# In search of sustainable catchments and basin-wide solidarities in the Blue Nile river basin

*A collaborative research programme of:*

- UNESCO-IHE Institute for Water Education
- Addis Ababa University
- University of Khartoum
- VU Amsterdam
- International Water Management Institute IWMI

*in collaboration with:*

- Ministry of Water Resources and Electricity, Sudan
- Ministry of Water and Energy, Ethiopia
- Eastern Nile Technical Regional Office ENTRO – NBI

*Project leaders:*

Pieter van der Zaag (UNESCO-IHE)
Belay Simane (Addis Ababa University)

Delft, 10 December 2013

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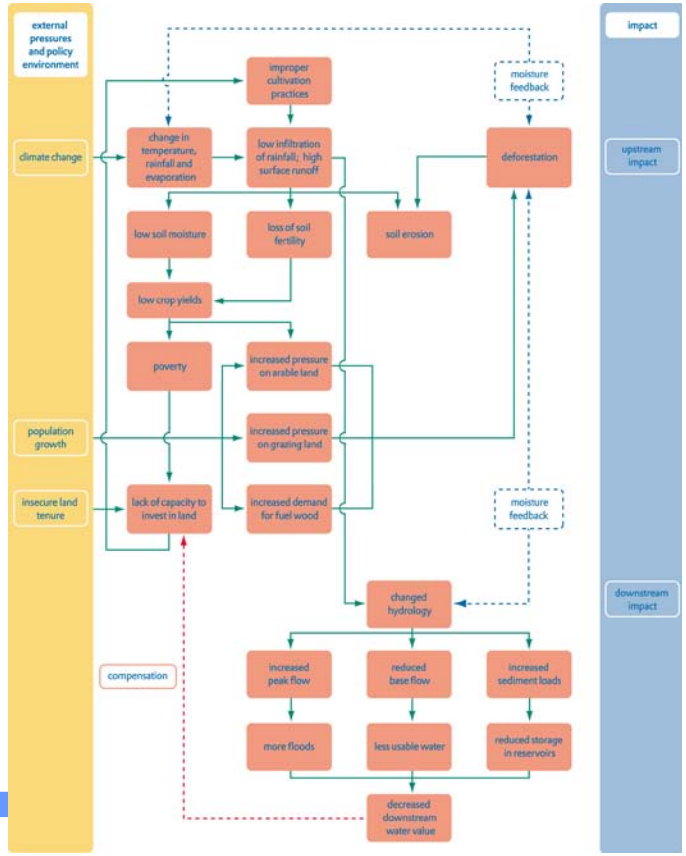
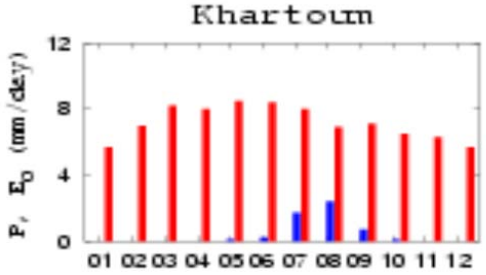
# In search of sustainable catchments and basin-wide solidarities in the Blue Nile river basin

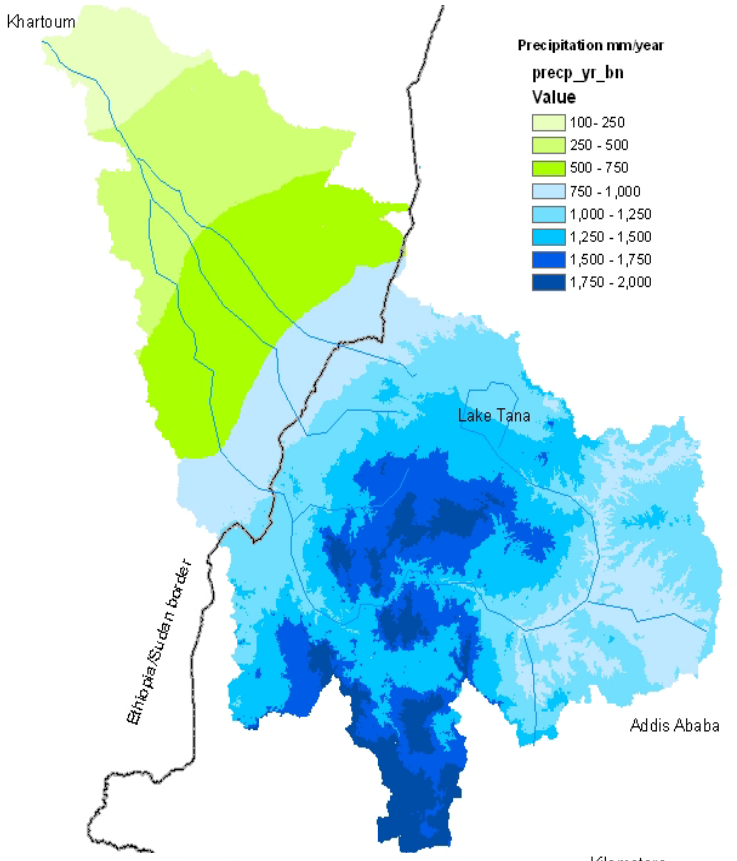
*Overall scientific objective*

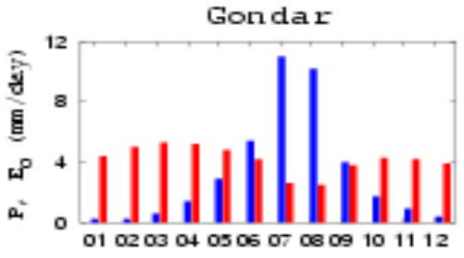
To quantify the environmental as well as socio-economic impacts of improved food security and livelihoods interventions on upstream catchments, and assess the downstream hydrological implications,

and to investigate how this knowledge can be used as a basis for sustainable and integrated basin management, taking the transboundary Abbay/Blue Nile river basin as a case

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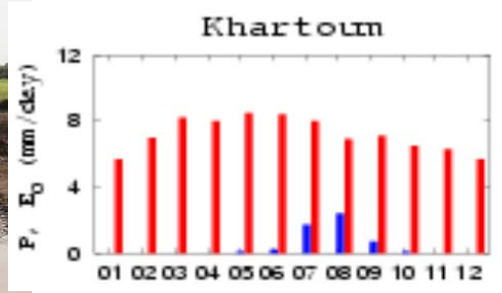


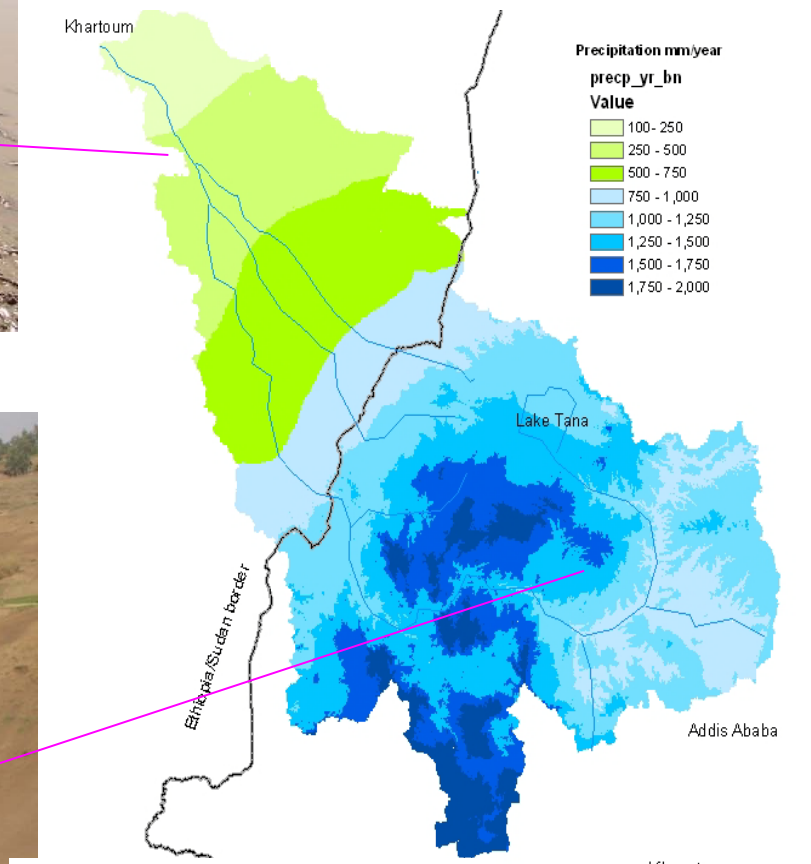


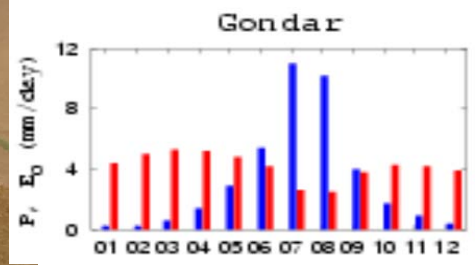


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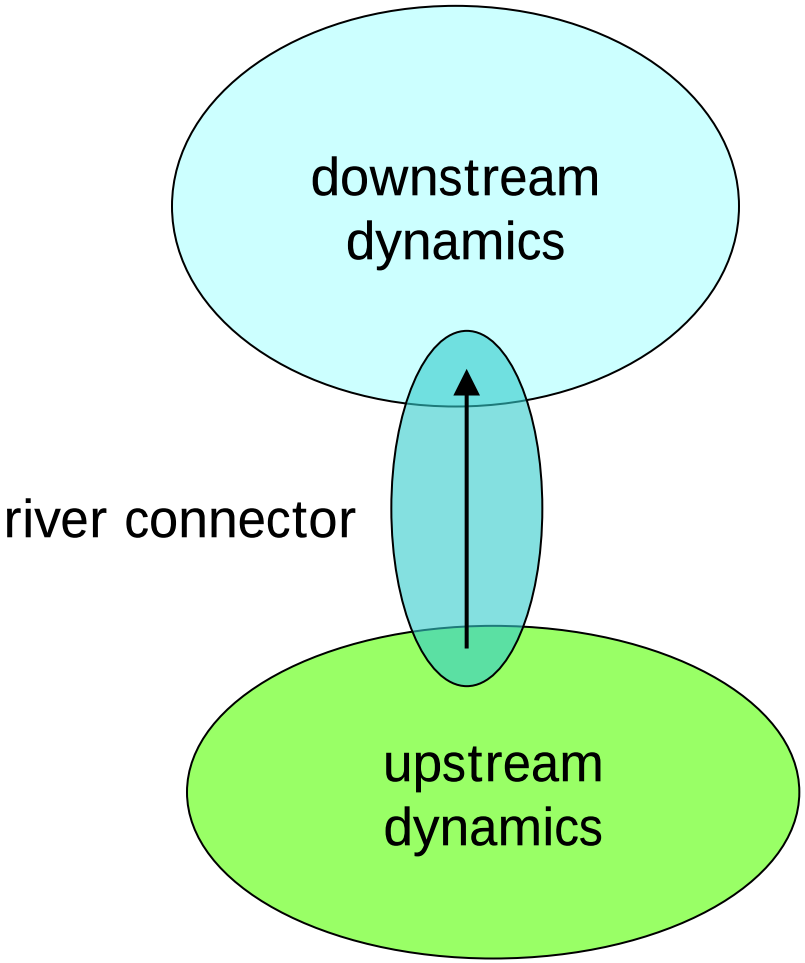
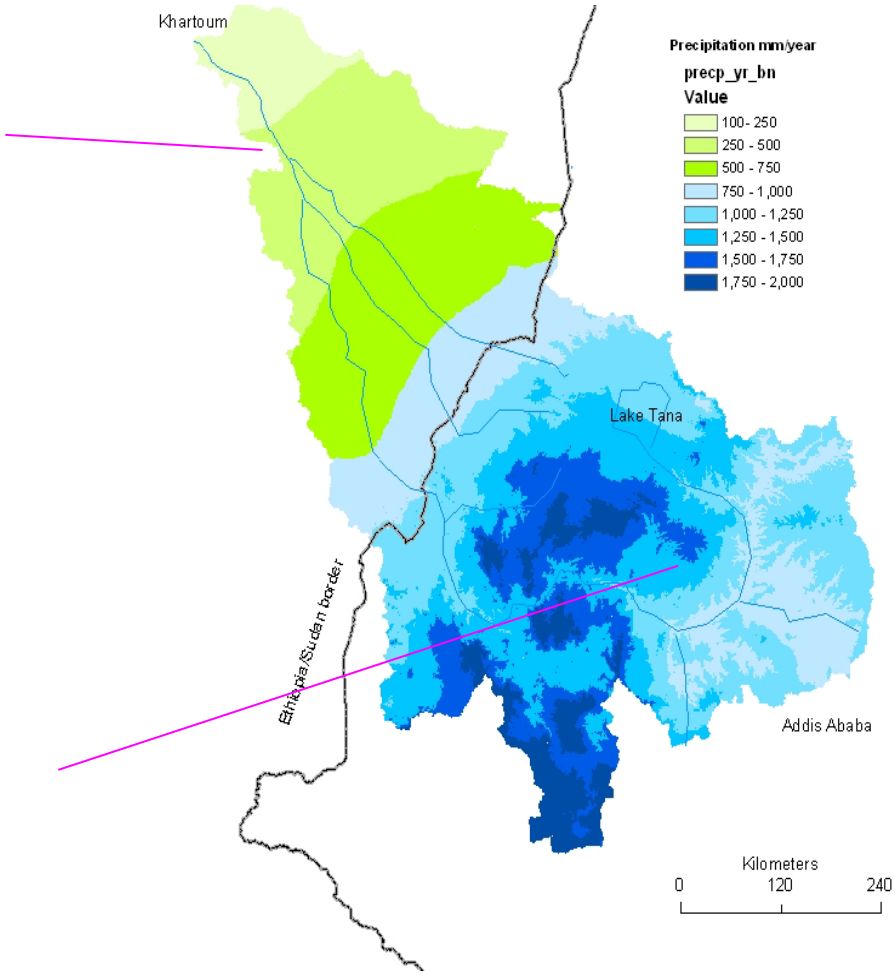

downstream dynamics
river connector
upstream dynamics


Khartoum
Lake Tana
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Ethiopia/Sudan border
Precipitation mm/year
precp_yr_bn
Value
100 - 250
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120
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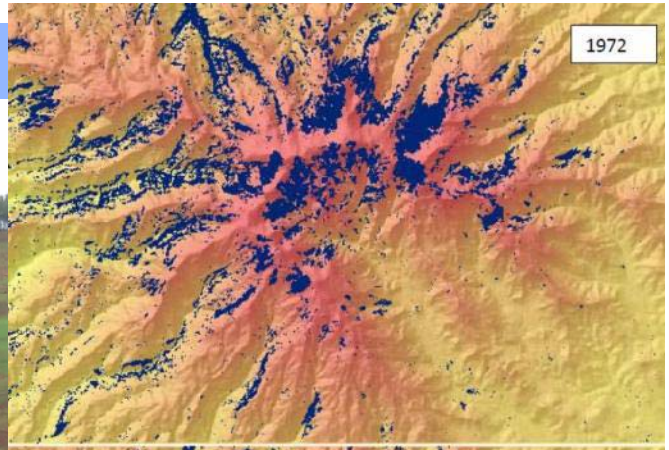
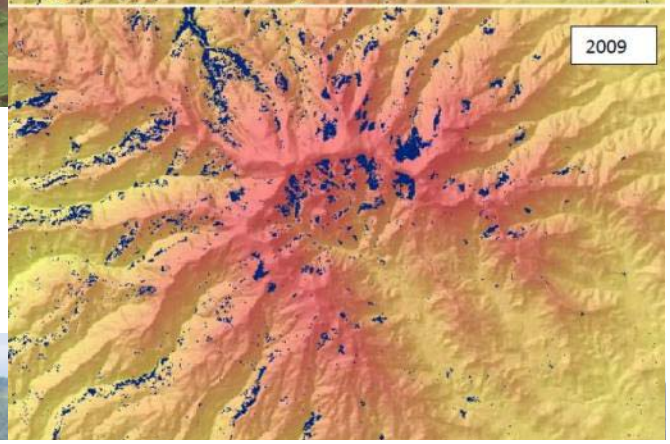
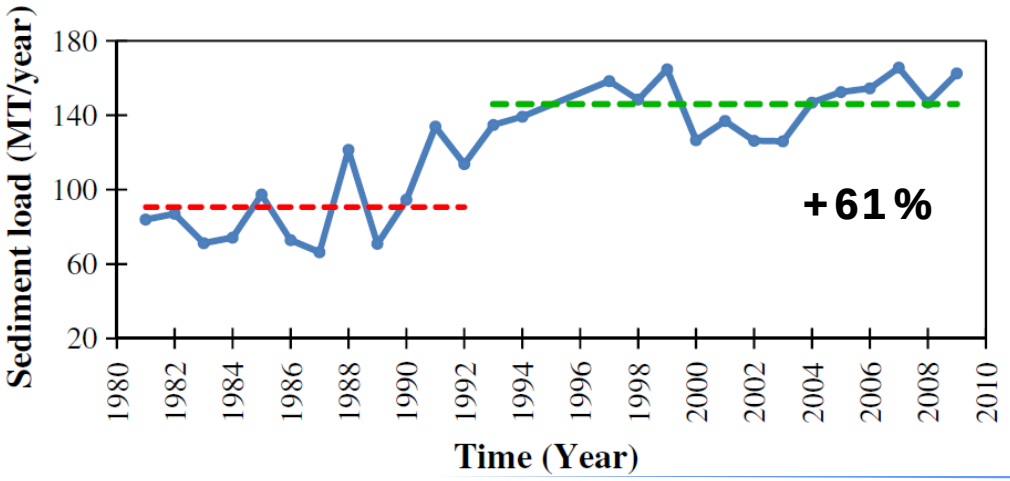


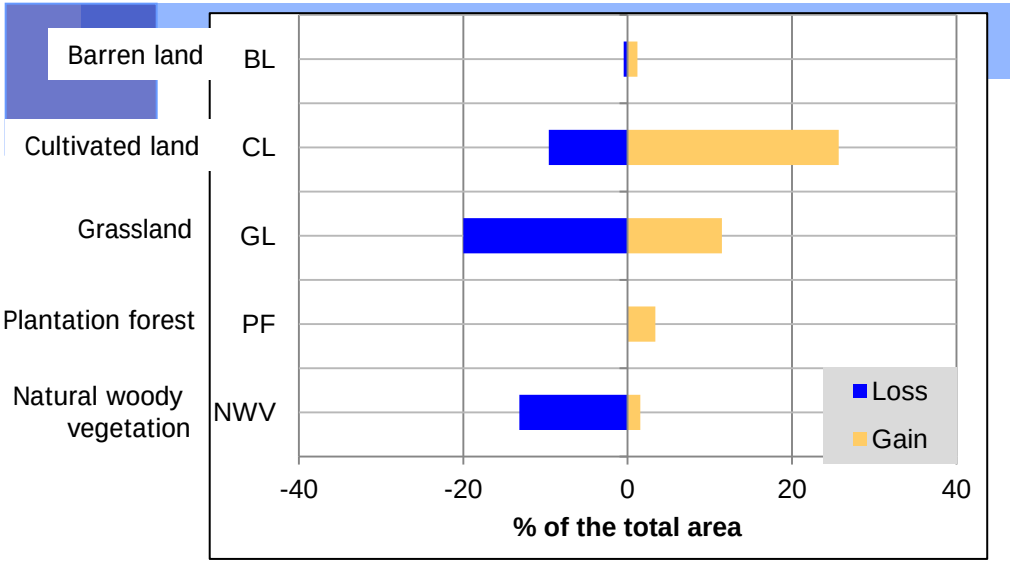




30% natural forest loss 1972-2009

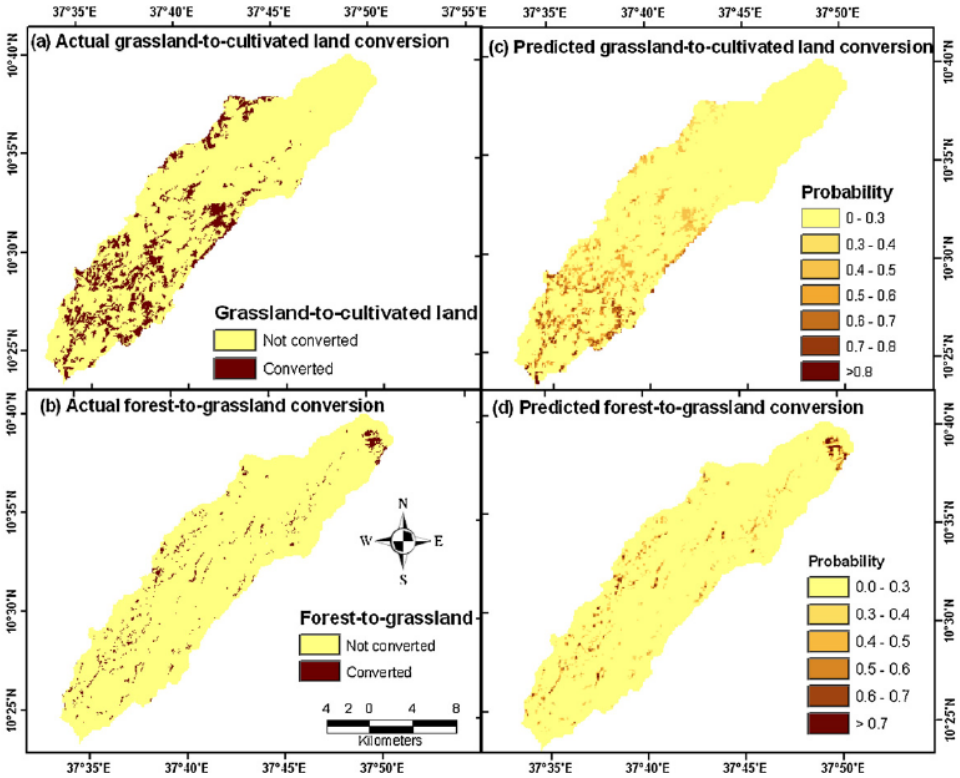
Source: Teferi & Simane, 2011

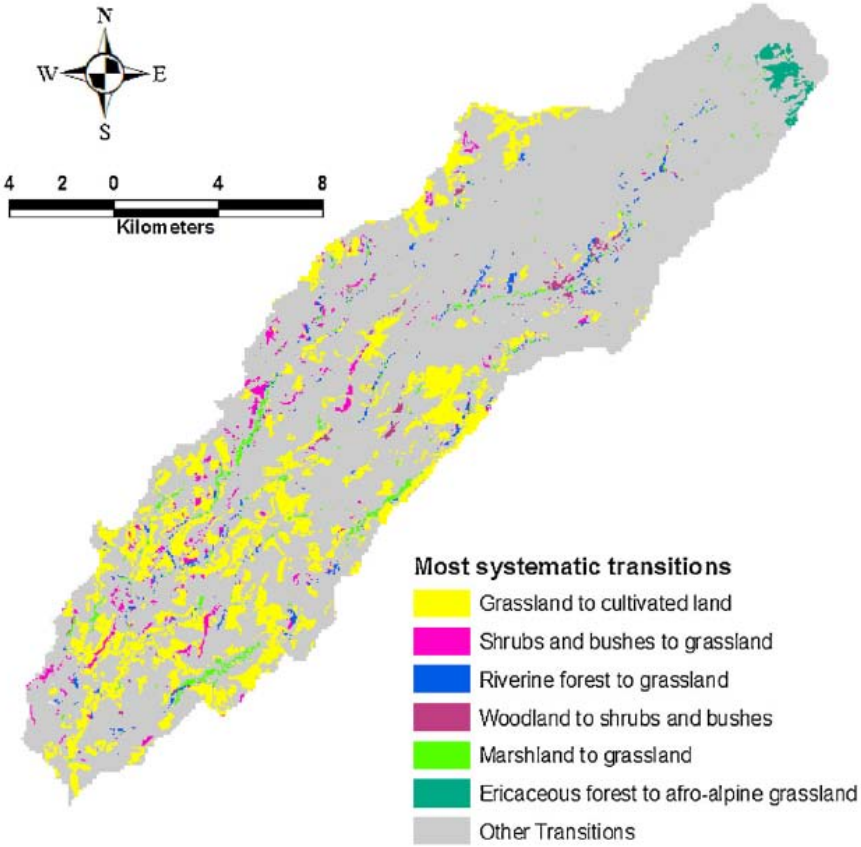



Source: Gebremicael et al., 2013




Land use change, Jedeb, 1957-2009

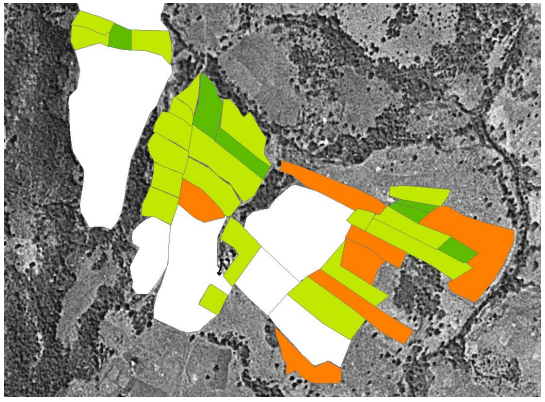


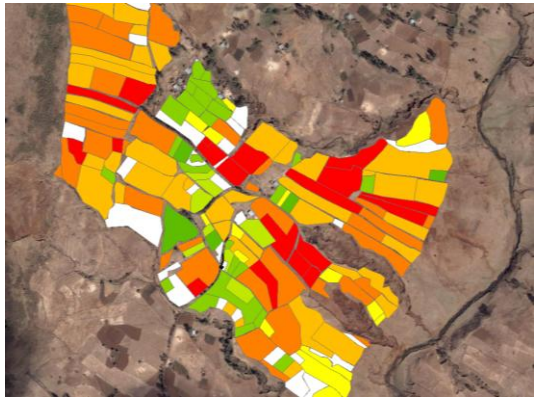

- Travel time to roads
- Distance from forest edge
- Distance from river
- Topographical wetness index
- Slope
- Elevation

Source: Teferi et al., 2013

Study area = 35 ha



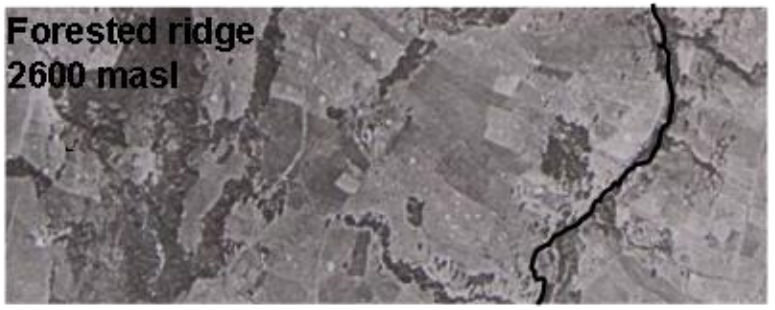
1957 (reconstruction)



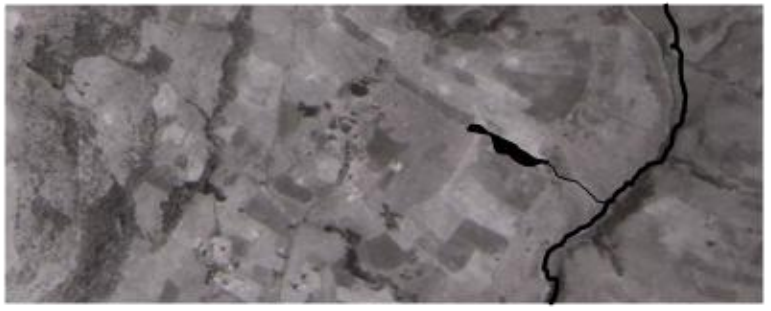
2010

**No. of plowings in that year**

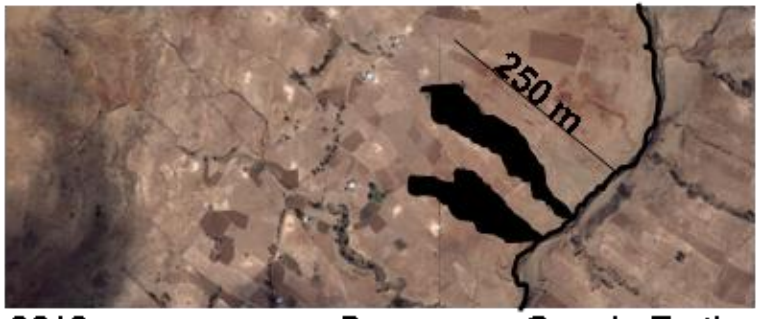
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 2 | 4 | 6 | 1 | 3 | 5 | >10 |




1957 Base map: Ethiopian mapping agency

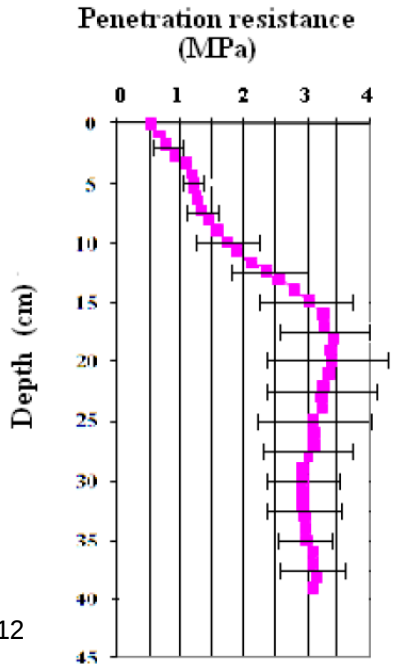


1986 Base map: Ethiopian mapping agency



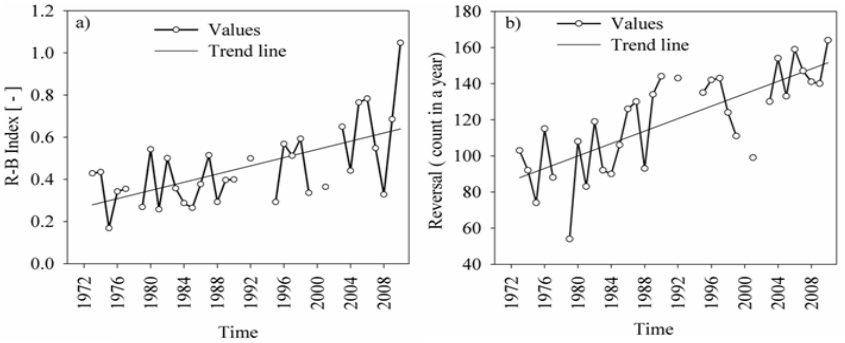

2010 Base map: Google Earth

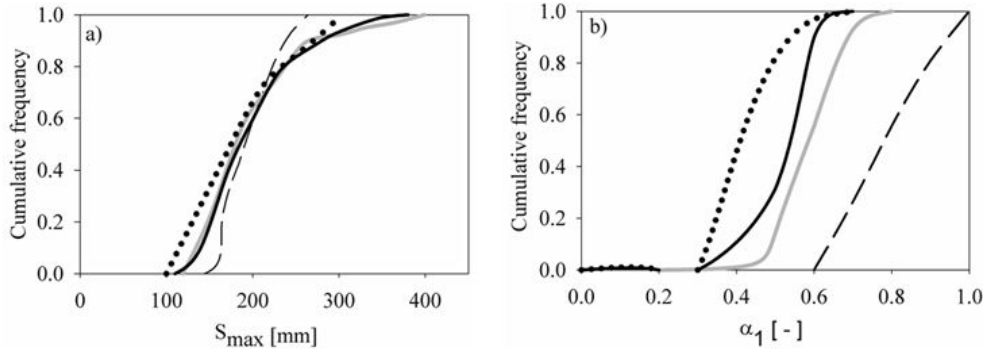
Source: Smit, in prep.

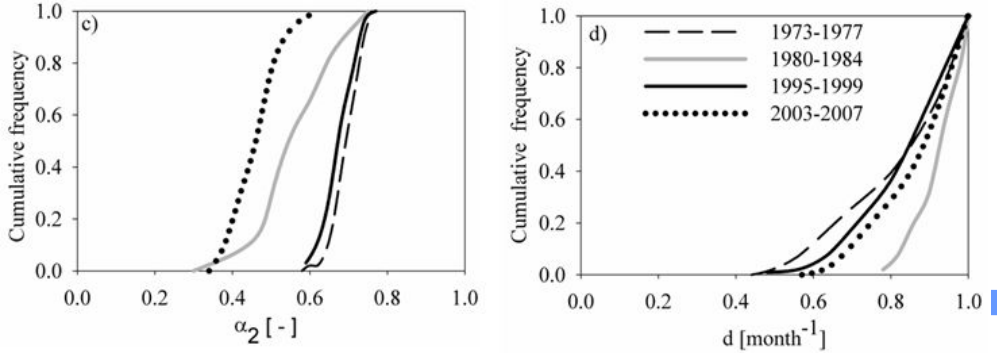


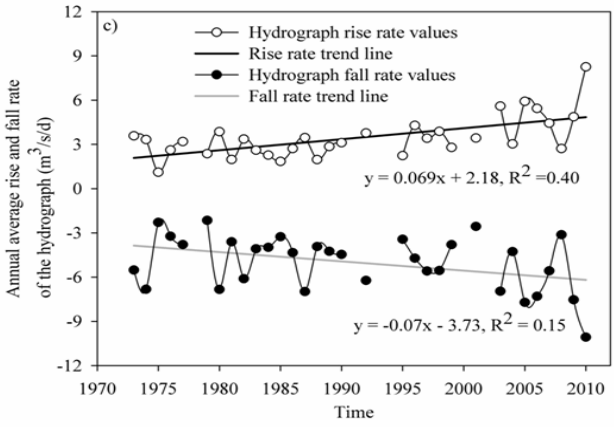


Source: Temesgen et al 2012




Source: Tekleab et al 2013a

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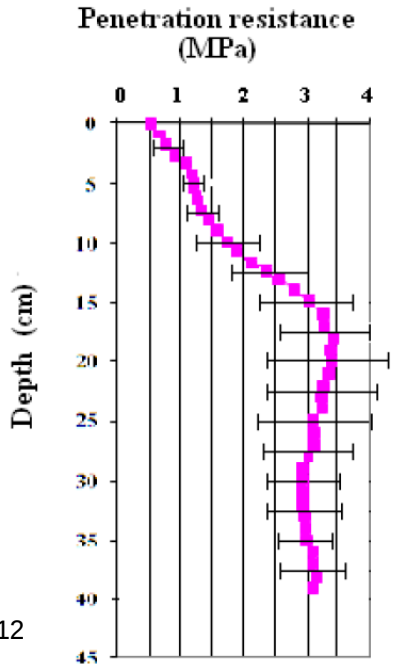



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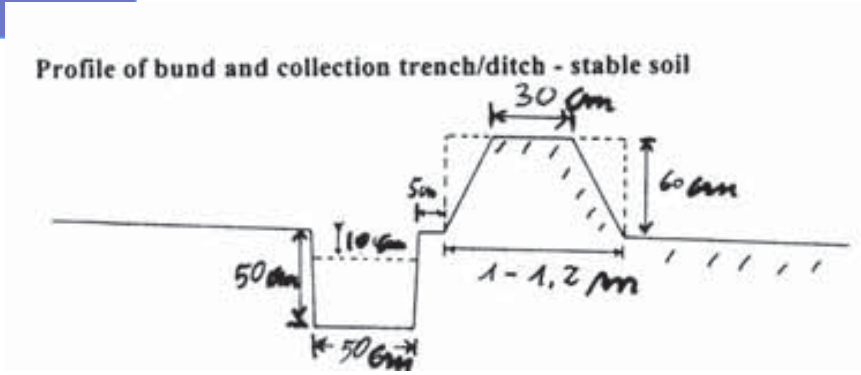
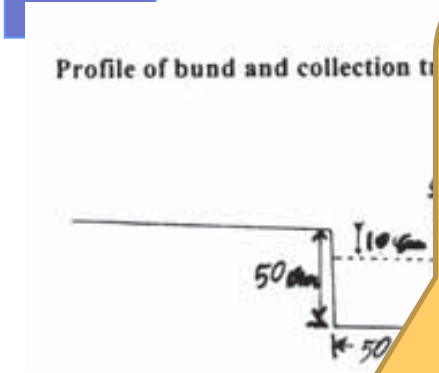



Design in guidelines

Source: Smit, in prep.

Negotiated ‘half’ terrace

Training 2010




Design in guideli

Source: Smit, in prep.

"Now I did two 15-day long trainings with farmer party members. But the farmers say:
*'what is new? we have been told this for 20 years or longer and every time we get rid of the terraces.'*

That's exactly the problem: there is not even one terrace left to serve as an example. The people at the top think it is simple but it is not."

Negotiated 'half' terrace

Training 2010

| | Contract 1 | Contract 2 | None of the two |
|---|---|---|---|
| Contract provider | Regional Board | Peasant Association | No contract |
| Contract length | 5 years | 1 year | Not applicable |
| Land use certificate | Yes | Yes | No certificate guarantee |
| Soil conservation measure | Stone bund | Fanya juu | No extra measures |
| Extension Service | 2 times/year | 6 times/year | No extra service |
| Monthly payment | 50 Birr | 300 Birr | 0 Birr |

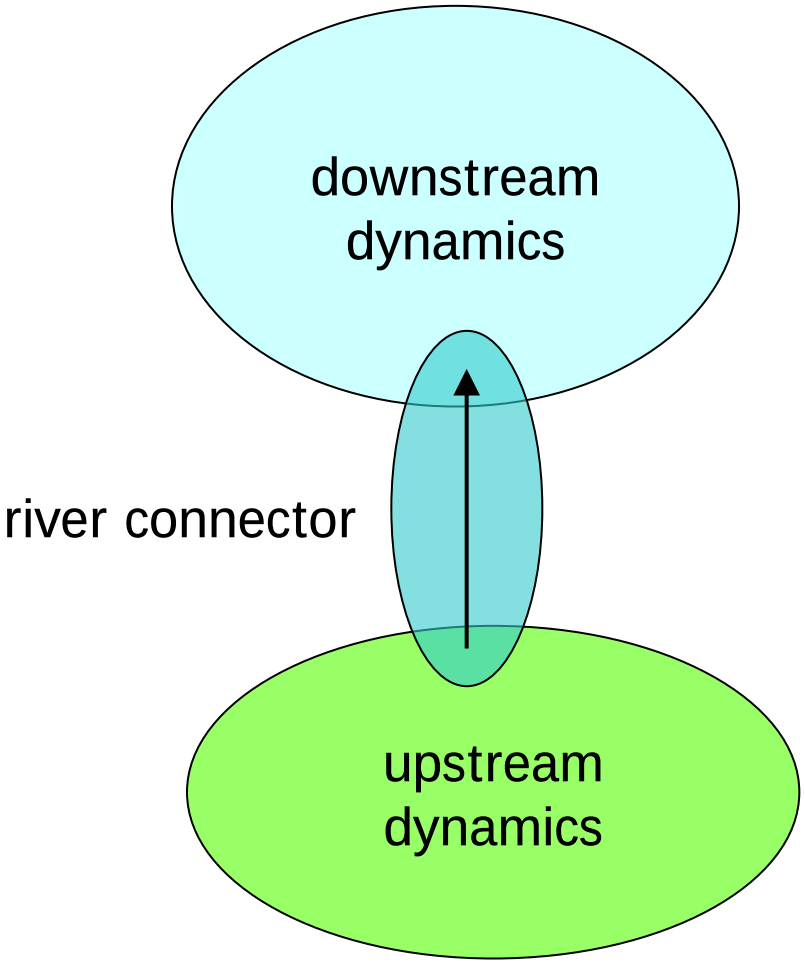
Source: Tesfaye and Brouwer 2013

artefacts & infra-structure

water & soil

goods & bads

people


downstream dynamics
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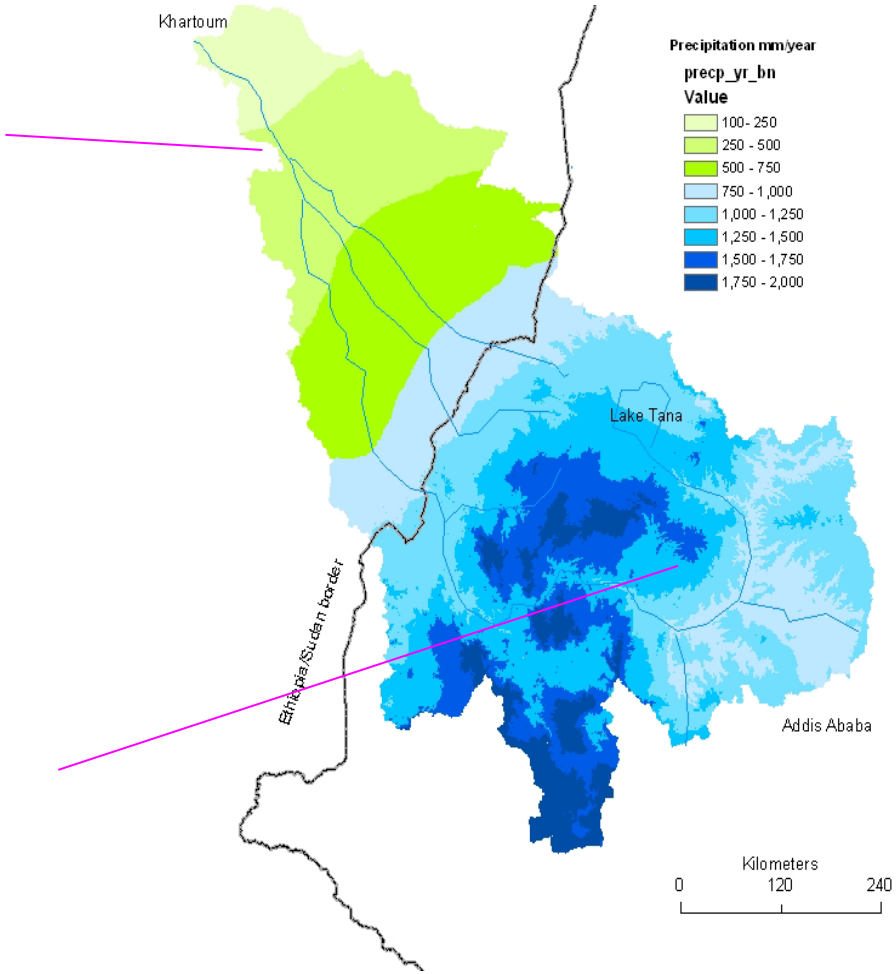
Khartoum
Lake Tana
Addis Ababa
Ethiopia/Sudan border
Precipitation mm/year
precp_yr_bn
Value
100 - 250
250 - 500
500 - 750
750 - 1,000
1,000 - 1,250
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1,500 - 1,750
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Kilometers
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120
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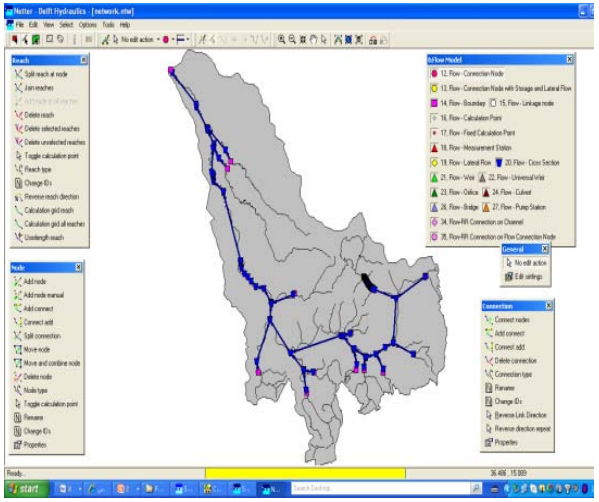

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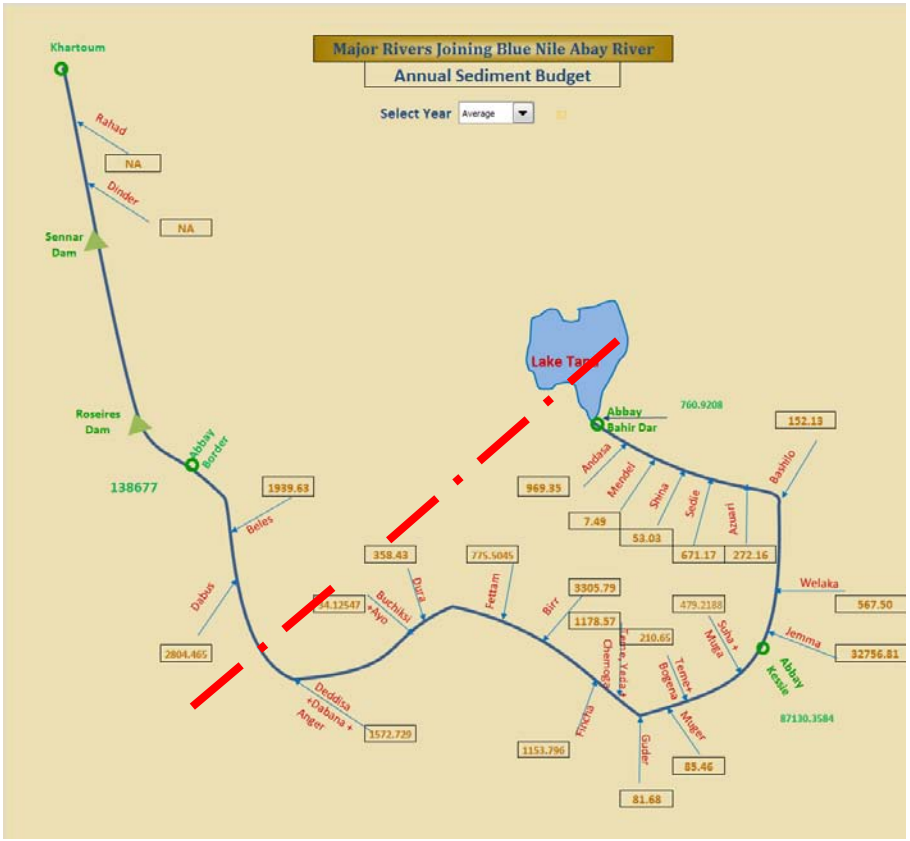
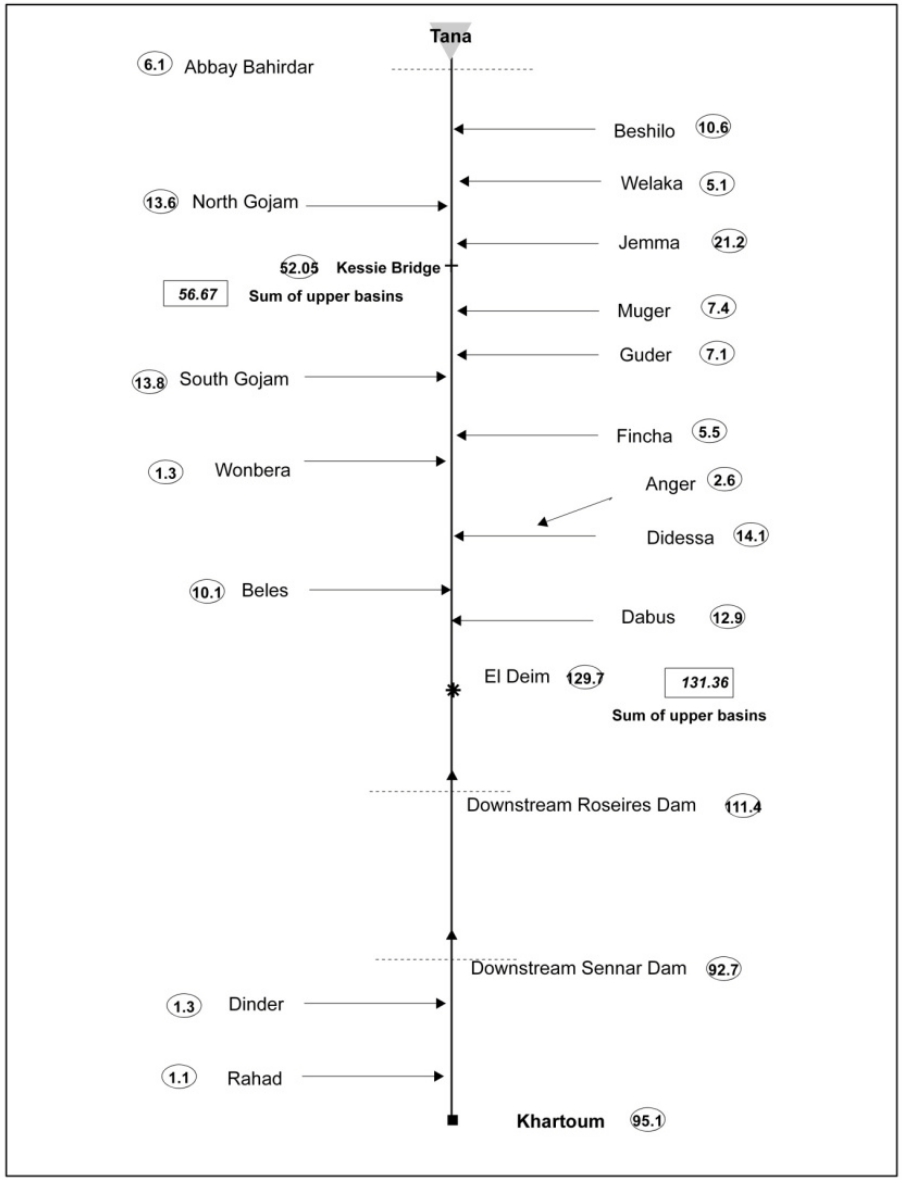
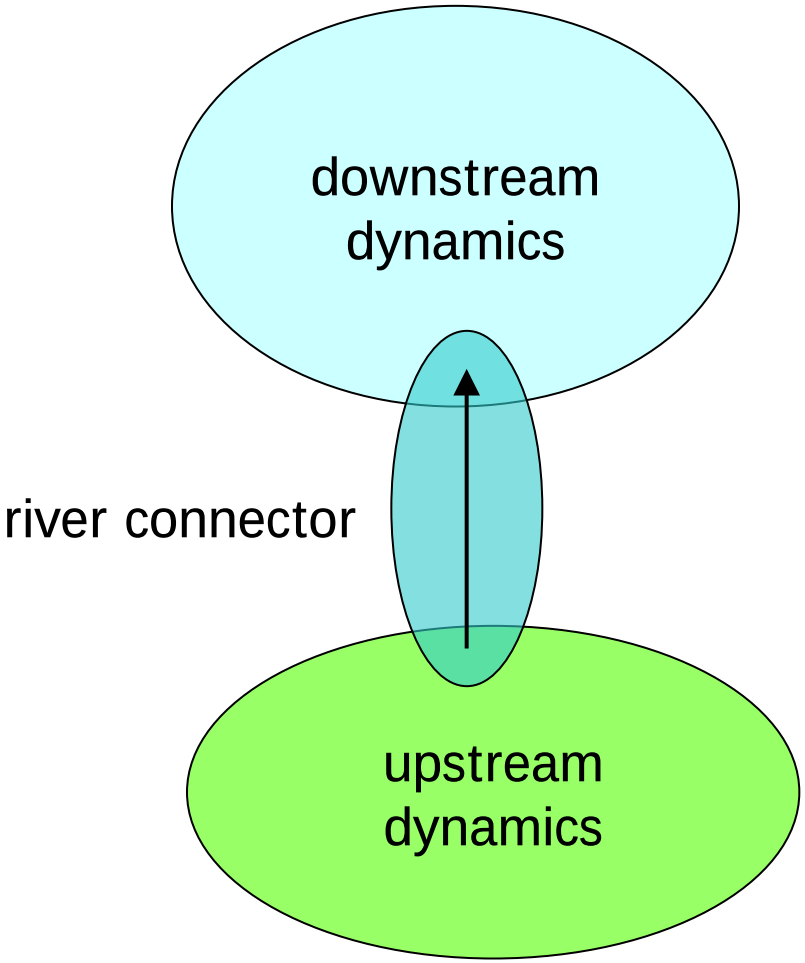
# Sediment loads 1980-2004
## (million ton/year)




Source: Salih Ali et al, in prep.

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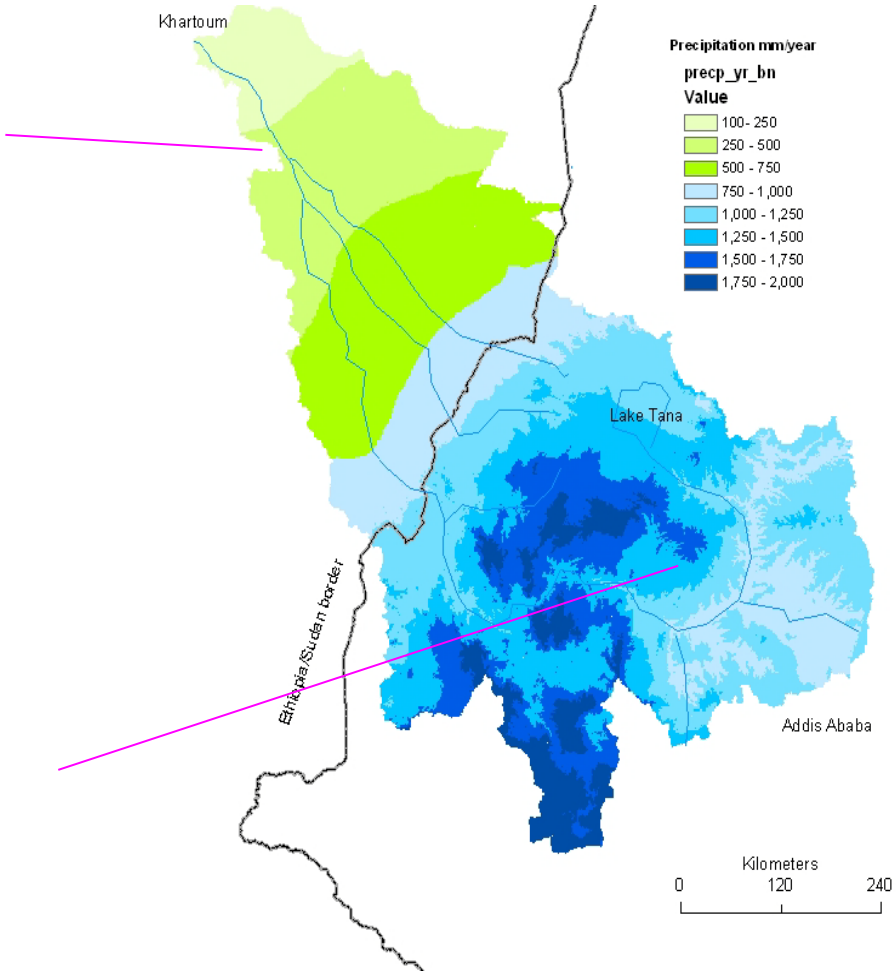
Khartoum
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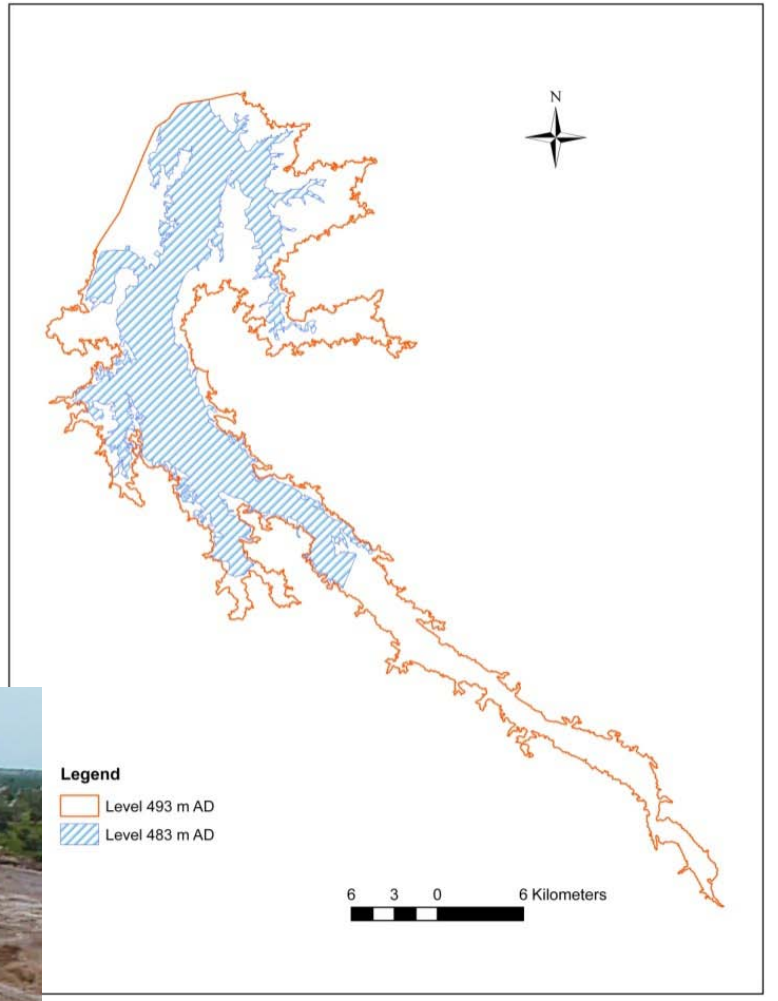



Source: Salih Ali et al, in prep.

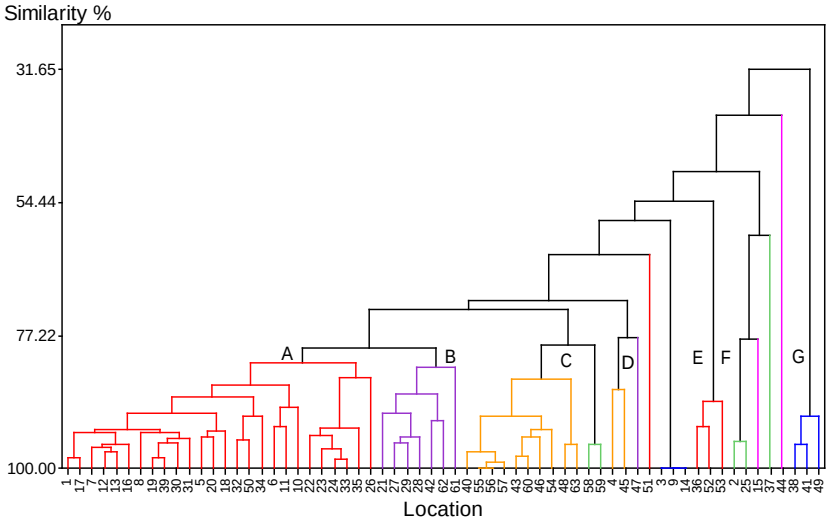
# The main source areas are:

- Jemma,
- Didessa
- South Gojam

Finer material on the top part of this sampling site

Average sand grain size

Calcareous concretions at the base of the site





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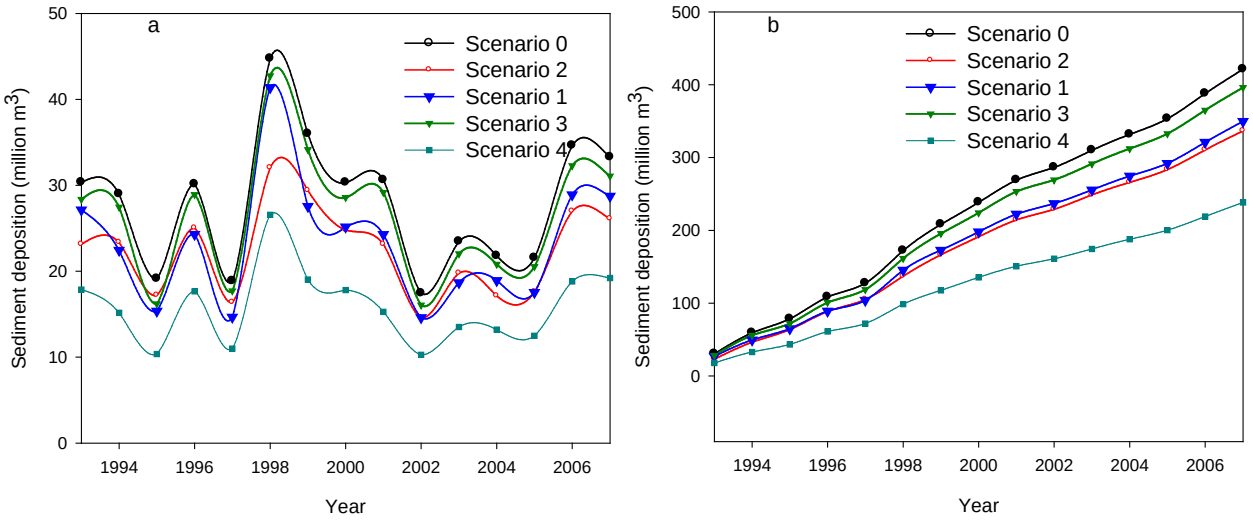
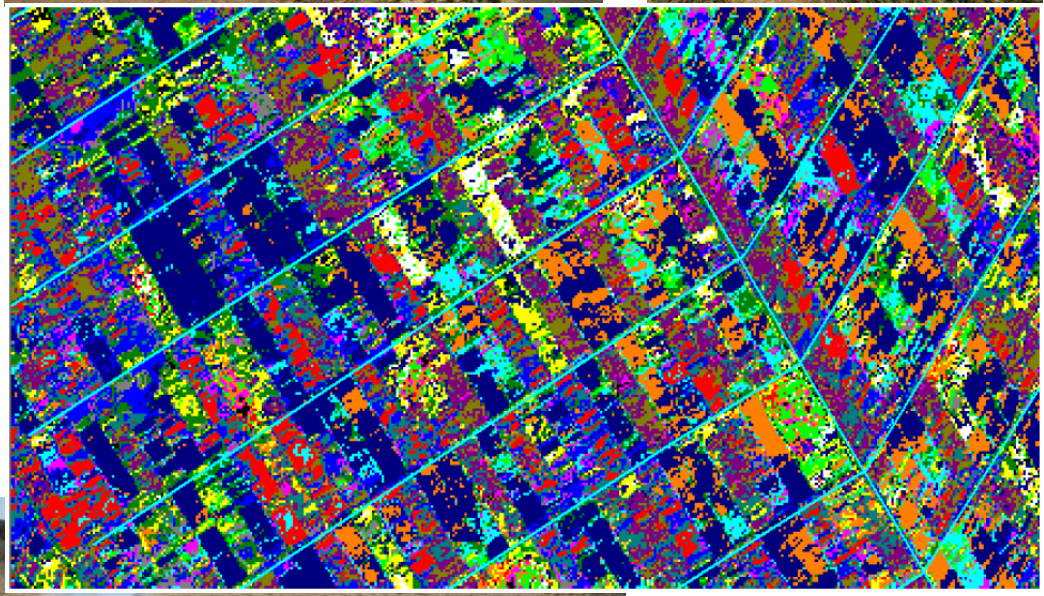
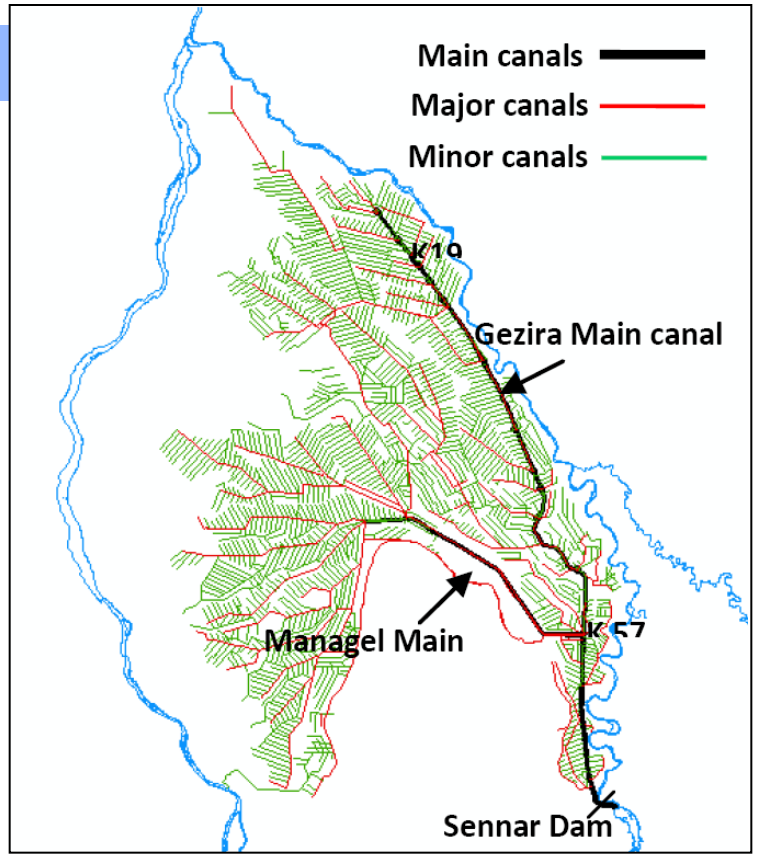


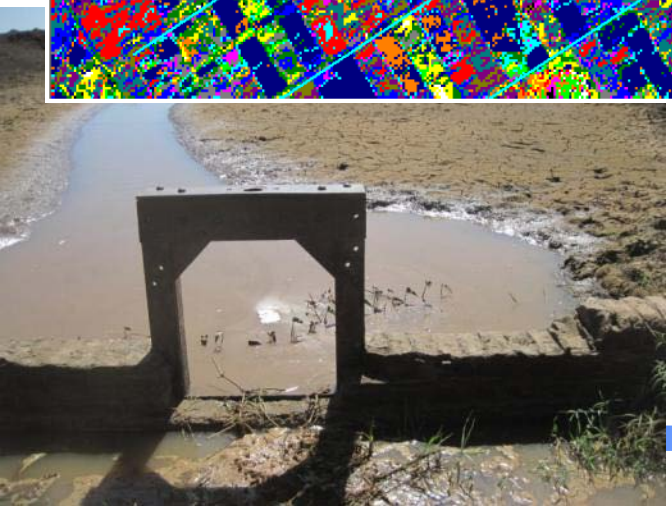

Sediment deposition inside Renaissance Dam for different erosion control practices scenarios (a) annual and (b) accumulation

Scenario 0, BAU – historical data 1993-2007.
In Scenario 1, it is assumed that no sediment entering the system from Jemma sub-basin.
In Scenario 2, it is assumed that no sediment entering the system from Didessa sub-basin.
In Scenario 3, it is assumed that no sediment entering the system from South Gojam sub-basin.
In Scenario 4, it is assumed that no sediment entering the system from above three sub-basins.

Source: Salih Ali et al, in prep.





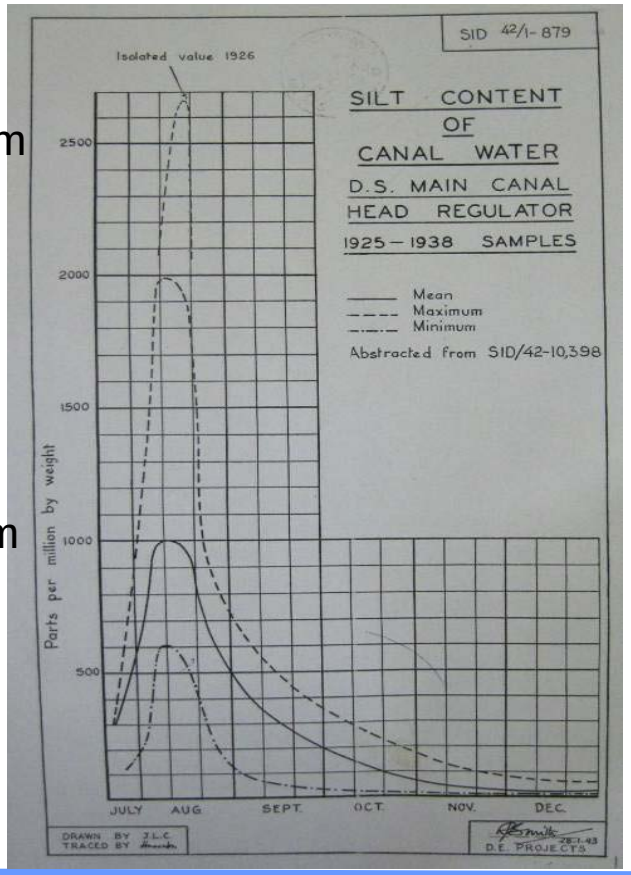
Source: Thiruvarudchelvan, 2010

Source: Smit, in prep.

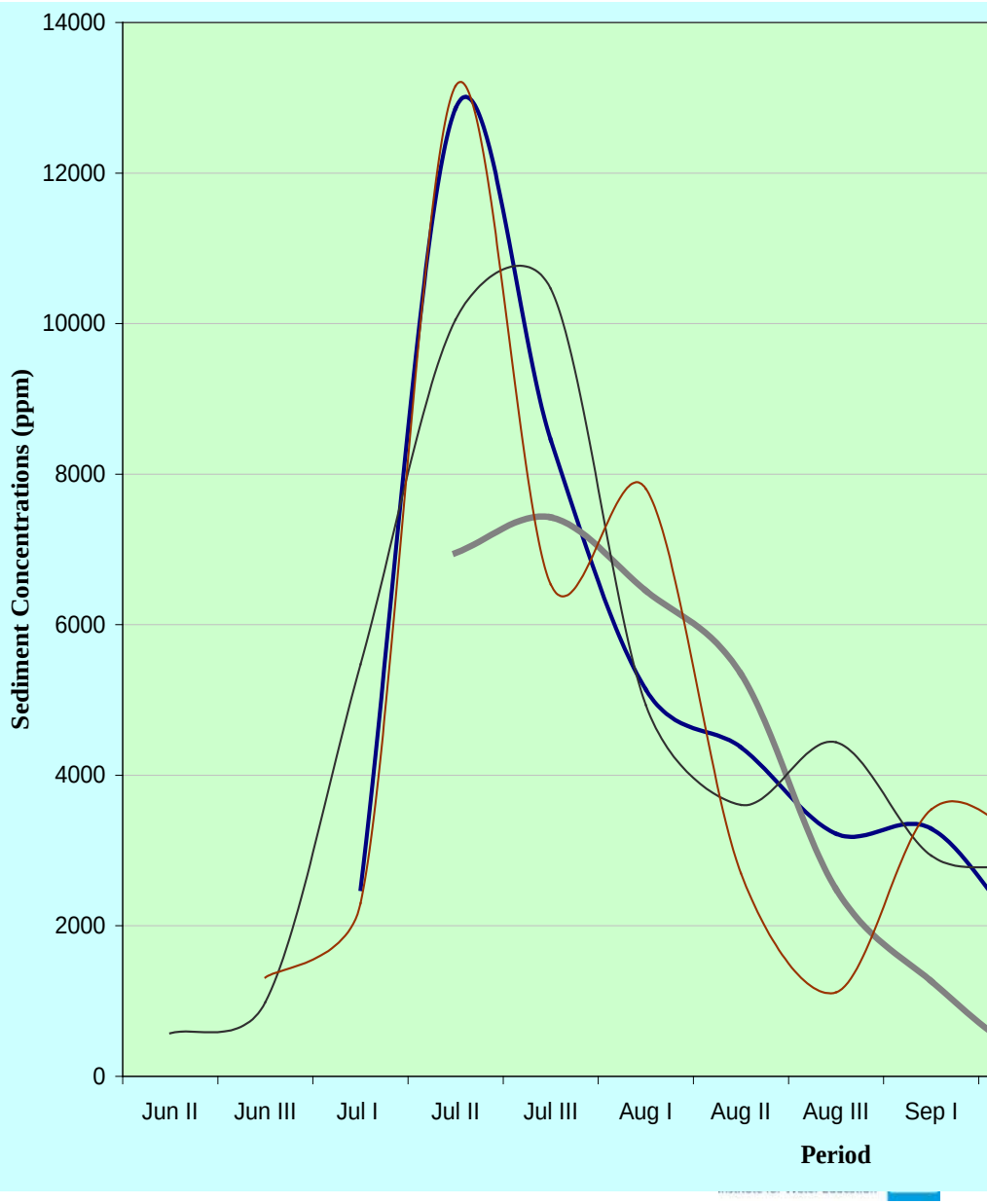
1930s

2500 ppm

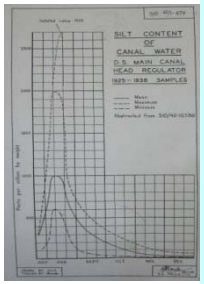
1000 ppm

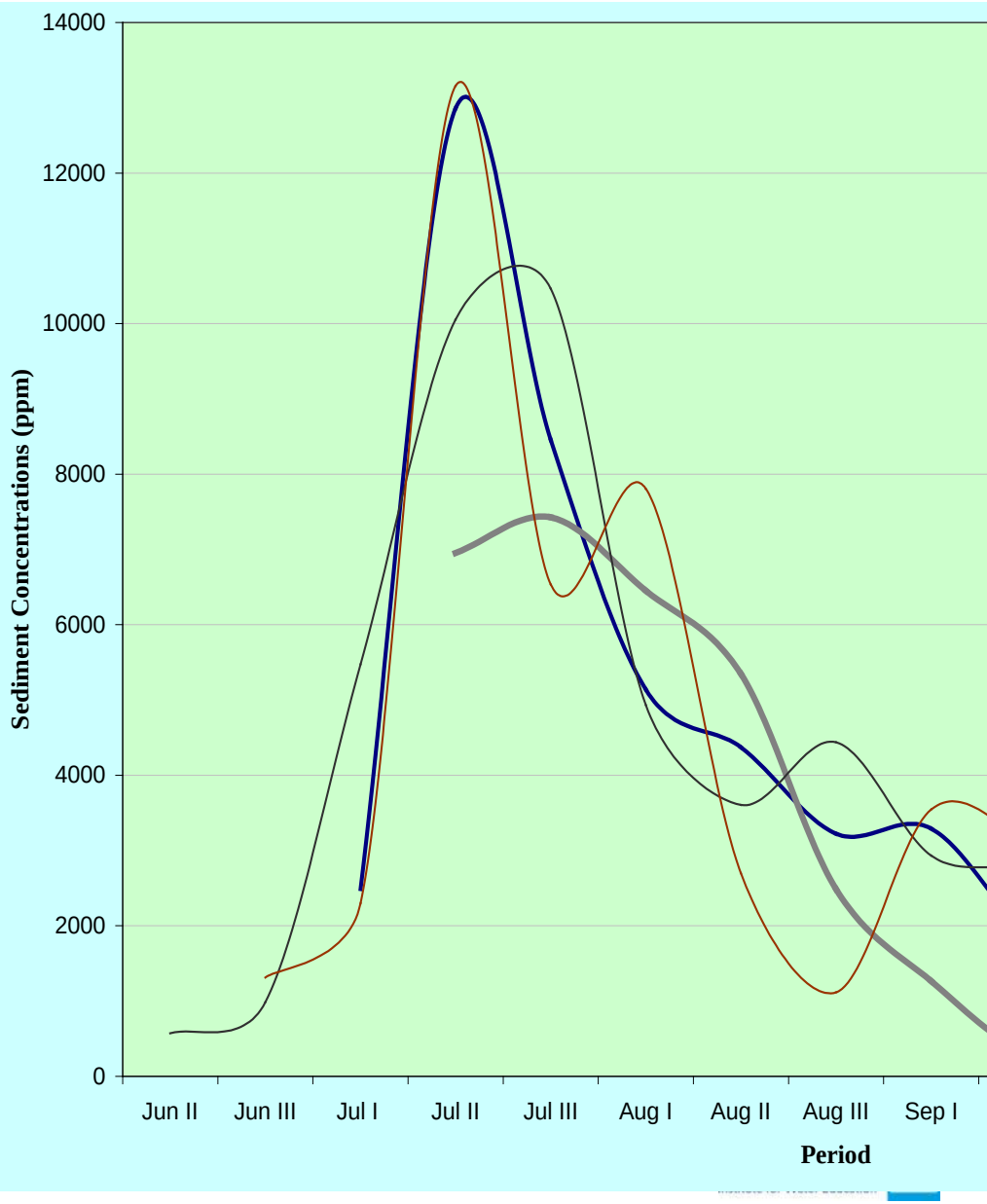


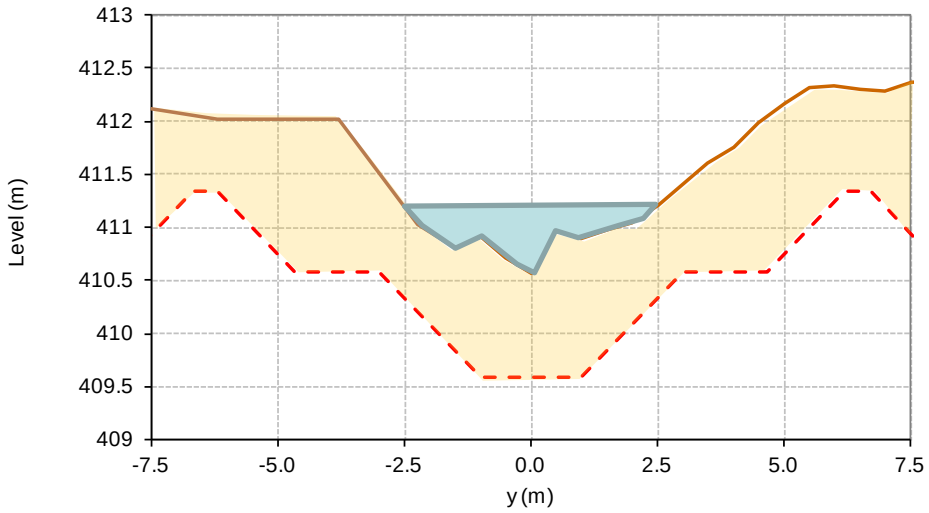

2000s



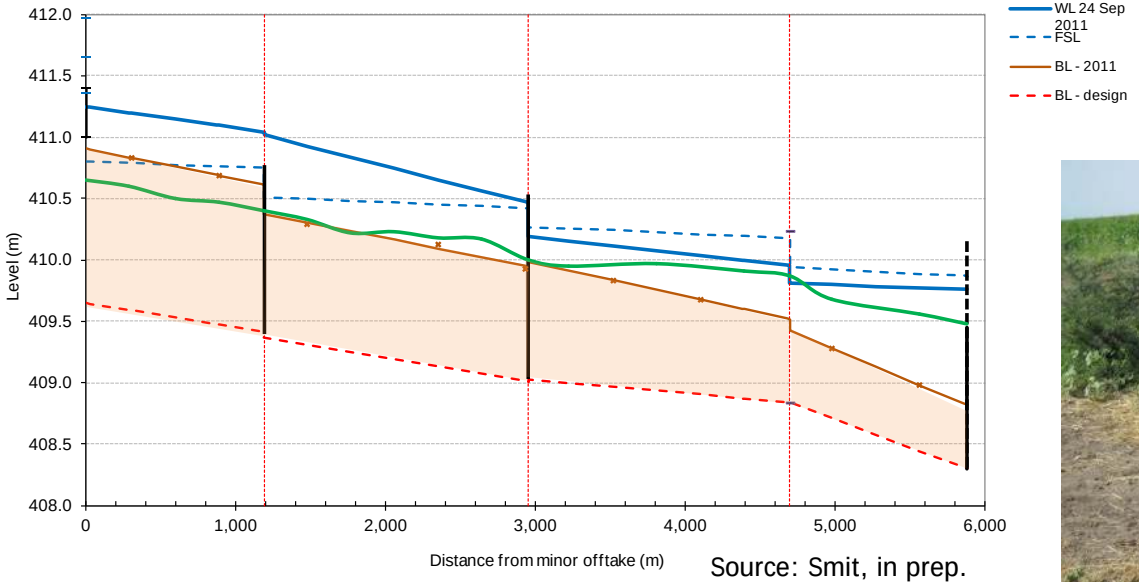
# 2000s


SILT CONTENT
OF
CANAL WATER
D.S. MAIN CANAL
HEAD REGULATOR
1925 - 1938 SAMPLES


14000
12000
10000
8000
6000
4000
2000
0
Sediment Concentrations (ppm)
Jun II
Jun III
Jul I
Jul II
Jul III
Aug I
Aug II
Aug III
Sep I
Period








Source: Smit, in prep.

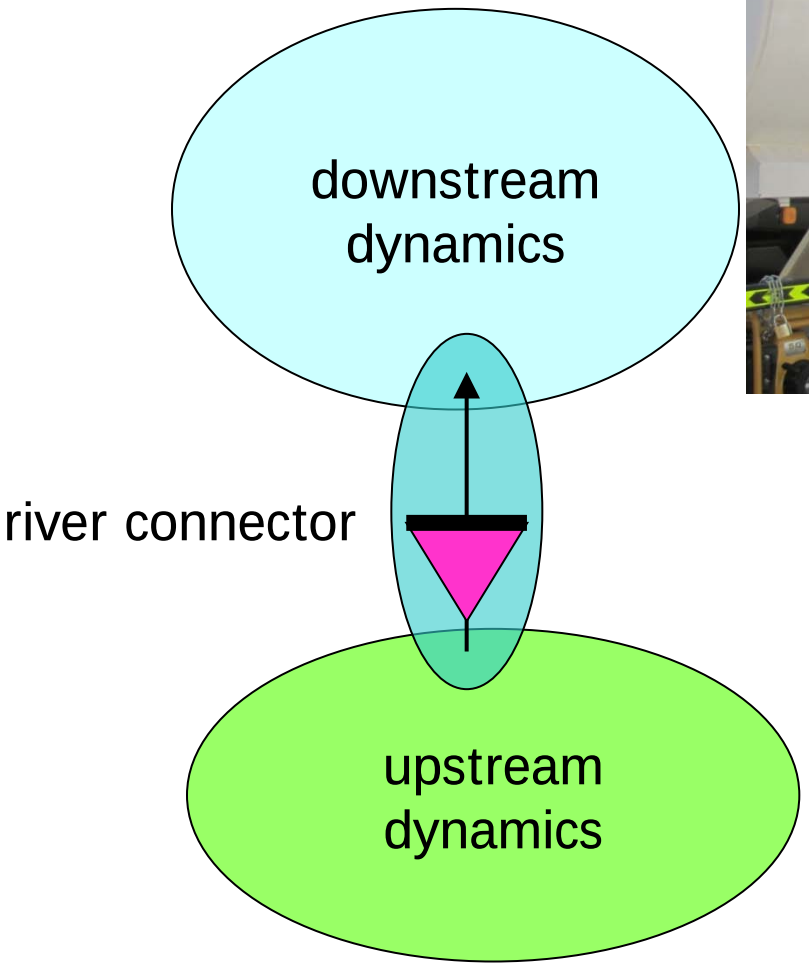
artefacts & infra-structure

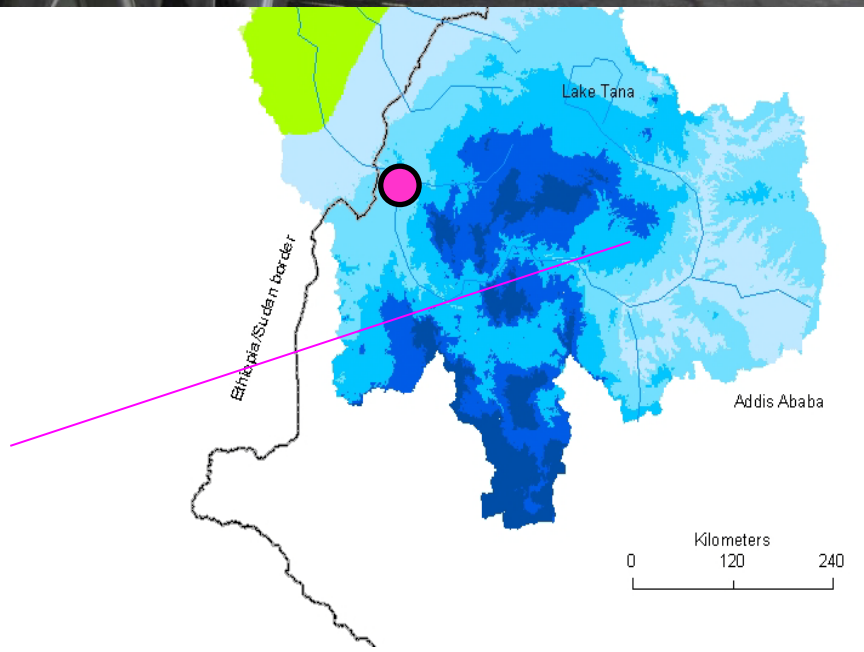
water & soil

goods & bads

people


Courtesy Gift
From The Republic Of Sudan To The
Brotherly People Of The Federal Republic
Of Ethiopia October 2011


downstream
dynamics
river connector
upstream
dynamics


Lake Tana
Ethiopia/Sudan border
Addis Ababa
Kilometers
0
120
240

# Synthesis

Upstream: erosion

- nutrient loss, land loss, directly affecting livelihoods
- recommended technologies do not seem to work
- lack of a coordinated approach
- most people seem to lose

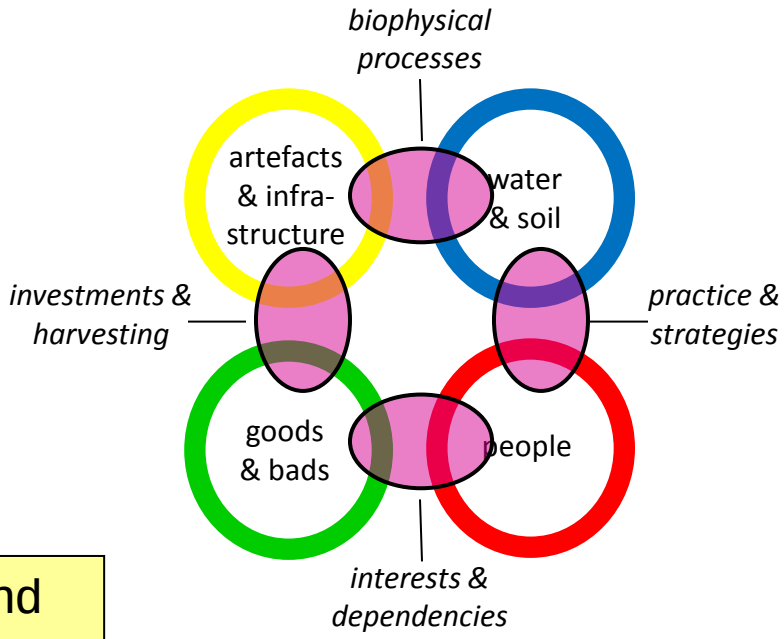
Downstream: siltation

- throughout the existence of Gezira this has been addressed
- currently scheme management is under severe stress
- many people seem to lose, yet not everybody...
- need for coordination

Basin-wide:

- erosion and siltation have not yet been connected institutionally
- politics on the (Blue) Nile - the (possible positive) effect of GERD

# Synthesis




Remarkable similarities between u/s and d/s:

- People are locked in struggles they do not fully master
- People cannot solve the problems individually

- Biophysical, technological, social, economic and political realms co-evolve, and may interlock
- Problems need to be addressed at appropriate social and geographical scales

This may explain the persistence of some problems

Forging collective action requires (among others):

- relevant knowledge & understanding
- legitimate leadership roles at appropriate scales

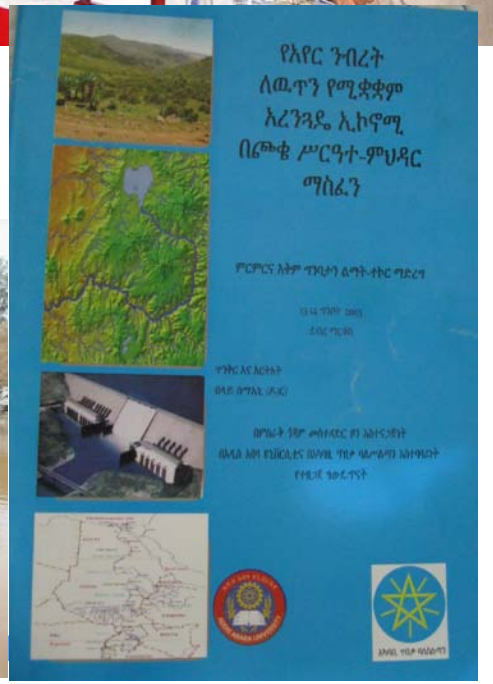
# Relevance for development

*biophysical*

What does this imply
for the Blue Nile basin?

1. The interlocking of different realms occurs at various spatial scales and is layered or ‘nested’
2. Actors jointly acknowledging (& debating) the interrelationships between issues at various scales is a first and necessary step,

   *transforming subjective information into inter-subjective understanding*
   (Dr Dinara, Peace Palace, The Hague)

# Follow-up

## Research that has already started

Ethiopia: - Choke Muntains Ecosystem Management Development project
- Dr Temesgen continues his work on improved plough, now with SRC

Sudan: - Hydraulics Research Centre followup in Gezira

## PhDs

Sediment and Water Management of Large Irrigation Systems, Case Study: Gezira Scheme, Sudan (Ms Ishraga Sir Elkhatim Osman, Sudan; since March 2010)

On optimising the operation of the multi-reservoir system in the Eastern Nile basin considering water and sediment fluxes (Ms Reem Fikri Digna, Sudan; since Jan 2011)

Sustainable development and management of the Nile River Basin - a cooperative game theoretic approach (Mr Tewodros Negash Kahsay, Ethiopia; since February 2011)

Understanding links between hydrology and ecology of the Dinder and Rahad River Basin (Mr Khaled Hassaballah, Sudan; since November 2012, Nuffic funded)

Integrated modeling and decision support for land-use and water resources management in Africa, including in the Upper Blue Nile basin (Mr Seleshi Yalew, Ethiopia; since February 2011; funded by two EU projects and UNESCO-IHE)

# Follow-up

Research opportunities

- PhD graduates may qualify as Postdocs with the Water Land and Ecosystems programme of CGIAR, led by IWMI
- Internship programme of ENTRO
- Make the regional New Nile Perspectives conference an annual event
- Develop a proposal for a 2nd phase, focusing on river basin management at the scale of the Blue Nile

We will continue
to work together


Support by NWO/WOTRO Science for Development
is gratefully acknowledged

website: www.unesco-ihe.org/Blue-Nile-Hydrosolidarity

# PhD theses

Tesfaye Tulu, Abonesh (2013) Institutional-Economic Incentives for Sustainable Watershed Management in the Blue Nile River Basin. VU Amsterdam, 11 November 2013; promoters: Roy Brouwer & Pieter van der Zaag

# MSc/MA theses

Aalbers, E.E. (2012) Water supply from minor canal to field level in the Gezira irrigation scheme, Sudan - Supervised by Maurits Ertsen and Hermen Smit - TU-Delft, MSc minor thesis TU-Delft

Amena, D. (2011), Comparison of two Modeling approaches to understand hydrologic response of upper Blue Nile catchments. co-supervised by Sirak Tekleab, MSc thesis Addis Ababa University

Bhrane Gebru, A. (2012) Expertise, positions and negotiations about Soil and Water Conservation: case study of the government SWC program in the Choke Mountains of Ethiopia - Supervised by Pieter van der Zaag and Hermen Smit MSc thesis UNESCO-IHE

Cordova, J.V.Z. (2011) Characterization of rainfall-runoff relationships using environmental isotopes (A study of hydrological processes and water resources in the Choke mountain area Ethiopia). co-supervised by Sirak Tekleab, MSc. thesis UNESCO-IHE

Goshu, T. (2011) Changes in livelihood strategies respnose to land degradation and land scarcity: the case of Tamamayng and Gira-Kedamin Kebeles of Machakel Woreda, East-Gojjam, -supervised by Yeraswork Admassie and Hermen Smit - MA thesis Addis Ababa University

Gurmu, M.G. (2010), Title: Estimation of ground water recharge and hydrograph separation in Chemoga catchment upper Blue Nile basin. co-supervised by Sirak Tekleab, MSc thesis UNESCO-IHE

Hiwot Abraha (2012) Land use and land cover change and its impact on urban climate Ethiopia. Co-Supervised by Ermias Teferi, MA thesis Addis Ababa University

Kassahun, B. (2013), The impact of land use and land cover change on soil physical and chemical properties. Co-supervised by Ermias Teferi. MSc thesis at Haremaya University, Ethiopia.

Kidane D. (2012) Rainfall partitioning as affected by conservation tillage system. Co-supervised by Melesse Temesgen, MSc thesis Hawassa University.

Köck, M. (2012) Forty years of the Aswan High Dam: the actors and interests involved in its history and the changes it brought in Egypt - Supervised by Pieter van der Zaag, Rhodante Ahlers and Hermen Smit, MSc thesis UNESCO-IHE

Mathot, K.A. (2011) Rummaging Through Reform Strategies of Gezira irrigation scheme actors to cope with irrigation management reforms in the face of strict state control, Sudan - Supervised by Alex Bolding and Hermen Smit -MSc thesis Wageningen University

Muche, H.(2012) Sediment transport and loss from cultivated fields as affected by the application of conservation tillage system. Co-supervised by Melesse Temesgen, MSc thesis Hawassa University.

# MSc/MA theses (cont.)

Nitsuhe Wolanios (2012) Economic valuation of the ecosystem services provided by the Blue Nile Basin in Ethiopia, Co-supervised by Abonesh, MSc thesis Vrije Universiteit Amsterdam

Omer, A.Y.A. (2011) Sedimentation of sand and silt in Roseires reservoir : vertical and horizontal sorting with time, Co-supervised by Yasir Salih, MSc thesis UNESCO-IHE

Tesfaye Muluneh Befekadu (2010) –Understanding Spatiotemporal Resource Flows , A village Level Study at Gira-Kidamen, East Gojjam - Supervised by Yirgalem Matheme and Hermen Smit - Geography and Environmental Studies – MA thesis Addis Ababa University

Woldegebriel, E. (2011) Irrigation Management Transfer in theGezira Scheme, Sudan - A case study on farmers' operation and maintenance strategies in Tuweir minor canal - Supervised by Alex Bolding and Hermen Smit - MSc thesis Wageningen University

Wondwosen Nigatie Mollaw (2010) Gendered land use and household food security -A case study in Girakidam Kebele of Machakel Woreda, Amhara Region, Supervised by: Dr. Belay Simane and Rahel Muche Kassa, MA thesis Addis Ababa University

Wolanios, N. (2012) Economic valuation of the ecosystem services provided by the Blue Nile Basin in Ethiopia, Supervised by Roy Brouwer and Abonesh Tesfaye, MSc thesis at Vrije Universiteit Amsterdam

Yilikal Worku Kebede (2010) - The Dichotomy of Agricultural Policies and Practice and their Influence on Production: the case of Gira Kidamin Kebele, East Gojam Zone, Ethiopia -

Supervised by Dr. Ignatius Mberengwa and Hermen Smit – Regional and Local Development Studies - MA thesis Addis Ababa University

Zini, S.(2011) Modelling of flow and sediment transport along the Blue Nile River in Sudan with a 1D model, Co-supervised by Yasir Salih, MSc thesis University of Florence

**BSc projects – completed**

Veldkamp, T.I.E. (2009) The costs and benefits of soil conservation measures in the Jedeb watershed in the Blue Nile river basin; BSc thesis VU Amsterdam.

Tanja, J. (2009) Vulnerability, source and adaptation possibilities: taking the case of the Jedeb Watershed in the Blue Nile river basin; BSc thesis VU Amsterdam.

# Major scientific publications to date

**Articles published and accepted in peer-reviewed academic journals**


Ali, Yasir S. A., A. Crosato, Yasir A. Mohamed, Nigel G. Wright, J.A. Roelvink, *in press.* Water resource assessment along Blue Nile River using 1D model. *Water Management*

Ali, Yasir S. A., A. Crosato, Yasir A. Mohamed, Seifeldin H. Abdalla, Nigel G. Wright, *in press.* Computation of the sediment balances in the Blue Nile River Basin. *International Journal of Sediment Research*

Brouwer, R., Tesfaye, A., and Pauw, P. (2011). Meta-analysis of institutional-economic factors explaining the environmental performance of payments for watershed services. *Environmental Conservation,* 38(4), 380-392, DOI:

Gebremichael, T.G., Mohamed, Y.A., Betrie, G.D., Van der Zaag, P. & Teferi, E. (2013). Trend analysis of runoff and sediment fluxes in the Upper Blue Nile basin: A combined analysis of statistical tests, physically-based models and landuse maps. *Journal of Hydrology* 482: 57-68,

Teferi, E., Uhlenbrook, S., Bewket, W., Wenninger, J., and Simane, B. (2010). The use of remote sensing to quantify wetland loss in the Choke Mountain range, Upper Blue Nile basin, Ethiopia, *Hydrol. Earth Syst. Sci.,* 14, 2415-2428,

Teferi, E., Bewket, W., Uhlenbrook, S. & Wenninger, J. (2013) Understanding recent land use and land cover dynamics in the source region of the Upper Blue Nile, Ethiopia: Spatially explicit statistical modeling of systematic transitions. *Agriculture, Ecosystems & Environment,* 165, 98-117

Tekleab,S., Uhlenbrook,S. Mohamed,Y., Savenije,H.H.G., Temesgen,M. and Wenninger,J. (2011). Water balance Modelling of upper Blue Nile catchments using top down approach. *Hydrol. Earth Syst. Sci.,* 15, 2179–2193,

Tekleab, S., Y. Mohamed, S. Uhlenbrook, 2013. Hydro-climatic trends in the Abay/Upper Blue Nile basin, Ethiopia. *Physics and Chemistry if the Earth* Vol 61-62, pp. 32-42,

Tekleab, S., Y. Mohamed, S. Uhlenbrook, J. Wenninger, 2013. Hydrologic responses to land cover change: the case of Jedeb mesoscale catchment, Abay/Upper Blue Nile basin, Ethiopia. *Hydrological Processes*.

Temesgen, M., S. Uhlenbrook, B. Simane, P. van der Zaag, Y. Mohamed, J. Wenninger and H.H.G. Savenije, 2012. Impacts of conservation tillage on the hydrological and agronomic performance of Fanya juus in the upper Blue Nile (Abbay) river basin. *Hydrol. Earth Syst. Sci.* 16, 4725-4735;

Tesfaye, A. & Brouwer, R. (2012). Testing participation constraints in contract design for sustainable soil conservation in Ethiopia. *Ecological Economics,* 73, 168–178

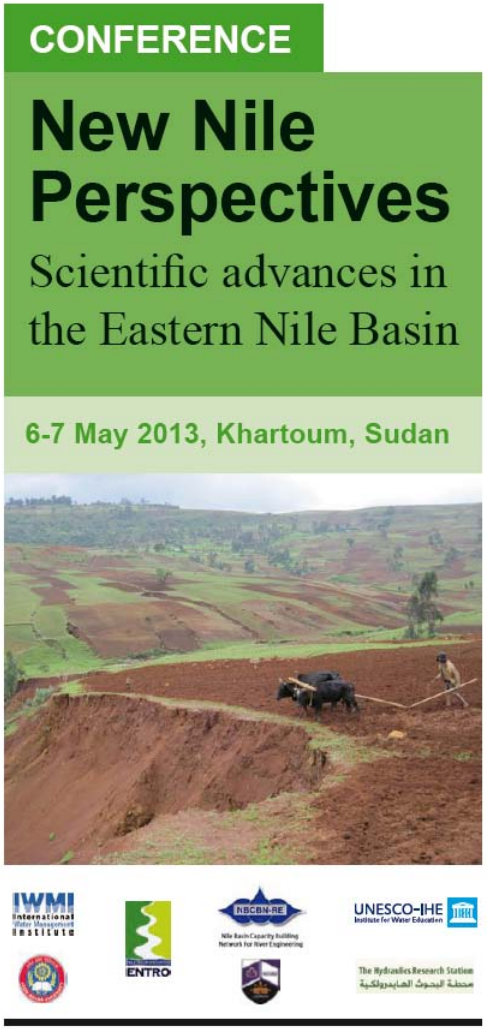
Tesfaye, A., Negatu, W., Brouwer, R. & Van der Zaag, P., 2013. Understanding soil conservation decision of farmers in the Gedeb watershed, Ethiopia, *Land Degradation & Development*

# Major programme events

| | |
|---|---|
| Apr 2007 | Preliminary proposal submitted |
| Jul 2007 | Stakeholder consultation in Bahir Dar, Ethiopia in preparation of full proposal |
| Feb 2008 | Formal approval from NWO/WOTRO |
| Mar-Aug 2008 | Selection of PhD candidates; interviews in Addis Ababa in May 2008; VC sessions. |
| Sep 2008 | Start of project, all f/t researchers appointed and in place |
| 29 Sep-2 Oct 2008 | 1st joint field visit of the programme to the Abbay river and Choke Mountain |
| 3 Oct 2008 | Formal launch of the Blue Nile Hydrosolidarity programme and seminar, Addis Ababa |
| 2-4 Nov 2008 | Formal launch of the programme in Sudan |
| 5-6 Nov 2008 | Joint field visit to the Blue Nile and Gezira |
| Dec 2008-Apr 2009 | All f/t researchers in Netherlands preparing research proposals; regular joint meetings Mar 2009 Blue Nile Seminar in Delft with external reviewers from TU Delft, WUR and ITC |
| 5 Oct 2009 | 1st annual scientific seminar, held in Addis Ababa |
| 6 Oct 2009 | Blue Nile Hydrosolidarity stakeholder workshop at ENTRO offices in Addis Ababa; |
| Jun 2010 | 2nd annual scientific seminar - Addis Ababa & Debre Markos |
| 5 Sep 2010 | Blue Nile/Tamamagn workshop, Choke Mountains |
| 21 Oct 2010 | Formal mid-Term review meeting with WOTRO |
| 26 Feb-4 Mar 2011 | 3rd annual scientific seminar, held in Khartoum, Wad Medani and Roseires |
| 20-21 May 2011 | Blue Nile/ Mount Choke research seminar held in Debre Markos 20-21 May 2011 |
| 23 Oct 2011 | Blue Nile /Gezira scheme Seminar - held in Wad Medani at the University of Gezira |
| Feb 2012 | ENTRO and IHE sign MoU |
| 13–18 May 2012 | 4th annual scientific seminar, held in Addis Ababa |
| 6-8 May 2013 | Intl. conf. “New Nile Perspectives - Scientific advances in the Eastern Nile Basin”, Sudan |
| 11 Nov 2013 | PhD graduation of Abonesh Tesfaye |
| 14-15 Nov 2013 | Special Nile session at the intl. conf. “Water Security and Peace” Peace Palace, Hague |

# New Nile perspectives conference- Scientific advances in the Eastern Nile Basin

- The goal was to disseminate and discuss state of the art research and to form new alliances for future research on Nile Basin.
- Conference themes:
    1. New Nile projects and politics;
    2. New Nile hydrology, morphology and climate change;
    3. New Nile land and water use and livelihoods;
    4. New Nile economics and optimization, ;
    5. New Nile futures - institutionalizing interdependencies.
- 120 participants from different countries: Sudan, South Sudan, The Netherlands, Ethiopia, Germany, USA, India
- 60 papers presented.
- The outcome is “Khartoum Declaration”. The participants committed themselves to continue on-going and develop new activities.
- The conference has been covered by:
    - 13 Sudanese newspapers
    - Sky News Arabic TV, Jazeera TV, Sudan TV, Blue Nile TV, Khartoum TV and Radio



Movie: “Why the Blue Nile carries brown waters- a closer look at soil particles” Hermen Smit and Yasir Salih, PhD students, were interviewed by Research News from NWO/WOTRO.
http://www.youtube.com/watch?v=pYlRPPDQLWo