Land Resources” students are invited to carry out research on topics of gully erosion rates and efficiency of gully control measures in their home country; it a main expertise of the Physical Geography research group.

Depending on the conditions in your country, an appropriate topic will be developed in agreement with the promoters.

See some examples of publications based on previous master thesis research:


