BOOK OF ABSTRACTS

TROPILAKES2015

Tropical lakes in a changing environment:

Water, land, biology, climate and humans

Bahir Dar, Ethiopia, 23-29 September 2015

Organizers

- Wase-Tana project

- Ghent University

- Bahir Dar University

- KU Leuven

- Amhara Regional Bureau of Water Resources,

- Amhara Regional Bureau of Environmental Protection and Land Administration

- VLIR-UOS

- International Water Management Institute

Organizing committee

Prof. Dr. Jan Nyssen (Ghent University, geography – Northern Ethiopia)

Prof. Dr. Enyew Adgo (BDU, soil science – Lake Tana)

Prof. Dr. Jean Poesen (KU Leuven, geography)

Prof. Dr. Niko Verhoest (Ghent University, hydrology)

Prof. Dr. Seppe Deckers (KU Leuven, land management)

Dr. Mekete Dessie (BDU and Ghent University, hydrology – Lake Tana)

Drs. Sil Lanckriet (UGent, Belgium, environmental changes – Lake Ashenge)

Drs. Hanibal Lemma (BDU and Ghent University, sediment transport – Lake Tana)

Ms. Birtukan Tamiru (Wase-Tana project, VLIR-UOS and Bahir Dar University)

Mr. Deribew Fante (Wase-Tana project, VLIR-UOS and Bahir Dar University)

Ms. Selamawit Girmay (Graben project, VLIR-UOS and Mekelle University)

Mr. Stefan Strohmeier (University NRLS Vienna, Austria, hydrology – Lake Tana basin)

Dr. Wassie Anteneh (BDU, fisheries – Lake Tana)

Dr. Yihenew Gebreselassie (BDU, soil science – Lake Tana basin)

Mr. Goraw Goshu (BDU, water quality management – Blue Nile Water Institute)

Dr. Getachew Fisseha (BDU, soil science – Lake Tana basin)

Dr. Getachew Alemayehu (BDU, agronomy – Lake Tana basin)

Mr. Seleshie Mesfine (Bureau of Water Resource Development – Amhara region)

Mr. Melesachew Fente (Bureau of EPLU Administration – Amhara Region)

Dr. Louise Karlberg (Stockholm Environment Institute – biomass for cooking and livestock)

Dr. Petra Schmitter (International Water Management Institute – reservoir/dam operations)

Dr. Simon Langan (International Water Management Institute – Head of Addis Office)

Scientific committee

Prof. Dr. Jan Nyssen (Ghent University, geography – Northern Ethiopia)

Prof. Dr. Enyew Adgo (BDU, soil science – Lake Tana)

Prof. Dr. Jean Poesen (KU Leuven, geography)

Prof. Dr. Niko Verhoest (Ghent University, hydrology)

Prof. Dr. Seppe Deckers (KU Leuven, land management)

Prof. Dr. Didas Kimaro (Sokoine University, land and water – Lake Victoria shores)

Prof. Dr. Feleke Woldeyes (president Arba Minch University – Lake Abaya and Chamo)

Prof. Dr. Luc De Meester (KU Leuven, Belgium, aquatic ecology – many tropical lakes)

Prof. Dr. Steven Loiselle (Siena University, Italy – EAGLO = Great Lakes Observatory)

Prof. Dr. Tammo Steenhuis (Cornell University, USA & BDU, hydrology – Lake Tana)

Prof. Dr. Valentijn Pauwels (Monash University, Australia, hydrology – Lake Tana basin)

Prof. Dr. Katrien Descheemaeker, Wageningen University, plant-water-livestock interaction

Prof. Dr. Andreas Klik (BOKU, Vienna)

Dr. Amaury Frankl (Ghent University, Belgium, hydrogeomorphology)

Dr. Eltigani E. Abdelgalil (Water Man. and Irrigation Institute, University of Gezira, Sudan)

Dr. Eshete Dejen (IGAD, Djibouti, fisheries)

Dr. Ferdas Ziadat (ICARDA, solicited)

Dr. Gete Zeleke (Water and Land Resource Centre (WLRC), Addis Ababa)

Dr. Irit Eguavoen (University of Bonn, Social Anthropology/ African Studies – Blue Nile)

Dr. Leo Nagelkerke (Wageningen University, Netherlands, aquatic ecology – Lake Tana et al.)

Dr. Negash Wagesho (Arba Minch University, Ethiopia, hydrology – Lake Abaya and Chamo)

Dr. Nigussie Haregeweyn (Tottori University, Japan, reservoir catchments in Ethiopia)

Dr. Seifu A. Tilahun (BDU, hydrology – Lake Tana basin)

Dr. Teklu Erkossa (International Water Management Institute, Addis Ababa – solicited)

Dr. Tilahun Amede (ICRISAT, intensification of agricultural landscapes)

Dr. Wondimu Bayu (ICARDA, agronomy – Lake Tana basin)

PROGRAM

Wednesday 23 to Friday 25 September	daily 8:00 am – 5:00 pm	Pre-conference excursion
Friday evening 25 September	5:00 pm – 7:00 pm	Reception and registration
	8:30 am – 9:15 am	Registration, coffee, mounting posters
	9:15 am – 9:30 am	Opening of the conference
	9:30 am – 10:00 am	Session 1: Climate and tropical lakes
	10:00 am – 10:30 am	Tea and coffee, poster gathering and discussion
	10:30 am – 12:30 pm	Session 1: Climate and tropical lakes
	12:30 pm – 1:30 pm	Lunch break
Saturday 26 September	1:30 pm – 2:45 pm	Session 2: Water balance of tropical lakes
	2:45 pm – 4:15 pm	Session 3: Tropical catchment hydrology
	4:15 pm – 4:45 pm	Tea and coffee, poster gathering and discussion
	4:45 pm – 6:30 pm	Session 4: Ecosystem services of tropical lakes
Sunday 27 September	8:00 am – 5:00 pm	Mid conference excursion
	8:30 am – 10:15 am	Session 5: Water quality and aquatic ecology of rivers, wetlands and springs
	10:15 am – 10:45 am	Tea and coffee
	10:45 am – 1:00 pm	Session 6: The aquatic ecology of Africa's lakes
Monday 28 September	1:00 pm – 2:00 pm	Lunch break
	2:00 pm – 3:00 pm	Session 7: Geomorphology and soils in tropical lake basins
	3:00 pm – 3:30 pm	Tea and coffee
	3:30 pm – 6:30 pm	Session 8: Catchment management, soil and water conservation
	6:30 pm – 7:15 pm	Break
	7:15 pm	Conference dinner
Tuesday 29 September	8:30 am – 10:15 am	Session 9: Land use, land degradation and soil erosion in tropical lake basins

10:15 am – 10:45 am	Tea and coffee
10:45 am – 12:00 pm	Session 10: Sediment deposition in tropical lakes and endorheic basins
12:00 pm – 1:00 pm	Lunch break
1:00 pm – 2:00 pm	Summary of sessions
2:00 pm – 3:30 pm	Networking meetings
3:30 pm	Official closure of the conference

Note that we program 15 minutes for oral presentations, including 12 minutes presentation and 3 minutes for questions.

PROGRAM DETAILS

Wednesday 23 to Friday 25 September 2015

Daily 8:00 am – 5:00 pm: **Pre-conference excursion**, *jointly with local stakeholders*

Meeting point: at the entrance of the RahNile Hotel.

Gathering is 10 min before departure.

For the detailed program, see the excursion guide.

Friday evening 25 September 2015

5:00 pm – 7:00 pm: **Reception and registration**

Saturday 26 September

8:30 am – 9:15 am: *Registration, coffee, mounting posters*

9:15 am – 9:30 am: *Opening of the conference by **Dr. Baylie Damtie** (President of Bahir Dar University) and address from the organizing committee*

9:30 am – 10:00 am: **Session 1** – *Climate and tropical lakes*

*Keynote by **<u>Prof. Dr. Tammo Steenhuis</u>**, The Hydrology of Lake Tana Basin, Department of Biological and Environmental Engineering, Cornell University.*

<u>10:00 am – 10:30 am</u>: ***Tea and coffee, poster gathering and discussion***

Poster gathering includes:

Major influence of the African Great Lakes on the hydrological cycle and atmospheric dynamics, by **Wim Thiery** (KULeuven, Belgium) et al.

Stream flow and sediment export from tropical catchments influenced by papyrus wetland encroachment, by **Nick Ryken** (KULeuven, Belgium) et al.

Evaluating effects of historical climate change and land use/cover change on Catchment hydrology of Gumara watershed, Upper Blue Nile basin, Ethiopia, by **Gashaw Gismu**.

Environmental challenges vis a vis opportunities: The case of water hyacinth in Lake Tana, Blue Nile basin of Amhara Region, Ethiopia, by **Shigdaf Mekuriaw** (Andassa Livestock Research Center, Ethiopia) et al.

Water footprint and virtual water trade to develop equitable water policy in trans-boundary basin: a case study for Nile, by **Amanuel Abate** (Addis Ababa University, Ethiopia).

Development of synthetic unit hydrograph for watersheds in Lake Tana sub-basin, Ethiopia, by **Achenafi Teklay** (Addis Ababa University, Ethiopia) et al.

Climate Change Impact on Sediment Yield in the Upper Gilgel Abay Catchment, Blue Nile Basin Ethiopia, by **Anwar Adem** (Bahir Dar University, Ethiopia) et al.

Spatial variability of top soil moisture and crop performance under different soil and water conservation structures in the semi-arid Ethiopian highlands, by **Gebeyehu Taye** (Mekelle University, Ethiopia) et al.

Predicting Spatial and Temporal Soil Moisture Distribution in an Agricultural Field of Gumara-Maksegnit Watershed, North Gondar, Ethiopia, by **Muuz Gebretsadik** (Gondar Agricultural Research Center, Ethiopia) et al.

Spatial and Temporal Simulation of Groundwater Recharge for Geba Catchment, Northern Ethiopia Using WetSpa, by **Alemu Yenehun Beyene** (Bahir Dar University, Ethiopia) et al.

Curve number and runoff coefficients for different soil and water conservation treatments on semi-humid tropical highlands, Blue Nile basin, by **Dagnenet Sultan** (Tottori University, Japan) et al.

The Opening of Sand Quarries in Dschang City (West-Cameroon, Central Africa): Source of Land and Lake Degradation, by **Ghislain Zangmo** Tefogoum (University of Maroua, Cameroon) et al.

Evaluating potential impacts of climate change on surface water availability of upper Awash Sub-basin, Ethiopia, by **Mekonnen Daba** (Arbaminch University, Ethiopia) et al.

A novel approach to map water holding capacity and nitrogen availability, by **Chantal Hendriks** (Wageningen University, The Netherlands) et al.

Modelling soil redistribution and gully head retreat in the Lower Nyando catchment (Kenya), by **Chantal Hendriks** (Wageningen University, The Netherlands) et al.

Evaluating potential impacts of climate change on surface water availability of upper Awash Sub-Basin, Ethiopia, by **Mekonnen Daba** (Arba Minch University, Ethiopia) et al.

10:30 am – 12:30 pm*: **Session 1 – Climate and tropical lakes***

Chair: Jean Poesen (KU Leuven); co-chair: Yihenew G/Sellasie (Bahir Dar University)

The Impact of future Climate Change on Runoff and Sediment Yield towards the Geba reservoir, northern Ethiopia, by **Amanuel Zenebe** (Mekelle University, Ethiopia) et al.

Impact of Climate Change on Lake Chamo Water Level, Ethiopia, by **Elias Gebeyehu** (Arba Minch University, Ethiopia) et al.

Land use and climate change decrease ecological stability of the African soda lake Nakuru, by **Alfred Burian** (Stockholm University, Sweden) et al.

Modeling the impacts of climate change and land cover degradation on the water resources in Benin, West Africa, by **Elliott Dossou-Yovo** (Abomey-Calavi University, Benin) et al.

Adapting Mechanism for Climate Change Impact on Hydrological Extremes and Crop Production, by **Kassa Tadele** (Arba Minch University, Ethiopia) et al.

Hydrological Response to Climate Change of the Upper Blue Nile River Basin: Based on IPCC Fifth Assessment Report (AR5), by **Sintayehu Legesse Gebre** (Jimma University, Ethiopia) et al.

Fishermen perception on the impact of climate change and fishing products in the low valley of Oueme River, by **Hermas Attingli** (Université d'Abomey-Calavi, Bénin) et al.

Hydrogeological Modelling of Palaeo-Carbon Dioxide Sequestration within an Intracratonic Limnic Lake. Southern Springbok Flats Basin, South Africa, by **Tshegofatso O.P. Mophatlane** (Indigenous Science Consulting, South Africa).

12:30 pm – 1:30 pm: *Lunch break*

1:30 pm – 2:45 pm: **Session 2** – *Water balance of tropical lakes*

Chair: Amanuel Zenebe (Mekele University); co-chair: Tammo Steenhuis (Cornell University, Bahir Dar University)

Hydrological impacts of the floodplain on river discharges and water balance of Lake Tana, Ethiopia, by **Mekete Dessie** (Bahir Dar University, Ethiopia) et al.

Preliminary findings from tree rings research from Gondar for reconstructing discharge from Lake Tana, by **Abrham Abiyu** (Gondar Agricultural research center, Ethiopia).

Response of a shallow aquifer to Micro-Dam Reservoir leakage and natural recharge: a water balance model approach, by **Gebremedhin Berhane** (Mekele University, Ethiopia) et al.

Grid-Based Parameterization of Monthly Water Balance Model for Simulation of River Flow at Ungauged Sites in Upper Blue Nile Basin, by **Birhanu Kebede** (Bahir Dar University, Ethiopia).

The Impact of Land Use System on Rainfall-Runoff and Groundwater Recharge in the Tekeze-Atbara River Basin, by **Khalid Biro** (Hydraulics research center, Wad Medani, Sudan) et al.

2:45 pm – 4:15 pm: **Session 3** – *Tropical catchment hydrology*

Chair: Paolo Billi (University of Ferrara); co-chair: Seifu Admassu (Bahir Dar University)

The nexus of land use changes and their impacts on agricultural and natural aquatic systems – The case of Malawi's 2015 floods, by **David Nangoma** (Mulanje Mountain Conservation Trust, Malawi) et al.

Understanding surface-groundwater interactions in semi humid environment using groundwater level observation in the Lake Tana sub-basin, Ethiopia, by **Temesgen Enku** (Bahir Dar University, Ethiopia) et al.

Hydraulic Interconnection between the Volcanic Aquifer and major springs, Lake Tana Basin on the Upper Blue Nile, by **Fenta Nigate** (Bahir Dar University, Ethiopia) et al.

Calibration and validation of the hydrological model SWAT using observed and remote sensing meteorological data in Abbay basin, Ethiopia, by **Erwin Isaac** (Technische Universität München, Germany) et al.

Assessment of Watershed Hydrology Responses and Rainfall Runoff Modeling in Lake Tana Basin, Case of Awramba Watershed, by **Mamaru A. Moges** (Bahir Dar University, Ethiopia) et al.

Estimating the hydrological response of soil and water conservation structures: Is the Curve Number method applicable?, by **Gebeyehu Taye** (Mekele University, Ethiopia) et al.

4:15 pm – 4:45 pm: ***Tea and coffee, poster gathering and discussion***

4:45 pm – 6:30 pm: **Session 4** – *Ecosystem services of tropical lakes*

*Keynote by **Prof. Dr. Harry Verhoeven**, Water Politics in Africa, Department of Politics and International Relations, University of Oxford/Georgetown University.*

Chair: Bedru Babulo Balana (IMWI); co-chair: Wassie Anteneh (Bahir Dar University)

Trade-offs or Synergies? Assessment of Ecosystem Services in Multi-use Small Reservoirs in Burkina Faso, by **Bedru Babulo Balana** (International Water Management Institute, Ghana).

Valuing Fishery: Ecosystem-Based Fisheries Management for Lake Naivasha, Kenya, by **Dawit Mulatu** (Environment and Climate Research Centre, Ethiopia) et al.

Wetland spatio-temporal change analysis and ecosystem services in two urbanising cities, by **Priyanie Amerasinghe** and **Daniel Van Rooijen** (IWMI) et al.

Sustainable fisheries and aquatic resource management of Lake Tana: Lessons from three decades of Ethio-Netherlands Cooperation, by **Eshete Dejen** (Intergovernmental Authority on Development, Djibouti) et al.

Potentials and challenges of eco-tourism development in Lake Tana, Ethiopia, by **Getinet Fetene** (Wageningen University, The Netherlands; Representing NABU).

Sunday 27 September

8:00 am – 5:00 pm: ***Mid conference excursion***, *by boat on Lake Tana*

Meeting point: to be announced.

Gathering is 10 min before departure.

For the detailed program, see the excursion guide.

Monday 28 September

8:30 am – 10:15 am: ***Session 5** – Water quality and aquatic ecology of rivers, wetlands and springs*

Keynote by **___Prof. Dr. Steven Bouillon___**, *Tropical Aquatic Ecosystems, Department of Earth & Environmental Sciences, KU Leuven.*

Chair: Luc De Meester (KU Leuven); co-chair: Mulugeta Kibret (Bahir Dar University)

Changes in the water quality and ecology of the Ethiopian rift valley lakes Chamo and Abaya, by **Luc De Meester** (KULeuven, Belgium) et al.

Spatial and seasonal variation in the macro-invertebrates and physico-chemical parameters of the Enfranz River, Lake Tana sub-basin (Ethiopia), by **Abrehet Kahsay** (Bahir Dar University, Ethiopia) et al.

The importance of environmental, land-use and spatial factors on composition and diversity of wetland bird communities, by **Seid Tiku Mereta** (Jimma University, Ethiopia) et al.

Establishing criteria to select reference sites for ecological and water quality assessment in Ethiopian highland freshwater ecosystem, by **Aschalew Lakew** (Ethiopian Institute of Agricultural Research at National Fishery and Aquatic Life Research Centre, Ethiopia).

Potentially Toxic Trace Element Contamination of the Little Akaki River of Addis Ababa, Ethiopia, by **Minbale Aschale** (Ethiopian Institute of Water Resources, Ethiopia) et al.

10:15 am – 10:45 am: *Tea and coffee*

10:45 am – 1:00 pm: *Session 6 – The aquatic ecology of Africa's lakes*

Chair: Steven Bouillon (KU Leuven); co-chair: Mulugeta Kibret (Bahir Dar University)

Composition, productivity and seasonality of phytoplankton in the crater lakes of western Uganda, by **Angela Nankabirwa** (Ghent University, Belgium) et al.

Impact of Water hyacinth (Eichhornia crassipes) on Water quality in the North Eastern part of Lake Tana, Ethiopia, by **Banchiamlak Getnet** (Bahir Dar University, Ethiopia) et al.

Identifying Sources of Nitrate pollution in the Lake Victoria catchment (Kenya) via Isotopic Fingerprinting, by **Benjamin Nyilitya** (Nairobi University, Kenya) et al.

Population and Paleogenetics structure of water fleas -Daphnia in space and time in the African Sky Islands Lakes, by **Haileselasie Tsegazeabe Hadush** (KULeuven, Ethiopia) et al.

Remote and Proximal Sensing Applications for the Determination of the Eutrophic Status of a lake, by **Gezahegne Gebremeskel** (EMA, Ethiopia).

Study of Environmental and Human Impacts of Mount Manengouba Lakes (Cameroon Line), by **Ghislain Zangmo** (University of Maroua, Cameroon) et al.

Major and Trace Elements Concentrations in Two Contrasting Rift Valley Lakes, Kenya: Water, Sediments, Fish and Parasites, by **Elick Otachi** (Egerton University, Kenya).

Could Sand Mining be a major Threat for the Declining Endemic Labeobarbus species of Lake Tana?, by **Shewit Gebremedhin** (Bahir Dar University, Ethiopia) et al.

Impact of waste water on Lakes: Case of Lake Obili Yaoundé Cameroon, by **Kamdjo Takougou Raoul Joel** (University of Yaoundé 1, Cameroon).

1:00 pm – 2:00 pm: *Lunch break*

2:00 pm – 3:00 pm: *Session 7 – Geomorphology and soils in tropical lake basins*

Chair: Jozef Deckers (KU Leuven); co-chair: Sil Lanckriet (Ghent University)

Effects of land drainage and physical soil and water conservation on topographical thresholds for gully head development in North Ethiopia, by **Elise Monsieurs** (Africamuseum, Belgium) et al.

Hydrogeomorphological changes due to River Bank Erosion and In-Channel Deposition) to Gumara River in the lacustrine plain of Lake Tana (Ethiopia), by **Minychl Gitaw** (Bahir Dar University, Ethiopia) et al.

Variation of Selected Soil Properties in Relation to Land Use Types and Slope Steepness in a Mountainous Watershed, Ethiopia, by **Hailu Kendie** (University of Vienna, Austria) et al.

Hydrological and morphological factors at gully heads in the humid Northern Ethiopian Highlands, Birr watershed, by **Meseret B. Addisie** (Bahir Dar University, Ethiopia) et al.

3:00 pm – 3:30 pm*: Tea and coffee*

3:30 pm – 6:30 pm*: **Session 8** – Catchment management, soil and water conservation*

*Keynote by **<u>Prof. Dr. Paolo Billi</u>**, Editor of "Landscapes and landforms of Ethiopia" (Springer Books, 2015), Department of Physics and Earth Sciences, University of Ferrara.*

Chair: Jozef Deckers (KU Leuven); co-chair: Dereje Tsegaye (Bahir Dar University)

Soil and water conservation effects of stone bunds at different scales – a case study from Gumara-Maksegnit watershed, Lake Tana Basin, Ethiopia, by **Stefan Strohmeier** (ICARDA, Jordan) et al.

A decade progress of conservation agriculture-based systems on in situ soil and water conservation and adaptation to climate change in the Ethiopian drylands, by **Tesfay Araya** (Fort Hare University, South Africa) et al.

Land management in the North-Western Highlands of Ethiopia: Adoption and Impact, by **Akalu Teshome** (Wageningen University, The Netherlands) et al.

Integrated watershed management implementation: Implication for reduce soil erosion, improve crop production and its associated impact in the upstream and downstream communities in Adulala Watershed, Ethiopia, by **Desale Kidane** (Samara University, Ethiopia) et al.

Effect of check dams in gullies on runoff response in the headwaters of Tekeze reservoir, by **Etefa Guyassa** (Ghent University, Belgium) et al.

The implications of participatory watershed management for reversing land degradation in Ethiopian highlands: The Birr watershed, by **Getaneh K. Ayele** (Bahir Dar University) et al.

Evaluating indigenous grass species as on-site sediment trapping measures, northwest Ethiopian highlands, by **Mulatie Mekonnen** (Wageningen University, The Netherlands) et al.

The role of on-farm forest resources as an adaptation strategy to climate change effects to the communities around Mkingu Nature Reserve in the Eastern Arc Mountains, by **Upendo Msalilwa** (Tanzania Forestry Research Institute, Tanzania) et al.

Impact of cover crop on runoff, soil loss, soil chemical properties and yield of chickpea in North Gondar, Ethiopia, by **Nigus Demelash** (Gondar Agricultural Research Center, Ethiopia) et al.

Effectiveness of soil and water conservation measures in two contrasting environments of the Ethiopian highlands, by **Nigussie Haregeweyn** (Tottori University, Japan) et al.

6:30 pm - 7:15 pm: *Break*

7:15 pm: *Conference dinner*

Tuesday 29 September

8:30 am – 10:15 am: *Session 9 – Land use, land degradation and soil erosion in tropical lake basins*

Chair: Stefan Strohmeier (International Center for Agricultural Research in the Dry Areas (ICARDA)); co-chair: Sil Lanckriet (Ghent University)

Spatial patterns of soil erodibility through soilscapes in land systems of Lake Tana catchment (Ethiopia), by **Jozef Deckers** (KULeuven, Belgium).

Effects of transnational land deals on peak discharge and sediment transport in the catchments around the Grand Ethiopian Renaissance Dam, by **Dereje Teklemariam** (Ghent University, Belgium) et al.

Impacts of Land Cover Change on Sediment Load of Lake Tana; a Case of Gilgel Abay Watershed, Blue Nile, Ethiopia, by **Anwar Adem and Leykun Ayele** (Bahir Dar University, Ethiopia).

Sediment production from gully erosion in the (semi) humid Ethiopian highlands: the Debre Mawi watershed, by **Assefa D. Zegeye** (Cornell University, USA) et al.

Contributions of peak sediment events to annual loads and the effects of Best Management Practices on peak loads in the sub-humid Ethiopian highlands: The Debre Mawi watershed, by **Dagnew Dessalegn** (Bahir Dar University, Ethiopia) et al.

Influence of the landscape context on stand structure and spatial patterns of the agroforestry dum palm tree in the Republic of Benin (West Africa), by **Rodrigue Idohou** (University of Abomey-Calavi, Benin) et al.

Vegetation Dynamics in Nech Sar National park, South Ethiopia Rift Valley, by **Shetie Gatew** (Arba Minch University, Ethiopia) et al.

10:15 am – 10:45 am: ***Tea and coffee***

10:45 am – 12:00 pm: **Session 10** – Sediment deposition in tropical lakes and endorheic basins

Chair: Jean Poesen (KU Leuven); co-chair: Michael Meharie (Bahir Dar University)

Sediment budget of Lake Tana and the role of lacustrine plains, by **Hanibal Lemma** (Ghent University) et al.

A comprehensive sediment yield database and map for Africa, by **Jean Poesen** (KULeuven, Belgium) et al.

Sediment Supply to the semi-endorheic Raya Graben (Northern Ethiopia), by **Biadgilgn Mullaw** (Ghent University, Belgium) et al.

Quantification of discharge and sediment transport in the Lake Tana Bain, Ethiopia, by **Fasikaw A. Zimale** (Bahir Dar University, Ethiopia) et al.

Biogas production from lake bottom sediments, by **Tibebu Dessie** (University of Eastern Finland, Finland).

12:00 pm – 1:00 pm: ***Lunch break***

1:00 pm – 2:00 pm: ***Summary of sessions***

2:00 pm – 3:30 pm: ***Networking meetings***

3:30 pm: ***Official closure of the conference,*** *by **Dr. Tesfaye Shiferaw** (Vice President for Research and Community Service of Bahir Dar University) and address from the organizing committee*

Climate and tropical lakes

Session 1

Climate and tropical lakes

Saturday 26 September

9:30 am – 12:30 pm

The Impact of future Climate Change on Runoff and Sediment Yield towards the Geba reservoir, northern Ethiopia

Amanuel Zenebe Abraha [1,2*], Gebremeskel Aregay[2], Atkilt Girma [1,2], Henok Shiferaw[1], Jan Nyssen[3], Jozef Deckers[4], Jean Poesen[4]

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[2] Department of Land Resources Management and Environmental Protection, Mekelle University, P.O. Box 231, Ethiopia
3 Geography Department, Gent University, Krijgslaan 281 (S8), B 9000, Gent, Belgium
[4] Department of Earth and Environmental Sciences, Division of Geography, KU Leuven, Celestijnenlaan 200 E, B-3001 Heverlee, Belgium

Abstract

The objective of this study was to assess the impact of future climate change on runoff and sediment yield for the planned lake (reservoir) on Geba river, using Statistical Downscaling Model (SDSM) and the Soil and Water Assessment Tool (SWAT) model. Three climatic variables (precipitation, maximum air temperature and minimum temperature) were downscaled at Hawzen station, assuming other climatic variables to be constant for the near, mid and long-term future using General Circulation Model (GCM) (HadCM3 A2a and B2a emission scenarios). SDSM was used to downscale to the study area, and the downscaled data was used as an input to the spatially-distributed Soil Water Analysis Tool (SWAT) model to predict future monthly surface runoff. On an annual basis, precipitation showed a decreasing trend while maximum and minimum air temperature showed an increasing trend. Precipitation decreases by 7.84% in the 2020s and by 29.93% in 2080s for A2a scenario and by 6.78% in 2020s and 21% in 2080s for B2a scenario. Similarly maximum air temperature showed an increase by 0.002°C in 2020s and by 0.02°C in 2080s for A2a scenario and by 0°C and 0.04°C for B2a scenario. Minimum air temperature also showed an increase by 0.1 $^{\circ}$C in 2020s and by 0.48°C in 2080s for A2a scenario and similarly by 0.16°C and 0.36°C for B2a scenario. The hydrological model was calibrated and validated at the outlet of the catchment and the performance was checked using statistical parameters and the performance was found to range from good to satisfactory. The results of the downscaling for the three climatic variables were used as an input for the hydrological model to assess the impact of the changes in these climatic variables on stream flow discharge and on sediment yield. Furthermore, runoff discharge and sediment yield for the catchment showed a decreasing trend for all time horizons for both A2a and B2a scenario. The decrease in precipitation expected for the future is higher in the rainy season, which implies a reduction in stream flow towards the Geba reservoir in the rainy months of July, August and September by respectively 8.6%, 6.9%, 2.5% in 2020s, by 12.5%, 11.8%, 3.2 % in 2050s and by 13.8%, 12.4%, 3.8% in 2080s.

Keywords: Climate change, GCM, SDSM, SWAT, Stream flow, Sediment yield

Impact of Climate Change on Lake Chamo Water Level, Ethiopia

Elias Gebeyehu[1] and Dr.Negash Wagesho[2]

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Abstract
One of the most significant potential concerns of climate change is to understand changes in hydrological components and subsequent change in lakes water balance. In view of this studying the water balance components such as surface water inflow from gauged and ungauged sub-watersheds, precipitation and evaporation pattern of the natural reservoir and their associated impacts vis-à-vis altering the water balance of terminal Lake Chamo has a major concern of the present study. It ultimately focuses on evaluating the impact of climate variability on water balance of Lake Chamo, situated in the southern part of the Ethiopian Rift valley lakes basin system. Lake Chamo is the one of Ethiopian Rift valley Lakes system with a total area of $328.63Km^2$ and average depth of 10.1m.

The A1B scenario Regional Climate Model (RCM) obtained from International Water Management Institute (IWMI) is used for future climate condition analysis. The raw A1B scenario outputs are characterized by significant biases and hence subjected to bias correction before applying is for the hydrological modeling. The bias correction for A1B scenario for precipitation, maximum and minimum temperature was done by using Linear scaling approach. This analysis is based on projection of two different scenarios of future time horizons: 2030s (2031-2040) and 2090s (2091-2100). Over lake evaporation is estimated by Penman Monteith formula, over-lake precipitation is computed by area weighing method and surface inflows are simulated by using HBV model. A hydrological model, HBV, was used in order to simulate the current and future inflow to the lake. The performance of the model was assessed through calibration and validation process and resulted in R^2 from 0.64 to 0.81 during calibration and from 0.63 to 0.77 during validation and the relative volume error RV_E is from -1.77% to 4.42% at the three stations. Mean annual inflow to Lake Chamo from gauged and un-gauged catchment is 257mmyr^{-1}. The estimated runoff for the period 2030s and 2090s is 215 mmyr^{-1} and 147mmyr^{-1} respectively. The result shows the mean annual inflow is decreased by 16.3% and 42.8% in 2030s and 2090s respectively from the base time period.

The result revealed that the maximum and minimum temperatures increase for the two scenarios in future time horizons. However, precipitation decreases in all future time horizons. The A1B scenario reveals the decreasing pattern of lake water storage due to decrease of inflows components such over lake precipitation and surface water inflow in all future time horizons. In this scenario, the over-lake evaporation is increased by 0.73% and 2.6% at 2030s and 2090s.

Keywords: Water Balance, Lake Chamo, RCM, A1B, Climate variability, HBV model.

Land use and climate change decrease ecological stability of the African soda lake Nakuru

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Abstract
Most African soda lakes are shallow, endorheic systems and are classified as climate amplifier lakes, strongly reflecting temperature and rainfall changes through lake-level fluctuation. Although they are of little direct importance for human communities (no fishing or freshwater usage), soda lakes support unique aquatic and terrestrial fauna and are major assets for East-Africa's tourist industry.

We have shown in earlier work that lake level changes can strongly affect primary producers and zooplankton. The impact of lake level changes is mainly transmitted through changes in salinity as well as the hydrological stability of the water-column and can lead to cascading effects from the base of the food web to top consumers. Changes in food availability could especially affect the lesser flamingo, the flagship species of African soda lakes.

Here, we present preliminary data on the relationships between land-use changes in the catchment, soil erosion rates and the bathymetry of Lake Nakuru, traditionally the most important Kenyan soda lake for flamingos. Hydrological changes driven by land-use change have the potential to strongly interact with altered temperature and rainfall conditions and substantially decrease the ecological stability of East African soda-lakes.

Modeling the impacts of climate change and land cover degradation on the water resources in Benin, West Africa

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Abstract

The development of industrial and agricultural activities, multiplication of transportation means and population increase are leading to an increase of the emission of greenhouse gases in the atmosphere, responsible of climate change. At a continental scale, Africa and particularly West Africa is the most vulnerable due to the dependency of its agriculture to climate and its low adaptation capacity. In this continental context, Benin country has recorded during the past thirty years an important decrease in precipitation and surface water, making though access of the population to water. This decrease in rainfall together with population pressure led to rapid decline of the vegetation. Such changes raised important issues concerning the sustainable development of the region.

This study was conducted in the Okpara catchment at the Kaboua outlet, stretching over a total area of 9,461 Km^2 representing 8.24 % of Benin Republic area. The geology of the catchment dominated by shelf makes difficult the access of population to drinking water. At this context already though for the population, are added the effects of climate change which will be responsible of 20% decrease of water resources according to UNESCO. Support for the population in sustainable access to water resources requires their precise quantification under climate change and land degradation. We used the Soil and Water Assessment Tool (SWAT) model to quantify the components of the water balance in the study area. After calibration and validation, the model was used to simulate the effects of climate change and land degradation on the water resources based of scenario modeling. Three scenarios were integrated in the model: (i) climate changes but land use does not change, (ii) climate does not change but land use changes, (iii) both climate and land use change.

After calibration and validation, it sprang out that 1,075.8 mm/a of precipitation fell in the watershed. The surface runoff was 106.6 mm/a (10% of precipitation) while the total recharge of aquifers was 225.4 mm/a (21% of precipitation). The actual evapotranspiration was 759.8 mm/year (71% of precipitation). The total volume annually produced in the catchment was about 4 billions m^3; more than 500 times the needs of the population who paradoxically suffered from severe water scarcity. For the future water production, results of the simulations (2015-2025) showed, compared to those obtained during the calibration and validation period (2000-2010), an important decrease of surface runoff (35-37%) and mean water yield (28%) as consequences of climate change and land use change. On the contrary, an increase in surface runoff (10.8-14.23%), and a decrease in water yield (4.3-6.1%) were anticipated as consequences of land cover degradation. Based on these results, suggestions were made for a better assistance to the population in the sustainable management of water resources and land use.

Adapting Mechanism for Climate Change Impact on Hydrological Extremes and Crop Production

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Abstract

Adaptation to climate change has become one of the focal points of current development discussion. In this regard, the ultimate goal of adaptation is to develop flexible and resilient societies and economies that have the capacity to address both the challenges and the opportunities presented by changing climatic conditions. This study, therefore, aims to develop an integrated adaptation mechanism for climate change (CC) impact on hydrological extreme and crop production at Abaya-Chamo Basin, Southern Rift Valley Basin, Ethiopia.

The study employed both scientific and indigenous tools to undertake integrated assessment of vulnerability of hydrological extremes and crop production to climate change and develop potential adaptation options. The study incorporates four major components: (1) Regional climate modelling, (2) Hydrological extremes modelling, (3) Crop production vulnerability for CC and (4) Indigenous tools for CC adaptation. The integral output of these working packages was used to develop adaptation options based on the degree of vulnerability in the study area. A Regional climate model (RegCM3) was implemented. To assess the impact of climate change on hydrology of watershed, SWAT hydrological model was used to simulate the water balane. For the development of flood inundation maps, HEC–RAS/HEC-GeoRAS, Global Mapper, Auto CAD , WMS and Arc-View GIS with extensions of spatial analyst were used. Moreover, for assessing drought incidents Standard Precipitation Index (SPI) was employed while to assess the impacts of climate change on crop production an agricultural model called Aquacrop was utilized.The result of this study indicates that temperature will show an average increasing trend by 1.1 oC during the 2030 period and 1.5 oC during 2090s. Unlike temperature, precipitation will not show increasing or decreasing trends, rather it shows inter-seasonal and annual variability for all climate periods. The indigenous knowledge assessment pointed out that 40% of the farmers responded that rainfall has showed a decreasing and seasonal shift trend in the past decades, while around 80% responded an increase trend of temperature. Moreover, the respondent, 65%, replied flood occurs at Baso watershed while the same percentage responded that draught occurred at Bilate watershed. Furthermore, farmers suggested different adaptation measures to climate change. On the other hand, constructing of levees at both sides of the Baso River was found the best measure among the other scenarios to reduce the flood incidence at Baso watershed. Besides, the SPI indicates that drought will occur between 2035 and 2039. On the other hand, crop production simulation for 2030 indicated that maize yield will be reduced unless rain-fed is supplemented with Irrigation. In general, it is proposed that for implementing adaptations to climate change in agriculture and extreme hydrological events there is a need to better understand and integrate both scientific and indigenous adaptation options to cope-up with impacts of climate change.

Keywords: Hydrological extremes, Regional climate modelling, crop production, Indigenous tools, climate change adaptation

Hydrological Response to Climate Change of the Upper Blue Nile River Basin: Based on IPCC Fifth Assessment Report (AR5)

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Abstract

Climate change is likely to affect the hydrology and water resources availability of upper Blue Nile River basin. Different water resource development projects are currently existed and under construction in the region. In order to understand the future impacts of climate change, we assessed the hydrological response of climate change of four catchments (Gilgel Abay, Gumer, Ribb, and Megech) of the upper Blue Nile River basin using new emission scenarios based on IPCC fifth assessment report (AR5). Five biased corrected 50 kms by 50 kms resolution GCMs (Global Circulation Model) output of RCP 4.5 and RCP 8.5 emission scenarios were used. The future projection period were divided in to two future horizons of 2030`s (2035-2064) and 2070`s (2071-2100). The Hydrologic Engineering Center-Hydrological Modelling System (HEC-HMS) was calibrated and validated for stream flow simulation. All the five GCMs projection showed that, maximum and minimum temperature increases in all months and seasons in the upper Blue Nile basin. The change in magnitude in RCP 8.5 emission is more than RCP 4.5 scenario as expected. There is considerable average monthly and seasonal precipitation change variability in magnitude and direction. Runoff is expected to increase in the future, at 2030`s average annual runoff projection change may increase up to +55.7% for RCP 4.5 and up to +74.8% for RCP 8.5 scenarios. At 2070`s average annual runoff percentage change increase by +73.5% and by +127.4% for RCP 4.5 and RCP 8.5 emission scenarios, respectively. Hence, the increase in flow volume in the basin may have a significant contribution for the sustainability of existed and undergoing water development projects. Moreover; it will help for small scale farmer holders to harness water for their crop productivity. However, a precaution of mitigation and adaptation measures ought to be developed for possible flooding in the flood plains area of the River basin.

Keyword: Blue Nile, GCM, HEC-HMS, RCP, Scenario

Fishermen perception on the impact of climate change and fishing products in the low valley of the Oueme River

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Abstract

Data based on socio-demographic characteristics of fishing producers, the constraints of fishing, their perception on climate change and adaptation measures to the impacts of hydro-climate variability in four municipalities of the rich valley of Ouémé were collected using a questionnaire administered to 266 individuals with at least 20 years of fishing practice in the municipalities of Aguegue, Dangbo, Adjohoun and Bonou. These actors are native of the area among which are fisher-farmers (43.98%), farmer-fishermen (35.71%) and 18.42% of fishermen reconverted into the dredging of river sand with 1.12% converted into inland coastal transportation and 0.7% in gasoline smuggling. Hence, 17 fishing camps have been explored. Fishermen have reported variation in temperature and rainfall, a rise in temperature and a decreased of rainfall; severe and persistent floods confirmed by analysis of hydro-meteorological data. Sex significantly affects the perception of fishermen on climate change. It is strongly influence the adaptation strategy (P <0.0001), as well as fisherman themselves (P <0.01). Among the most important conclusions of the fishing industry, there are the decline of fishing products, the extinction of some economically viable species, the prolonged drying of waterways and the overflowing of the main rivers. Besides, the adaptation strategies of fishermen are also a source of pollution to the lower valley.

Keywords: perception, fishermen, climate change, adaptation

Hydrogeological Modelling of Palaeo-Carbon Dioxide Sequestration within an Intracratonic Limnic Lake. Southern Springbok Flats Basin, South Africa.

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Abstract

The Springbok Flats Basin, a Sub-Cratonic basin located in the north-eastern parts of Southern Africa, has in the past decade received much deserved attention due to the energy challenges the region is currently experiencing. This study is an expansion of M.Sc research being conducted through the University of the Witwatersrand, which is investigating the hydrogeological contamination risks that would be associated with the implantation of the Clean Development Mechanism Method of anthropogenic carbon dioxide sequestration within the basin's coal seams. The aim of this paper is to investigate palaeo-carbon dioxide sequestration within a limnic lake located within the south-western limits of the Springbok Flats Basin and to consequently produce a 3D hydrogeological conceptual model of the lake waters. The methods included; geological and hydrogeological desktop studies utilising Eriksson et al. (2001) and Department of Water Affairs, (1986) respectively, the South African National Space Agency SPOT 6 satellite remote sensing resources, QGIS Chugiak, the Department of Water Affairs National Groundwater Archive, USGS PHAST 2.0 simulator and field hydrogeological and geological sampling. Geological and hydrogeological maps together with remote sensing suggest that the geomorphology 0f the lake is a small scale mirror equivalent of the northern Springbok Flats Sub-Basin. The lacustrine basin has a minimum depth of 100m and the deepest parts reach 350m.The basin's basal bedrock consists of Karoo age sandstone and neptunic nebo-granite plutons that are overlaid by basaltic overflows. The lava flows are overlain by Quaternary a sediment load that is predominantly grey-white to pink fine to coarse grained sands derived from the Pretoria Group, introduced into the system by the Apies River along the lakes western shoreline. The shape file of the lake basin digitised with QGIS and SPOT 6 indicates the basin to have a current area of 2100km^2. Preliminary modelling indictates that there are two carbon dioxide plumes which have been modelled as bicarbonate ions. There is a thin (±2.5m) single layer carbon dioxide plume along the surface of the sediment load bound northward of the fissure vent, ranging in concentration from 0.002 to 0.004 mg/l and flowing northward towards the north bound shield volcanoes. The other carbon dioxide plume system is a dual layered plume, bound southward of the Strombolian vent, consisting of the thin layer of similar concentration range and an overlying layer of ±7.5m in thickness ranging in concentration from 0.172 to 1.069 mg/l flowing towards the south bound shield volcanoes.

Water balance of tropical lakes

Session 2

Water balance of tropical lakes

Saturday 26 September

1:30 pm – 2:45 pm

Hydrological impacts of the floodplain on river discharges and water balance of Lake Tana, Ethiopia.

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Abstract

This paper presents a study on an extensive floodplain adjacent to Lake Tana (Ethiopia) and its lowland tributaries, to enhance our understanding of the runoff transfer to the lake and to better manage the lake and the natural resources in the floodplain. Runoff discharge measurements made at 12 river stations in 2012 and 2013 and a simple rainfall-runoff model were used for this purpose. The effects of the floodplain on river discharges and consequently on the water balance of the lake were investigated using the upstream (at the interface of the floodplain) and downstream (in the floodplain) discharge observations of the Gumara, Rib and Megech Rivers and by conducting scenario-based studies. Analyses revealed that runoff abstraction is the dominant hydrological process in the floodplain from the onset of the rainy season to end of July with a corresponding increase in floodplain storage. In contrast, from August until the middle of September the floodplain releases stored water to the lake. Since the floodplain acts as a storage of flood water, the magnitude of peak flood discharges were much smaller downstream than upstream in the floodplain. We found an average yearly runoff abstraction by the floodplain of 420×10^6 m^3 or 6% of river inflows to the lake in 2012 and 2013. Simulated lake levels compare well with the observed lake levels ($R^2 = 0.95$) and the water balance can be closed with a closure error of 82 mm/year (3.5% of the total lake inflow). This study demonstrates the importance of floodplains and their influence on the water balance of the lake and the need of incorporating the effects of floodplains to improve lake water balance studies.

Keywords: Floodplain; Lake Tana; Water balance; rainfall-runoff model

Preliminary findings from tree rings research from Gondar for reconstructing discharge from Lake Tana

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Abstract

Tree ring growths were examined in tree rings of three species from church forests in and around the Simen mountain area of Ethiopia. The main purposes of the study was to prove the presence of annual tree rings, evaluate the relationship between radial growths and discharge from Lake Tana and climate parameters in Ethiopia. Preliminary results showed that some of the samples from Juniperus procera crossdated successfully. Samples from Eric a arborea and Hypericum revolutum formed distinct growth boundaries, but crossdating was difficult. The mean annual diameter increment ranged from 1.5 to 3.5 mm. Juniperus procera showed enhanced growth than Erica arborea and Hypericum revolutum. Positive correlations were found between tree-ring width chronologies and precipitation data, and discharge from Lake Tana. These results may bring additional evidences for the linkage between tree-ring chronologies and climate in northwestern Ethiopia, which will be important for paleoclimatic reconstructions in the area.

Response of a shallow aquifer to Micro-Dam Reservoir leakage and natural recharge: a water balance model approach

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Abstract

Understanding the rainfall−runoff−recharge nexus is one of the useful approaches for sustainable water quality and quantity management and in planning, design of water harvesting and flood control structures, and for developing watershed management plans. The runoff, recharge and response of the shallow aquifer to Arato Micro-Dam Reservoir (MDR) leakage were assessed using Soil Conservation Service Curve Number (SCS-CN), soil moisture balance (SMB) and diver (automatic data logger) measurements for 182 days in the MDR and a shallow hand dug well. Recharge was also estimated using chloride mass balance (CMB) and water table fluctuation (WTF) methods. Results show that the runoff from the catchment was found to be about 48.8 mm (7.7% of the rainfall) while recharge was estimated at about 104 mm, 90 mm and 95 mm using SMB, CMB and WTF methods respectively. Moreover, based on the water balance model of Arato MDR, the leakage amount from the reservoir was estimated at 18.2 mm/day which corresponds roughly to about 1452 m^3/day or $0.26*10^6$ m^3 of water in 182 days. The estimated leakage is quite higher than the seepage foreseen during the initial design of the project (9965 m^3). The results of the automatic diver data loggers show a continuous water level decline in the reservoir, while constant water level in the shallow well during the dry period, confirming the strong interaction between the surface water in the reservoir and the groundwater in the shallow aquifer found next to the reservoir. The result of this research project shows the importance of using actual measured climatic and physical characteristics of a watershed rather than using data from literature, in reservoir and other water resources planning, as well as the requirement of adequate site investigation to reliably quantify hydraulic conductivity for leakage estimation.

Keywords: curve number method, diver data, groundwater recharge, Ethiopia, Tigray, Ethiopia

Grid-Based Parameterization of Monthly Water Balance Model for Simulation of River Flow at Ungauged Sites in Upper Blue Nile Basin

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Abstract

Predicting the spatial and temporal distribution of water resources in Upper Blue Nile Basin and the future impacts of changes in land use and/or climate on the availability and accessibility of water resources using hydrological models, and understanding the water balance will significantly contribute to optimal and sustainable development of the water resources in the basin. However, though stream flow data are very important for the water resources development activities, often they are limited and are rarely available for the specific river under investigation, as most rivers are unguaged, while there are relatively plenty of rainfall records in the basin.

The purpose of this research is, therefore, to provide gridded values of the 3-parameters of Monthly Water Balance model using catchment characteristics for simulating monthly runoff at ungauged rivers in the basin. The aim here is to identify the physical variables that affect the rainfall-runoff transformation, and then to look for a regression relationship between model parameters and physical characteristics.

The model was calibrated and validated for selected 28 gauged catchments using FORTRAN program. Monthly rainfall and monthly potential evapotranspiration were model inputs. The optimized model parameters were then linked to physical catchment characteristics using regression equations and a grid-based parameterization scheme was developed.

Finally the basin was discretized into grids of size 10km by 10km and the three model parameter values were estimated for each grid using the regression equation. Then the model was tested at kessie gauging site and the result shows that the model can simulate the low flow very well but it slightly over simulate the peak flows, and its result can still be improved by using gridded inputs data. As the model was developed mainly for unguaged sites, it was also tested for ungauged site taking Muger sub-basin as unguaged catchment

Keywords: Water Balance Model, Guaged catchments, Unguaged catchments, Parameterization , Calibration, Validation, Grid

The Impact of Land Use System on Rainfall-Runoff and Groundwater Recharge in the Tekeze-Atbara River Basin

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Abstract

The right watershed management generates multiple benefits; hydrological, economic and environmental. However, there are very limited studies at basin scale on watershed management of the Tekeze-Atbara (T-A) basin. This study was conducted in the T-A basin aiming at (i) develop watershed inventory of the T-A basin through land-use/land-cover (LULC) mapping based on public domain satellite imageries, (ii) assess runoff for different watershed management scenarios using grid rainfall-runoff modeling, and (iii) conceptualizing possible effects of watershed management on groundwater of T-A basin. MODIS satellite datasets were used for LULC mapping during both wet and dry seasons for 2013/2014. Supervised and unsupervised classifications were employed to identify the LULC classes within the basin. The Wflow rainfall-runoff model was used to compute runoff based on public domain datasets which include: DEM, land cover, soil map, rainfall and potential evapotranspiration. The produced LULC maps for the wet season during September 2013 indicate that agricultural land, mixed land, bare land and sand had occupied 41%, 36%, 14% and 9% of the T-A basin respectively. While the result during the dry season (i.e. January – April 2013/2014) shows a significant increase of bare land areas compared to wet season. The supervised classification scheme of lower T-A basin within Sudan resulted into 6 LULC classes. Here, the mixed land class was further classified into woodland and carab land. The Sudanese part of the T-A basin is dominated by bare land about 48% and 56% of the area during the wet and dry season respectively. The overall LULC classification accuracy ranges from 80% to 87% for the wet and dry seasons. The computation of runoff by the Wflow model showed good performance for the discharge measured at Rumela station, located at the outlet of the basin. The model scenarios show that the change in land-use from forest in Upper Atbara catchment to bare soil had a big impact on the runoff. It increased the flow in the catchment by 26 %. Nevertheless, the change in land-use from forest to crop land had a moderate impact on the runoff, which increased the flow in the catchment by 16 %. However, the change in land-use from crop land to bare soil had a small impact on the runoff. It increased the flow in the catchment by 8 %. The inventory of the groundwater systems in the T-A basin shows that the existence of water reservoirs behind large dams may positively affect the mode and amount of water recharge. We conclude that using LULC for watershed monitoring and management with satellites technology has a high potential in T-A basin. Similarly, Rainfall-Runoff modeling with public domain datasets can inform strategic decision of watershed management in transboundary river basins.

Keywords: Land-use/Land-cover Mapping; Rainfall-Runoff Modelling; Groundwater Assessment; Tekeze-Atbara Basin.

Tropical catchment hydrology

Session 3

Tropical catchment hydrology

Saturday 26 September

2:45 pm – 4:15 pm

The nexus of land use changes and their impacts on agricultural and natural aquatic systems – The case of Malawi's 2015 floods

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Abstract

Malawi remains one of the world's least developed and most densely populated countries. The economy is heavily agro-based, with a largely rural population. The Malawian government depends a great deal on external aid to meet its development needs, although this has decreased since 2000. To sustain a rapidly growing population, agricultural expansion into marginal lands and government protected areas has become a necessary evil with myriad attendant environmental degradation effects, key amongst which is soil erosion, especially caused by rain water. The absence of a household energy policy continues to fuel the demand for charcoal and firewood, which in turn pushes the charcoal producers back into Malawi's remaining forested hills and protected areas. The continued decline in agricultural productivity pressures communities to encroach into Malawi's protected areas/ reserves whilst rural market failures and shortage of alternative sources of steady incomes also militate against soil/water conservation and biodiversity protection.

Against a background of climate change and accelerated human activities, changes in natural rainfall regimes have taken place in Malawi and will be expected to become more pronounced in future decades as has been evidenced by the recent nationwide high rainfall and floods. In this poster presentation, knock-on effects of a number of drivers of land use changes and their impacts on land degradation, soil erosion, sediment load, soil and water conservation and ecosystems loss are explored in the context of devastating floods Malawi has undergone in 2015. The inadequate capacity of government to address these challenges will impede development efforts at the national level and it is argued that unless these drivers of deforestation and habitat loss (and capacity constraints) are addressed at a large enough scale, Malawi's agro-based ecosystems and natural aquatic systems, particularly rivers, wetlands and inland lakes will remain under threat.

Understanding surface-groundwater interactions in semi humid environment using groundwater level observation in the Lake Tana sub-basin, Ethiopia

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Abstract

Understanding surface and groundwater interactions is important for water balance modeling. Existing water balance models in the Lake Tana sub basin refer groundwater contribution as minor or negligible. These assumptions possess neither empirical soundness nor the statistical evidence to substantiate the arguments. To understand the interaction between groundwater and the lake water, shallow groundwater level was observed at weekly time step for the dry periods of 2014 and 2015 in thirty-two abandoned wells distributed over a floodplain (500 sq. km) adjacent to the lake. The study area lies in tropical monsoon climate, where the rainfall dominated by the Inter tropical convergence zone (ITCZ). Vertisols (black cotton soil) is the major and dominant soil type in the Fogera floodplain.

The groundwater depleted during the dry seasons was about 700mm based on the observed moisture profile in the vadose zone and the depth of the groundwater. This volume of water had recovered during the wet seasons as recharge from the rainfall and flooded waters. A 10 meters level difference was observed between the lake and the farthest observation well located at 20km from the lake based on which a hydraulic gradient of 0.05% was determined. This indicates that the drainage to the Lake is a small term in the water balance of the plain; which is attributed to the very low saturation hydraulic conductivity of the soil (<1m/day). This indicates that for average and above average rainfall years, the Fogera plain will flood irrespective of flooding from rivers occurs or not.

Key words: Lake Tana, groundwater level, Fogera floodplain, Ethiopia

Hydraulic Interconnection between the Volcanic Aquifer and major springs, Lake Tana Basin on the Upper Blue Nile

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Abstract

Hydrochemical and stable isotope ($\delta^{18}O$, δ^2H) data were used to identify the recharge sources of major springs and the hydraulic interconnection between the volcanic aquifer and springs in the Gilgel Abay catchment and adjacent areas. The hydrochemical data analysis showed that all water samples of springs and shallow wells have freshwater chemistry, Ca-HCO$_3$ to Ca-Mg-HCO$_3$ types. This is mainly controlled by dissolution/hydrolysis of silicate minerals. The analyzed stable isotope data indicate that springs water, except Dengel Mesk, Kurt Bahir and Bility springs, and well waters, except Dangila well, fall close to the LMWL. This clearly shows that the infiltrated rainwater did not undergo much evaporation and $\delta^{18}O$ values for spring water and groundwater are nearly equal to the value of Ethiopian summer rainfall, which is -2.5‰. Therefore, generally both stable isotope and hydrochemical data show the recharge source to springs and shallow groundwater is primarily from precipitation. Furthermore, data suggest that rock-water interaction has remained relatively limited, pointing to relatively short residence times, and local recharge rather than regional recharge.

Calibration and validation of the hydrological model SWAT using observed and remote sensing meteorological data in Abbay basin, Ethiopia

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Abstract

SWAT (Soil and Water Assessment Tool) is a physically and river basin scale computer model with distributed parameters which has been developed to quantify and predict the impact of diverse land use management practices, weather, runoff, erosion, sediment, nutrient transport, fertility and crop production for a better understanding of complex watersheds, their water and food quantity and quality, and therefore socioeconomic factors. The land use in Abbay basin has been experiencing significant changes in recent years, and as agricultural activities are demographically the broadest economic sector in Ethiopia, these areas continue to increase. Along with these changes, the land degradation and water conservation come to be factors of high importance. Agricultural development plays a significant role in the overall of the socio economic conditions of Ethiopia: regional food security and the economic development of every farmer and the country as a whole. However, this development has to be controlled and balanced in such a way that the necessary crop yields and economic benefits are achieved without excluding the environmental aspects. Irrigation is nowadays one of the most important factors to be considered, since the water supply for the agricultural production and for domestic supply is basically depending on the Blue Nile River. Therefore, the optimization of the water use and the controlled management of the land use are significant to develop an effective and advanced agricultural productivity. If a good distribution of these factors is achieved better socio-economic conditions can be created: job opportunities, control of floods and prevention of droughts, food security and electricity generation. For the present study, the Blue Nile Basin in Ethiopia is the investigated region. The main objective of this study is to analyze the hydrological conditions of Abbay basin and develop a calibrated and validated SWAT model to derive the required parameters of the hydrological conditions of the watershed using several geospatial databases. SWAT will be implemented to understand the condition and interaction of the weather, land use, soils and agricultural activities in Abbay basin. Then recommendations to improve the hydrological conditions of Abbay basin and to reduce the negative impacts of agricultural activities on soils, water and environment in general will proposed. During the first stage of this study a land use map and a soils map from FAO, and a SRTM digital elevation model from the CGIAR-CSI (Consultative Group on International Agricultural Research Consortium for Spatial Information) were obtained. To complete the required input data for SWAT, weather data from the National Meteorological Agency of Ethiopia and also corrected remote sensing data from CFSR (Climate Forecast System Reanalysis) was obtained. After providing SWAT with all this input data, a model for 15 years was simulated (from 1990 to 2004), which provided a better understanding of the behavior of the rainy and dry seasons in the region. After the calibration and validation of the model were performed, the results show a good model that can be used as a potential tool for water resources management in Abbay Basin.

Keywords: SWAT, land use changes, soil degradation, water conservation, agricultural development.

Assessment of Watershed Hydrology Responses and Rainfall Runoff Modeling in Lake Tana Basin, Case of Awramba Watershed

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Abstract

Investigation of hydrological processes in few watersheds of the Ethiopian highland indicated the dominance of saturation excess runoff processes. To generalize this in the highland, repeated investigation and replication is necessary. The main focus of this study is twofold 1) Investigating the hydrological response in the new experimental watershed and 2) modeling the rainfall runoff l to assess performance of several models. The Awramba micro watershed with an area 7 km^2 was selected for this study. Hydrometeorlogical instrumentation on the watershed was done prior to the rainy season. Rainfall, stream flow, ground water table, and infiltration rate were measured in the main rainy season of 2013 and 2014. Three Hydrological (PED, SWAT and HBV-96) models were analyzed in the watershed. The results showed that the water table in the saturated areas rises quicker and stayed longer period than the water table readings at the top and mid slopes of the watershed. The median infiltration rate has been exceeded only 9 % of the time by rainfall intensity of the storm. Hydrological sensitive area was mapped using GPS from observation and using topographic wetness index (GIS application). The area which is periodically saturated was found around 6% of the watershed area. These results found were similar with previous investigations in the highland indicating saturation excess dominates. Based on the outputs from the model for the daily basis with R^2 values of 0.6, 0.41, and 0.32 for PED, HBV-96 and SWAT models respectively. On the monthly bases al models fit reasonably with Nash Sutcliff efficiency of more than 60%. In general PED (Parameter Efficient Semi-Distributed) model fits for daily values better than HBV-96 and SWAT models. This might be due to that the PED model does not generate surface runoff until the periodically saturated are filled to capacity by interflow from the hillsides and rainfall on the area itself.   . This indicates PED model can be one of the choices for rainfall runoff modeling for daily discharge predictions for small watershed responses in the highlands of Ethiopia.

Keywords: Sediment, Stream flow, Infiltration, Saturation PED, SWAT, HBV-96

Estimating the hydrological response of soil and water conservatiostructures: Is the Curve Number method applicable?

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Abstract

Land degradation combined with strongly seasonal and insufficient rainfall is a challenge to rainfed crop production and food security in the arid and semi-arid Ethiopian highlands. To reverse land degradation and ensure food security, soil and water conservation (SWC) structures, water harvesting and irrigation development have been implemented since 1980's. However, the success of water harvesting reservoirs is limited due to insufficient inflows. There are no adaptable hydrological models which account for local conditions such as SWC structures for an optimized design of ongoing water harvesting reservoirs. As a result most of the constructed reservoirs were over-designed and less area was irrigated. The objective of this study is therefore, to apply the runoff curve number method on the measured rainfall-runoff data and to estimate runoff depth for the runoff plots treated with different SWC structures.

This study was conducted at Mayleba catchment located in Tigray at ca. 40 km to the west from the regional capital Mekelle. 21 large runoff plots (600 to 1000 m^2) were installed in cropland and rangeland and treated with different SWC structures: stone bunds, trenches and stone bunds with trenches and a control plot without SWC structures. Plot sites were selected on gentle (5%), medium (12%) and steep (16%) slope gradients for both land use types. At the lower slope of each plot a 17.7 m^3 collector trench was installed and lined by 0.5mm thick geomembrane to collect runoff. During the rainy season in 2010 to 2012 rainfall-runoff depths were measured and recorded. The rainfall depth was measured using manual rain gauges installed at each plot site. Depth of the water in the collector trench was measured and runoff volume was obtained using calibration curve developed for each collector trench. Measured rainfall-runoff data were divided into two-third for calibration and one-third for cross-validation of the CN method for each plot. 200 alternative subsamples were drawn randomly for the calibration and cross-validation. Using these alternative subsamples the corresponding maximum retention potential and CN values were obtained considering the initial abstraction ratio of 0.05. Model efficiency (ME) and relative root mean square error (RRMSE) were also calculated for cross-validation to evaluate the CN method. The result indicates that the CN values obtained for the runoff plots based on land use type, treatment practices, hydrological condition and hydrological soil group (HSG) of the national engineering handbook (NEH) ranges from 78 to 89 for all the plots in cropland and rangeland.

The median calculated CN values besed on the measured rainfall-runoff data ranges from 34, for a plot treated with stone bunds and trenches in cropland, to 91 for a control plot in rangeland, while the corresponding ME ranges from -3.01 to 0.49. The CN values selected for plots based on NEH is overestimated by 21% compared to those calculated from measured rainfall-runoff data. The overestimation is particularly large for plots with SWC structures. Application of the CN method to estimate surface runoff is more reliable for plots on rangeland than the corresponding plots in cropland due to a high runoff production on rangeland plots. The CN method is less applicable for plots with more effective SWC structures as their ME is negative for most plots. Over estimation of the CN methods when using plot characteristics somehow explain why water harvesting structures are overdesigned

Keywords: Curve number, stone bunds, trenches, rangeland, cropland, rainfall-runoff

Ecosystem services of tropical lakes

Session 4

Ecosystem services of tropical lakes

Saturday 26 September

4:45 pm – 6:30 pm

Trade-offs or Synergies? Assessment of Ecosystem Services in Multi-use Small Reservoirs in Burkina Faso

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Abstract

Small reservoirs (SRs) development, as a strategy to enhance food and water security in water-scarce regions, has long attracted the interests of governments and development agents. The main argument put forward was that by providing water for small-scale agriculture, they can cushion the impacts of drought and rainfall variability on vulnerable and less-developed regions. Because of the dominance of interests in small-scale irrigation, performance assessments of SRs have concentrated on irrigation outcomes. The multiple non-irrigation uses/benefits and potential negative externalities were largely neglected in the measurement of their performance. The publication of Millennium Ecosystem Assessment in 2005 triggered the concept of 'ecosystem services' and prompted both academia and policy decisions to consider multiple effects/impacts of human activities on natural capital, ecosystem services, and human wellbeing. Along the lines of the surge in thoughts in 'ecosystem services', SRs, besides irrigation use, could generate multiple benefits such as improved access to domestic water, enhance women's position, recreation, livelihood diversification, fisheries, water availability for livestock, limiting floods, and increased biodiversity. On the other hand, SRs may have unwanted side-effects such as environmental deterioration, decrease in water quality, adverse health impacts (e.g., harbour mosquitos), and reduce environmental flows and ground water recharge. Thus, SRs' performance need to be assessed against these multiple benefits/dis-benefits and whether there exist trade-offs or synergetic relationship.

In the context of ecosystem services (ES), trade-offs between ES arise from management and/or utilization choices made by humans, which can change the type, magnitude, quality and relative mix of ES. Trade-offs occur when the provision of one or more ES is reduced as a consequence of increased use of another ES. In some cases, trade-offs may be an explicit choice; in others, it may take place without explicit account or even without awareness of the decision makers. As human activities transform ecosystems to obtain more of specific services, other services tend to diminish (trade-offs). Understanding how trade-offs operate temporally and spatially in various ecosystems and analysis of either to minimize the trade-offs or find synergetic solutions could provide decision support evidence for sustainable management of natural resources and human wellbeing.

Most parts of Burkina Faso (BF) suffer from physical water scarcity and irregular distribution of groundwater. SR development has been promoted as a key strategy aiming at enhancing water and food security in BF. A conservative estimate shows that there are about 1500 SRs in BF. These are used for small-scale irrigations, livestock, and domestic purposes. From 2002 BF has initiated a program to develop village irrigation, which facilitates the exploitation of all the

irrigable areas around the SRs and inland valleys. On the other hand these reservoirs may have negative effects such as flooding and health impacts. Using an ecosystem services-based approach on a sample of small reservoirs in BF, this study investigates the multiple ecosystems services/dis-services, their trade-offs, and synergetic relationships. This provides evidence for improved management and utilization of the SRs in order to minimize the trade-offs and enhance synergetic solutions that ultimately contribute to water and food security.

Valuing Fishery: Ecosystem-Based Fisheries Management for Lake Naivasha, Kenya

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Abstract

Ecosystem-Based Fisheries Management (EBFM) is a new direction for fisheries management and can be an important complement to the existing fisheries management approaches to maintain ecosystem health and functions. Effective EBFM requires the identification of goals and conservation targets that reflect the interconnected nature of ecosystems and their multiple natural, social, cultural and economic values. In 2011, the Kenya government launched the 'Imarisha Naivasha' ('Empower Naivasha' programme') as an umbrella organization to coordinate local industries and communities with government agencies and Non-Government Organizations (NGOs) in an effort to restore and maintain the Lake Naivasha basin ecosystem services. The 'Imarisha Naivasha' programme has recognized the need to encompass fishing communities through EBFM to improve the lake ecosystem services. EBFM approach would play a fundamental role in maintaining the Lake Naivasha ecosystem health and functions as opposed to approaches that address only parts of the ecosystem or just individual species. The preferences of the fishing community should be taken into consideration for the successful implementation of EBFM around Lake Naivasha, however, to the authors' knowledge no valuation of ecosystem-based fisheries management of the Lake Naivasha has been conducted so far. Therefore, this study analyses the preferences of the fishing community for EBFM attributes of Lake Naivasha and estimates the willingness to pay using a choice experiment approach. Fishing communities in Lake Naivasha are organized by Beach Management Units (BMUs). A total of 91 respondents were selected at random from the BMUs and interviewed using a questionnaire.

Three attributes are identified as relevant EBFM attributes for the choice experiments: protection of fish breeding grounds; improvement on Tilapia fish abundance; and, accessibility of fishing zones. In addition to a conditional logit model, mixed logit models are estimated to account for preference heterogeneity. The study results suggest that fishing communities are most concerned about the protection of fish breeding grounds and Tilapia fish abundance as they have a higher willingness to pay for these two EBFM attributes. This study revealed that fishing communities are willing to pay a considerable amount of money for the improvement of Lake Naivasha ecosystem services, relative to their low-income from fishing. Moreover, the willingness to pay

results has implications on fishing permit fees. Fishing permit fees can be an alternative source of funding to restore the lake ecosystem and can encourage the fishing community's involvement in co-management of fisheries resources. This study indicates also applying a choice experiment model can improve the understanding of EBFM valuation study significantly. Although, the methodology and the model results seem to be very appealing, application of these methods needs to include other EBFM attributes in further studies. For example, the choice between species as the lake is dominated by alien species, and the choice on applying different annual closure periods as a fisheries management approach. Finally, our findings indicate that valuing fishery at an ecosystem level is vital to prioritize and choose between alternate interventions for the implementation of EBFM. Therefore, studying these aspects may contribute to the implementation of sound ecosystem-based fisheries management.

Wetland spatio-temporal change analysis and ecosystem services in two urbanising cities

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Abstract

Wetlands in India are under stress due to many natural and anthropogenic events. While the definition of a wetland can extend from small ponds/marshes to large reservoirs, a recent study estimates the wetland area to be 4.7% of country's geographic area. Key drivers for wetland loss are urbanization and associated land-use changes, population growth and pollution. It is well known that functionally, they provide a variety of ecosystem services (ESS) for human wellbeing and inextricably linked to the hydrological cycle and therefore, the environment as a whole. Usually, wetland loss is assessed only after ground level observations, however, RS/GIS tools offers a way to assess the areas that are rapidly losing wetlands that can be regarded as "Hot spots". This study was aimed at providing the evidence for wetland loss and showcase the important Ecosystem Services (ESS) they provide, so that planners can take appropriate steps to conserve and safeguard this natural resource.

Urban and peri-urban wetlands distribution was studied in two cities, namely, Kolkata, West Bengal, and Nagpur, Maharashtra. Supervised Image classification and Modified Normal Difference Water Index (MNDWI) were used to assess the changes in landscape and loss of wetland area respectively, during the period 2000 and 2013, covering an area of urban sprawl. A wetland inventory was prepared to the extent possible, from the satellite images available in the public domain. A checklist of ESS were prepared through a participatory process (wetland users and key informants) based on the TEEB's approach to assessing ESS. A total of 27 ESS were selected, based on observations and surveys. Further, in each site, 4 wetlands were investigated to validate the ESS and wetland dependence by poor communities.

The satellite images enabled the visualization of wetlands of a size class of 0.36 ha and above. Change analysis for the city of Kolkata indicated an increased land area for built-up areas (6%) and waste/open lands (1%), calculated against the mapped area of 87,500 ha. Decreased coverage was observed for water bodies (3%), orchards and trees (5%), agriculture and shrub lands (10%). Development activities appeared to impact especially the water bodies. Based on wetland inventories and water density maps, 4 types of wetlands appeared to be prominent. These were tanks, aquaculture/paddy rice, riverine marsh/lagoons and treatment units, which covered a total area of 10,645 ha (year 2000). Tanks constituted 12% of the total area, while only 1.2% (127 ha) could be classified as natural. The rest of the area that included much of the EKW (East Kolkata Wetland) was influenced by anthropogenic activities over time. A 50% reduction (5930 ha) in the wetland area was attributed to the loss of aquaculture/paddy rice areas. Interestingly, the EKW area had increased marginally, perhaps due to the conservation efforts through the Ramsar

program, although areas close to the city were constantly under threat. While the reduction in the overall area of tanks was marginal, the number of tanks had halved, indicating the impact urbanization has had on the water bodies. Among the 37 wetlands studied in detail, 7 were in the peri-urban areas and were part of the EKW. A rich array of ESS were attributed to the wetlands by the wetland users, where the ESS scores ranged from 4-20, with over 75% receiving scores of 15-17.

In the city of Nagpur, the increase in built-up areas was similar to Kolkata (5%). The overall changes in the area for water bodies were marginal. While the agriculture/shrub land area had increased overtime (3%), the vegetation and forest areas (5%), and open/fallow lands (3%) indicated a decline. The sand mines/stone quarry areas remained the same. Four types of wetlands were identified, in the mapped area of 92,500 ha, and they were, tanks, reservoirs, water logged areas in quarries and treatment plants which accounted for over 844 ha. Tanks and reservoirs constituted over 90% of wetland area, and of the 182 wetlands that were mapped only 0.4% could be visualised as natural. Marginal increases in wetland area was attributed to high rainfall and consequent filling up of active quarries and increases in the surface area of tanks, but the loss of natural tanks was significant (70%). Water density maps showed that the southern parts of the city were experiencing water scarcity, probably associated with over abstraction. Eight urban and 4 peri-urban wetland analysis showed a rich diversity of ecosystem functions, with a majority having a range in scores 15-23. Hot spots of wetland loss was clearly evident in both Kolkata and Nagpur, highlighting the need for their conservation. City areas close to the EKW were subject to constant threats, with mounting garbage dumping sites. Considering the rich diversity of ESS of wetlands in both cities, a well-planned conservation program can have benefits that are far reaching.

Sustainable fisheries and aquatic resource management of Lake Tana: Lessons from three decades of Ethio-Netherlands Cooperation

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Abstract

Lake Tana fishery remained completely subsistent until a fisheries development project assisted by Dutch Non Governmental Organization ISEE-Urk was launched in 1986. Three years later Wageningen University Research Center (WUR) in collaboration with Ethiopian Ministry of Agriculture started detailed research on fisheries and fish ecology.

Major research findings include identification of 15 unique endemic fish species and quantified the fisheries resource potential of the lake (annual maximum yield between 7,000-10,000 tons). Fish breeding season (June-October) and breeding areas (rivers and streams feeding lake Tana) mapped for all fish species. Between the 1990s and early 2000s the Labeobarbus stocks decreased by 75%, most likely due to the increased fishing pressure on spawning aggregations during their upstream migrations. Food-web analysis at different trophic levels and key species for the proper functioning of the lake ecosystem were identified. Physical, chemical and biological characteristics of this meso-oligotrophic lake over time have been documented. The juvenile ecology of the migratory riverine spawning Labeobarbus species has been investigated. These findings were presented for policy makers to develop sustainable fisheries management

plans and also regional fisheries legislation was gazetted in 2003. Moreover, the research result provided scientific evidence for Lake Tana to be recognized as UNESCO biosphere reserve site. The major threats identified are environmental degradation, economic factors forcing the people to over exploit the natural resources, high population pressure, poverty, pollution, irrigation dams and the recent Water hyacinth infestation.

The objective of this paper is therefore to provide salient achievements of the last three decades of research and development through the intervention of the Ethio-Netherlands cooperation and to propose research gaps to be addressed for sustainable evidence based management of the lake Tana resource.

Keywords: biodiversity protection, biosphere reserve, evidence-based fisheries management

Potentials and challenges of eco-tourism development in Lake Tana, Ethiopia

Getinet Fetene

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Abstract

Lake Tana, situated in the north-western part is the largest lake in Ethiopia and the 7th largest lake in Africa. It is well-known in its inlands and freshwater resources that provide ecosystem services to the local livelihood options, regional development and environmental protection. For example, the water resources are used for irrigation, domestic use, transportation, eco-tourism, hydro-electric power and home for aquatic species. These resources attract huge population for centuries and leads to unwise utilizations of resources which is resulting in a rapid degradation of resources of Lake Tana. Some of the major human activities that are common in this area are uncontrolled expansion of wet lands into agricultural land, overgrazing, overfishing, pollution (use of agri chemicals near by the lake), deforestation, spontaneous and horizontal urban growth and invasion of exotic species. As the result, Lake Tana has encountered with loss of biodiversities, alteration of ecosystem, siltation, declining of agricultural and fish products and degradation of heritages and other landscapes. On the other hand, Lake Tana has huge eco-tourism potentials that benefit the local community through creating income and employment opportunities, maximizing profit to private businesses and conserving the environments. Hence, the major eco-tourism development potentials of Lake Tana are the presence of diversified tourist attractions (historical and religious monasteries, mosaic of landscapes, fascinating Blue Nile Falls and spectacular biodiversities), its strategic location (bordering to the regional state capital city and the outlet of the Blue Nile River, closeness to the major two tourist destinations of Ethiopia) and its international recognitions (as proposed UNESCO biosphere reserve, among important bird area of the world and the 250 lakes of the world rich in biodiversities). Consequently international and domestic tourists are visiting Lake Tana area since 1960s and it is remained among the major tourist destinations of Ethiopia. However, the findings so far indicate the existence of low tourist arrivals, inadequate benefits of local community from tourism sector, low duration of tourists stay, inadequate promotion of tourist resources , concentration of tourist services and infrastructures around Bahir Dar and Gondar, poor linkage between local community and tourism businesses, and poor coordination among eco-tourism stakeholders. Hence, to promote eco-tourism in Lake Tana area, the most recommended activities based on various studies are establish trekking routes, develop diversified tourist facilities/services and infrastructures, properly promote eco-tourism resources, establish mechanisms of linking local community with tourism businesses of Bahir Dar and /Gondar, establish eco-tourism development stakeholders plate forum, aware the local community to support eco-tourism initiatives and support financially the local community to start small eco-tourism businesses. Among this recommended activities, NABU is supporting as piloting phase some community businesses initiatives and some infrastructure developments in Zegie, some promotion and capacity development related activities in Bahir Dar.

Water quality and aquatic ecology of rivers, wetlands and springs

Session 5

Water quality and aquatic ecology of rivers, wetlands and springs

Monday 28 September

8:30 am – 10:15 am

Changes in the water quality and ecology of the Ethiopian rift valley lakes Chamo and Abaya

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Abstract

Abaya and Chamo Lakes are the largest Ethiopian Rift Valley Lakes. With their remarkable biological diversity, the two lakes have outstanding potential as tourism hot spots and have key socio-economic benefits for fisheries, transport and water supply. We compiled data from earlier studies covering four decades and supplemented these with the results of recent sampling campaigns. Our observations indicate that the water quality of these two large and important lakes is deteriorating at a dramatic rate, with a striking parallel between increasing fertilizer use rate in Ethiopia and, with a time lag, nutrient enrichment in both lakes. Currently the two lakes are hypertrophic, likely as the result of land use change and intensification of agriculture. While increasing nutrients are expected to lead to increased growth of algae populations, this is not what we observe. In Lake Abaya, chlorophyll a levels have dropped in the last 40 years, while chlorophyll a levels in Lake Chamo showed a spectacular increase in the 1970s and 1980s, but then showed a dramatic decline since the early 1990s. This is caused by light limitation due to an increase in suspended particulates associated with erosion. As a result, the euphotic zones in both lakes are relatively narrow. In this presentation we will present these data and link them to changes in the ecology and functioning of the lakes, the risk of toxic cyanobacteria blooms and ecosystem services such as fisheries.

Spatial and seasonal variation in the macro-invertebrates and physico-chemical parameters of the Enfranz River, Lake Tana sub-basin (Ethiopia)

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Abstract

The main objective of the study was to assess the water quality of the Enfranz River by studying the distribution of its macro-invertebrates over a longitudinal river gradient. The macro-invertebrate community of the Enfranz River, located northwest of Bahir Dar city in the southern part of Lake Tana watershed, was studied to family taxonomic level in wet and dry seasons from August 2010 to May 2011. The river was sampled along its whole length at four sites from headwaters until its outflow in Lake Tana. A total of 15,286 macro-invertebrate individuals belonging to 35 families and 2 higher taxa were collected. The Shannon-Wiener diversity Index, the Hilsenhoff family-level biotic index, and three macro-invertebrate metrics, were measured and related to five physico-chemical parameters. Macro-invertebrate diversity and biotic indices, and community metrics differed significantly among sampling sites ($p < 0.05$), diversity being higher at the headwaters. Spearman's correlation coefficients showed that dissolved oxygen was significantly correlated with the macro-invertebrate diversity and biotic indices, and all three macro-invertebrate metrics ($p < 0.05$). Diversity index, percent Ephemeroptera and percent Trichoptera were positively correlated to dissolved oxygen, whereas the biotic index and percent dipterans showed negative correlations. Furthermore, percent Ephemeroptera was negatively correlated with conductivity ($p<0.05$) and diversity was negatively related to total dissolved solids and conductivity. We conclude that the river downstream is severely affected by land use of the people living along the river.

Keywords: Water quality, Water quality management, Effects of land use, Biodiversity.

The importance of environmental, land-use and spatial factors on composition and diversity of wetland bird communities

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Abstract

The aim of this study was to evaluate the unique and combined importance of environmental, land-use and spatial variables on the distribution of bird assemblages in natural wetlands of southwest Ethiopia, which are bio-diverse areas that are under serious threat due to land encroachment. We surveyed 63 sampling sites distributed over seven different wetlands during the wet and dry season in 2010 and 2011. We applied variation partitioning to determine the independent and combined effects of environment, land use and spatial variables on the abundance and presence-absence of wetland specialist, generalist and associated birds. Forward selection was performed for each set of predictor variables to select those variables significantly ($P<0.05$) explaining the variation in bird species composition. A total of 9,654 bird individuals belonging to 141 species, 54 families and 15 orders were recorded in and around the wetlands. Our results suggested that abundance and richness of bird communities in these wetlands were strongly influenced by the environment, while the contribution of land-use and space alone was relatively small. The combined effect of environment and land-use explained most of the variation in bird species composition, probably due to the indirect effect of land-use on the environmental variables. Wetland dependent birds (specialist and generalist) were strongly influenced by the environmental conditions, suggesting that conservation of the wetland birds should target local habitat quality and environmental landscape heterogeneity. The large percentage of unexplained variation can probably be ascribed to other environmental factors that were not taken into account in this study and that may operate at different spatial scales.

Keywords: Bird diversity, Generalist, Habitat disturbance, Land-use, Specialist, Variation partitioning

Establishing criteria to select reference sites for ecological and water quality assessment in Ethiopian highland freshwater ecosystem

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Abstract

The concept of a reference condition is increasingly used to describe benchmarks against which current condition is compared. Regional reference conditions are required to implement monitoring programs aiming to assess the ecological status of surface waters and to measure the degree of deviation caused by different stressors in a specific region. This study defines criteria that represent reference (near natural or least impaired) sites against which current condition of other sites are compared in highland rivers of Ethiopia. A total of 104 sites were studied in four major river basins of Ethiopia. Evaluation of a priori criteria during extensive spatial survey revealed that the most relevant criteria were those related to point and diffuse source of pollution, land use change, riparian vegetation, and river morphology and regulation. Among a priori reference criteria proposed elsewhere and region specific criteria observed in the field, 20 criteria were chosen as representative for Ethiopian highlands and they reflect some general aspects of naturalness and address wide range of human disturbances. Of 104 study sites, 22 were selected as a priori reference sites by applying the proposed criteria. The a priori reference sites were subjected to validation using benthic macroinvertebrate (BMI) community distribution and by applying ETHbios score thresholds for 'high' ecological status. Of the potential biotic components, BMI are proved as the taxa group of choice for biomonitoring in Ethiopian highland streams and rivers. The distribution of benthic invertebrates in non- metric multi-dimensional scaling (NMS) analysis showed a clear stress gradient between a priori reference and impaired sites, although small overlap was observed with few impaired sites which could be due to the presence of some sensitive taxa in these sites. Moreover, ETHbios score threshold for 'high' ecological status revealed that 95% of a priori reference sites were considered valid reference sites. Therefore, reference criteria proposed here can be considered as robust to implement biomonitoring program in Ethiopian highland freshwater ecosystems where true pristine areas are nonexistent as a result of different human activities and urbanization.

Potentially Toxic Trace Element Contamination of the Little Akaki River of Addis Ababa, Ethiopia

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Abstract

In this study, river water samples taken from 26 different locations along the course of the Little Akaki River in Addis Ababa were analyzed to determine potentially toxic trace element concentrations using ICP-MS. The mean concentrations in µg L^{-1} for Mn 1540.04, Fe 1075.92, B 383.04, Sr 336.75, Ba 132.17, Cr 67.04, Sb 42.80, Zn 25.50, Ni 6.66, Cu 5.61, V 4.87, Pb 3.13, Co 2.62, As 1.46, Cd 0.06 and Hg <0.05. Overall metal concentration were in the order Mn > Fe > B > Sr > Ba > Cr > Sb > Zn > Ni > Cu > V > Pb > Co > As > Cd > Hg. A strong positive correlation was observed between several of the trace elements indicating common sources. The concentrations of Cr, Mn, Sb, B and Pb exceeded the permissible limits of the Ethiopian, European Community and WHO for drinking water quality guidelines. Fe and Sr exceeded the permissible limits of the Ethiopian drinking water guideline and Sr exceeded the WHO thresholds. The concentration of Cr, Zn, Cu and Pb exceeded the annual average thresholds for surface waters set in SI 272 of 2009. The concentration of Cr, Mn and Sr were also higher than the international guidelines value for irrigation water. The pollution of the river water is increasing alarmingly and poses serious threat to human health. Many of the concentrations were higher than previously reported. It is, thus, necessary to take serious and essential measures from the concerned bodies. Adoption of adequate measures to remove the heavy metal load from the industrial waste water and upgrading of sewage treatment plants are suggested to avoid further deterioration of the river water quality.

Keywords: River water, Potential toxic elements, Heavy metal contamination, Drinking water standards

The aquatic ecology of Africa's lakes

Session 6

The aquatic ecology of Africa's lakes

Monday 28 September

10:45 am – 1:00 pm

Composition, productivity and seasonality of phytoplankton in the crater lakes of western Uganda

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The VLIR-VLADOC project 'Vulnerability of tropical crater lakes to water-quality loss: a natural experiment in western Uganda' aims to assess how the depth and water-column mixing regime of Ugandan crater lakes affects the vulnerability of their water quality to intensive land use in their catchments. This is achieved by a comparative study of water-column mixing, nutrient budgets, productivity and phytoplankton composition in 26 crater lakes situated along gradients of land-use intensity and lake depth. As part of the project, this study concerns a detailed analysis of the taxonomic composition, productivity and seasonality of the phytoplankton communities of these crater lakes. During the more productive mixing season and averaged over all lakes, Cyanobacteria (blue-green algae) were the most abundant algal group with 82%, followed by Chlorophyta (green algae; 13%) and Bacillariophyta (diatoms; 4%). During the typically less productive season of water-column stratification, blue-green algae comprised 75% of the phytoplankton, followed by diatoms (14%) and green algae (8%). Chrysophyta, Euglenophyta, Cryptophyta and Dinoflagellates together contributed 1% during mixing, and 3% during stratification.

The study lakes were then classified according to their mixing-season aquatic productivity using the Trophic Index TI = Chl a/Secchi-disk depth. Among our 26 study lakes, three are oligotrophic (low productivity, TI < 0.02), six are mesotrophic (moderate productivity, 0.02 < TI < 0.12), eight are eutrophic (high productivity, 0.12 < TI < 0.6) and nine are hypertrophic (very high productivity, TI ≥ 0.6). Oligotrophic lakes are characterized by the cyanobacteria Planktolyngbya and Synechococcus, the green algae by Crucigenia and Cosmarium, and the diatoms by Achnanthidium. Mesotrophic lakes are characterized by the cyanobacteria Planktolyngbya and Synechococcus, and the green alga Monoraphidium. Eutrophic lakes are again characterized by the cyanobacteria Synechococcus and Planktolyngbya. Hypertrophic lakes are completely dominated by cyanobacteria, of the genera Microcystis, Synechococcus, Chroococcus and Cyanothece. We found a clear relationship between high aquatic productivity and intensive but poor land-use practices in the catchment, indicating that it is a significant contributor to allochthonous nutrient loading. Preservation of water quality and aquatic biodiversity in these lakes should be of primary importance, given their relevance as food and water sources.

Impact of Water hyacinth (Eichhornia crassipes) on Water quality in the North Eastern part of Lake Tana, Ethiopia

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Abstract

The intricate and unique structure of Eichhornia crassipes makes it one of the most resilient aquatic plants enabling it to infiltrate major water systems throughout the world . This study aimed at investigating the impact of water hyacinth on water quality in Lake Tana and its surrounding ecosystem. A total of 10 physico-chemical and biological Water quality parameters were measured and analyzed from 4 impacted and 1 non impacted sites during October 2012 to July 2013 in the months of post, dry and rainy seasons. Physico-chemical parameters measured were TDS, water temperature, conductivity, pH, transparency, dissolved oxygen, phosphate and nitrate .The data were subjected to one-way analysis of variance (ANOVA). There was significant difference at ($p < 0.05$) spatial variation in all physico-chemical parameters mentioned between the two habitats. The value ranged for TDS 66.73-160.01 ppm and 33.31-80.31ppm, water temperature ranged between 30.3 – 35.5°C and 17.9-24.4°C ,dissolved oxygen 0.11-3.95mg/l and 4.26-8.45mg/l in water hyacinth infested areas and in open water respectively. Biological parameters measured were Chl-a, zooplankton and phytoplankton. Chl-a shows significant different at (<0.05) both in sites and seasons. A total of 8 zooplankton and 9 phytoplankton genus specimens belonging to 3 taxa were collected during this study period. The major zooplanktons were Rotifera. The abundance of zooplankton ranged from 7.69- 16.30 and 14.42-27.57 in water hyacinth infested areas and non infested arear respectively. The major phytoplankton were Bacillariophyceae and their abundance is 6.49 -16.83 and12.42 – 25.57 in water hyacinth infested areas and non infested arear respectively. It can be concluded that the presence of water hyacinth was found to have effect on the ecology of the lake and its utility. Therefore effective control of water hyacinth in Lake Ecosystem is important, in order to prevent both ecological and economic loss due to loss of biodiversity.

Keyword: Water quality, Eichhornia crassipes, Plankton, Physico-chemical parameter, proximate analysis

Identifying Sources of Nitrate pollution in the Lake Victoria catchment (Kenya) via Isotopic Fingerprinting

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Abstract

Nitrate pollution of surface and groundwater resources has become a worldwide environmental problem. Increased input of reactive nitrogen (N) into water bodies is attributed to intensive land use practices like; increased use of N-containing organic and inorganic fertilizers, animal manure, industrial and urban discharges, and elevated atmospheric N deposition. Nitrate concentration in Lake Victoria catchment, Kenya has rapidly increased in the last three decades with increase in human population, human activities, and land use changes in the catchment. The effects of excess nitrate are evidenced by increased eutrophication of the lake, occurrence of algal blooms, decrease in water transparency, hypoxia leading to decrease in fish population and other aquatic life, rapid proliferation of water hyacinth, decrease in drinking water quality and general disruption of the lake ecosystem.

Nitrate-N inputs from various sources such as agricultural fertilizers, atmospheric deposition, groundwater input among others are hard to identify, because they are emitted over large areas. Nowadays, a powerful tool to distinguish different nitrate sources is the determination of stable isotope ratios of nitrogen and oxygen. Different NO_3^- sources can be discriminated from each other because NO_3^- originating from different sources shows characteristic $\delta^{15}N$ and $\delta^{18}O$ values.

This paper discusses the application of the dual isotope method ($\delta^{15}N$ and $\delta^{18}O$ of NO_3^-) for identifying and quantifying the sources of excess nitrate input in to the Trans boundary Lake Victoria. Success in this field of isotopic applications will be of great importance to the Nile basin countries since it shall provide missing information for the development of effective policies and measures aimed at addressing the excess nitrate input into surface water resources in the basin.

Population and Paleogenetics structure of water fleas - Daphnia in space and time in the African Sky Islands Lakes

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Abstract

Genetic diversity is an essential component of both the short and long-term persistence of species. It can be regarded as the basis for evolutionary potential and favors an adaptive response to changing environments. Organisms producing resting stages which often are preserved in large numbers representing entire populations captured in an evolutionary inert state for decades and even centuries provide unique opportunities for reconstructing the genetic history of natural populations. These dormant stages can act as a time capsule for biological information and allows population persistence for long period withstanding varying harsh ecological conditions. Besides, it accumulates over years and such a continuous genetic record allows analyzing changes in species assemblages; to trace the population structure and enable a direct comparison of historical and contemporary genetic diversity. We wanted to assess the genetic diversity and differentiation between populations of sky Island lakes of East Africa using nuclear and mitochondrial markers. The underlying tested hypothesis is that environmental changes may impact population stability and persistence, eventually translating into turnover in evolutionary lineages, as revealed by changes in clonal or haplotype composition. We investigated 178 individuals from active community and 130 individuals from dormant community of water flea-Daphnia across space and in time over the past 200 years. Two species: Daphnia pulex and D dolichocephala were morphologically identified from lakes investigated. There is a clear spatial and temporal difference in abundance of Daphnia pulex ephippia. Furthermore, Daphnia ephippia abundance varied among lakes investigated and along depth within lakes. We have detected 14 clones out of which 3 were found in three lakes both in the active and dormant community. However each of the three lakes has a unique clone. Thompson has the highest number of clones (n=9) three shared only with Teleki and another 2 clones shared only with Höhnel. The mean allelic richness is 2.89, 2.44 and 2.77 alleles per locus for, Höhnel, Teleki and Thompson, respectively. COI sequence analysis indicated that most of clones from the sky island lakes belong to previously reported Daphnia pulex from Lake Naivasha-Kenya with much closer relationship to Canada Daphnia pulex and further related to European D. pulex. In conclusion, based on our paleogenetics analysis, it is clear that there is a dynamics of clonal and haplotype succession in Teleki and Thompson which is in concordance to temperature regime change over the past 200 years inferred from sediment lakes' cores.

Remote and Proximal Sensing Applications for the Determination of the Eutrophic Status of a lake; Case Study: Lake Abijata (Rift Lake) & Lake Tana (Higland Lake)

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Abstract

Apart from their aesthetic, mineral and micro-climatic importance, lakes, especially eutrophic (productive) with their phyto and zoo planktonic resources offer high benefit to a nation.

The principal objective of the study peers at determining the eutrophic state of a lake using imaging and non-imaging systems. The imaging system is based on the newly proposed "Lacustrine Eutrophic State Index (LESI)". It is image algebra (image ratio) between two visible bands, Landsat ETM+ green and red spectral bands. The output of LESI later would be used as an input to the newly proposed "Green Axis Decision Rule" which allows to classify lakes in to eutrophic (productive), mesotrophic (moderately productive) and oligotrophic (unproductive or sterile) lake. The Lacustrine Eutrophic State Index (LESI) was done on two Ethiopian Lakes, namely Lake Tana which is a highland lake and the main reservoir for the Blue Nile source and Lake Abijata which is one among the quartet Rift Lakes of Ethiopia.

The proximal sensing is based on the application of grating Spectro-radiometer as a non-imaging system on a boat platform. Acquisition of reflectance data on the biological structure was attained through scanning of the Lake Abijata using Spectro-radiometer. Parametric analysis on the spectral profile exhibits the eutrophic state of the lake. Both of the proposed technical approaches had yielded tenable results. The technical approaches would contribute to the science and technology of remote sensing. It would also help environmentalists and limnologists for the automatic determination of lakes' productivity. In turn, determination of lakes' productivity offers benefit not only to the fishery industry, but also tourism, especially birds some of which are migratory like the flamingos and pelicans (Pelicanus onocratalus).

Keywords: Proximal sensing, alloctonous, autochthonous

Study of Environmental and Human Impacts of Mount Manengouba Lakes (Cameroon Line)

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Abstract

The Cameroon Line (CL) is an oceanic-continental structure (stretching from the Gulf of Guinea, Atlantic Ocean to Lac Chad, African Continent) that constitutes the main proof of the internal geodynamics that is affecting the Cameroon territory. It is made up of several plutonic and volcanic apparatus. Mount Manengouba (MM) is one of the major volcanic apparatus that characterize the south continental part of CL. Its summit presents two nested sub-circular calderas: Elengoum and Eboga. MM is also dominated by 4 lakes whose the ecological influence is significant. Accordingly, these lakes are considered as true ecosystems of the MM:

- the Female Lake is a sub-circular crater lake found in the Eboga caldera (EC); it is 22 ha in area and 168 m deep (Kling, 1988). Numerous types of aquatic fauna species live in the waters. The southern and eastern internal rims of the crater are covered by well-developed gallery forest that is characterized by some flora and fauna species.

- the Male Lake is a circular crater lake found in EC; it is 2 ha in area and 92 m deep (Kling, 1988). Since the lake is not accessible, the waters are not disturbed; this state favours the development of phytoplankton that give them a green colour. Moreover, the gallery forest is developed on the eastern rim of the crater. It is made up of important fauna and flora species.

- the Child Lake is also found in EC. Unlike Female Lake and Male Lake, Child Lake is not a closed system (there is an outlet). It is shallow and seasonal, recharged during the rainy season (June to October) (Zangmo Tefogoum et al., 2014). The presence of water during this period fosters the development of phytoplankton. During the dry season, some phytoplankton disappear and the lake floor is overgrown with endemic grasses.

- the Beme Lake is also a circular crater lake located on the North-western slopes of MM, precisely at the Beme village. It is the largest lake is in the region, some 60 ha in area and 14.5 m deep (Kling, 1988). This lake constitute a real biotope that encourages the proliferation of aquatic fauna species.

MM' Lakes have an impact on anthropogenic activities in the region. The presence of fishes in the crater lakes fosters fishing activity led by craftsmen for securing their livelihood. The Female

Lake are often used for traditional rituals. Moreover, the overflow of this Lake is evacuated through an outlet (North-western slopes of EC) and is used to refuel the city of Bangem. The Child Lake is an utmost source for breeding activity. It is accessible and supply cattle and horses with water during the rainy season. In the dry season the endemic grasses covering the lake floor constitute the main food for cattle. The breeding activity appears as the main activity led by Brororo people who are still migrating and settling in the EC and surroundings.

Major and Trace Elements Concentrations in Two Contrasting Rift Valley Lakes, Kenya: Water, Sediments, Fish and Parasites

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Abstract

This study presents the distribution of 17 major and trace elements in surface water, sediments, fish and their parasites in two contrasting Rift Valley Lakes: Naivasha and Turkana, Kenya. Lake Turkana is considered pristine-like, whereas Lake Naivasha is clearly under a strong anthropogenic influence owing to land use changes in the catchment and around the lake. Eight sediment and 10 water samples from the west bank of the Lake Turkana and 10 samples each of water and sediments from Lake Naivasha were obtained during the period-February to August 2011. Element concentrations were determined by inductively coupled plasma-optical emission spectroscopy (ICP-OES) and graphite-furnace atomic absorption spectrometry (GF-AAS). Interestingly, in both lakes, the concentration of elements in the water and sediments showed no sign of pollution but reflected the geology of the area: none of the investigated trace elements, including Pb, Cd, Cu, and Zn, showed elevated values. Contrastingly, the levels of some elements in muscles and liver of the selected fish species for the two lakes were elevated compared to the WHO standards. In elongate tiger fish Hydrocynus forskahlii, a piscivore, Li, Zn and Cd showed relatively high abundances in the muscle, with mean concentrations of 206, 427 and 0.56 mg/kg dw, respectively. The calculated target hazard quotient (THQ) values for Li, Zn, Sr and Cd were 138.7, 1.9, 4.1 and 0.76, respectively; therefore the consumption of this fish poses a health risk to humans in the area. Similarly, in blue spotted tilapia Oreochromis leucostictus, an omnivore from Lake Naivasha, concentrations in the muscle were equally high: 299, 34.43, 18.16, 604, 0.74 for Li, Si, Rb, Zn, Cd, respectively, and the THQ were greater than 0.1 for all but Rb, of which THQ value was not determined. This indicated a potential health risk to the consumers of this fish. In both fish, Contracaecum multipapillatum an anisakid nematode showed a good accumulation capacity for most trace elements, compared to fish muscle, but not compared to the fish liver. Accordingly, the bio-indicating abilities of this nematode are poorer than other endohelmith species.

Keywords: Rift Valley Lakes, Major elements, Trace elements, Parasites, Bio-monitoring

Could Sand Mining be a major Threat for the Declining Endemic Labeobarbus species of Lake Tana?

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Abstract

The effect of sand mining on migratory routes and spawning grounds of the highly threatened Labeobarbus species of Lake Tana was assessed from July 2012 to June 2013 in selected sites of Arno-Garno and Ribb Rivers. Physic-chemical parameters were measured using standard methods. Primary information on sand mining activities was obtained through the administration of a well-structured questionnaire for miners. Temperature, conductivity and total dissolved solids showed significant differences ($P<0.05$) among sampling sites. In Ribb and river mouth of Arno-Garno Rivers, mining was undertaken November - May by digging at 0.5 - 3 m depths. In the upstream areas of Arno-Garno River, it was practiced July-September through filtering, coincident with the peak spawning season of Labeobarbus species. More than 65% of the sample respondents pointed out that sand mining severely affected the physical characteristics of the studied rivers like decrease in gravel bed cover, loss of vegetation cover and increase in rivers depth. Sand miners observed massive movement of fish, fish eggs and even fish kills during mining. In both rivers, 92% of the respondents witnessed a decline in fish production due to sand mining. From this study, it is clear that unregulated sand mining brought in conflicting interests with fisheries management and environment, and appropriate regulatory measures should be taken to avoid such negative consequences. Thus, urgent policy inventions should be made to protect the ever declining Labeobarbus species of Lake Tana and the environment as well.

Keywords: Effect, Migratory routes, sand mining, spawning grounds, Rivers

Impact of waste water on Lakes: Case of Lake Obili Yaoundé Cameroon.

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Abstract

This study was carried out in Yaoundé the Capital city of Cameroon from January to March 2015. Yaoundé is a town of four seasons; two dry seasons and two raining seasons, its climate is described by Suchel (1972) as "Yaoundéen" (climate that seculate only within Yaoundé). It has a humid and hot equatorial climate. The Lake Obili is located on the river Olézoa, in a valley between the popular quarters Melen, Obili, Bonamoussadi, Hospital university centre and the university hostel of Yaoundé 1.This lake of Obili measures about 80m large, 100m long and the maximum of 2,5m deep. Part of this lake is use for fish breeding and sometimes this zone is cleaned by the agent of the breeding ministry. It is known that this lake is exposed to a heavy pressure of population due to its geographical location, all other waste water coming from the neighborhood and waste products are thrown into the lake. With the main aim of evaluating the impact of waste water on the lake Obili situated in the center of Yaoundé. Several internal have been carried out on water pollution, but few were carried out in the impact of waste water on the lake in Cameroon. The raison why waste water from homes without being purified are often thrown into this lake. This waste water once in this lake will modify however the ecology of water or its normal operation on the quality of the parameters (pH, temperature, Suspended matter, conductivity etc…) on the lake and on the biodiversity (macro invertebrates, zooplankton and fishes). The physicochemical variables were measured in the field and inside the laboratory by the spectrophotometer. However, this study carried out in the Lake shows us a fall on the specific diversity. The results of this study reveal that the waste water used in this lake could modify the physicochemical parameters such as the pH, electric conductivity, etc and would have very strong values of the indicator parameters of organic pollution, of degree of mineralization and eutrophication (DBO5, NH4 + , dissolved O2, Suspended matter, conductivity). In addition, we observe also several indicating species of pollution and a considerable fall of the biodiversity into the Obili lake. However, this reveals that the Lake Obili is an eutrophic lake like many others in Cameroon. Nowadays, the eutrophy of this water can be explained by the contribution of the strongly domestic pollution effluents and solid waste water resulting from the anthropic activities. Thus, their multiple morphological variations, and especially the reduction in their density, implicate the eutrophic state this waste water could cause the disappearance of several living species, and the future disappearance of this lake. We therefore call on all the social ranks, the scientific community and the government to protect the aquatic areas like the lake Obili, to restorate it, to make this lake a touristic sight and the creation of a purification area center to facilitate the management of waste water before flows into the lake.

Keywords: waste water, zooplanktons, macroinvertebrates, Eutrophication, eutrophy, anthropic.

Geomorphology and soils in tropical lake basins

Session 7

Geomorphology and soils in tropical lake basins

Monday 28 September

2:00 pm – 3:00 pm

Effects of land drainage and physical soil and water conservation on topographical thresholds for gully head development in North Ethiopia

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Abstract

The use of drainage ditches on sloping farmland has an impact on the farmland itself and on the downstream area, though its environmental impacts are not unequivocal. Researchers are still divided about the balance of the positive and negative effects which can be both on-site and off-site. A case study area was chosen around Wanzaye (North Ethiopia) where three different cropland-management practices were studied in 75 catchments: (i) the catchment-wide use of stone bunds on the contour, (ii) the use of slightly sloping drainage furrows (feses), and (iii) the combined use of stone bunds and feses. Three trends in cropland management around Wanzaye and the wider region are observed: (i) feses are exclusively made on rather steep slopes where small drainage areas lead to the rapid development of gully heads; (ii) stone bunds are constructed on both steeper and gentle sloping cropland; and (iii) larger and gently sloping catchments seem to be most suitable for the combined use of drainage ditches and stone bunds. A standardized procedure for topographical threshold analysis was applied to study the impact of different land management practices on gully head development in cropland. Topographical thresholds for gully head development reflect the vulnerability of lands to gullying, i.e. $s > kA^{-b}$, where s represents slope gradient of the soil surface and A the drainage area at the gully head, b an exponent, and k the resistance of the land to gully head development. The lowest k-values are found for feses catchments, which implies that catchments with the exclusive use of drainage ditches are the most vulnerable to gully head development compared to mixed catchments and stone bund catchments. Yet, on-site sheet and rill erosion are reduced by the use of feses as they reduce the runoff gradient.

Keywords: Sloping farmland; Topographical threshold ; Soil erosion ; Cropland management.

Hydrogeomorphological changes due to channel Erosion and In-Channel Deposition to Gumara River in the lacustrine plain of Lake Tana (Ethiopia).

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Abstract

The contribution of river bank erosion to sediment yield has so far been poorly investigated. The main objective of this study is to investigate the Gumara River in the lacustrine plain of Lake Tana (Ethiopia). In-channel deposition and the contribution of bank erosion to the total sediment load at its outlet were analyzed using historical aerial photos. To this end, measured sediment concentration, aerial photograph analysis, field observation and discussion with the local people were conducted. The Environment for Visualizing Images (ENVI 4.2) and ArcGIS were used to estimate and analyze river bank erosion and in-channel deposition. The result of sediment analysis showed that, the sediment yield decreases from the upper reach to the lower reach during maximum flows during storm and increases during minimum flows with no rain. The sediment load at the upper reach of Gumara River (5.9 million tons i.e.46.7 t/ha) is higher than in the lower reach (5 million tons i.e. 38.8 t/ha) of the river for maximum flow from the measurements of three months (June 2 to Sep. 2, 2012). This result indicates that the main source of the sediment during maximum flow is the upper catchment and 0.9 million tons of sediment were deposited between the two gauging stations. For minimum flow condition, the sediment load at the upper reach was 0.96 million tons and at the lower reach was 2.3 million tons. It indicates that 1.34 million tons of sediment loads is mobilized in the river channel within the same period. The analysis of aerial photographs of 1957 and the recent Google Maps (2014) show that the area occupied by the river has increased by 3.7 ha for the period of 57 years (annual mean expansion of 0.065ha corresponding to a sediment yield of 1649.7 ton/year. From these results, we conclude that channel erosion is not the major contributor to the total sediment load but in-channel deposition in Gumara River is significant. The major source of sediment for Gumara River is the upper catchment and the contribution of the lower catchment is low compared with the upper catchment because of its gentle slope and plainness.

Keywords: River bank, sediment yield, aerial photo, Google map, Gumara.

Variation of Selected Soil Properties in Relation to Land Use Types and Slope Steepness in a Mountainous Watershed, Ethiopia

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Abstract

Deforestation of the native forests for crop production in the Gumara-Maksegnit watershed, located in the Lake Tana basin, Ethiopia, dramatically increases the vulnerability of the soil for rainfall driven erosion. Hence, the central task of the study is to investigate general links of land-use and topography related to selected soil properties. The $53.7km^2$ watershed was divided into a 500m by 500m square grid to sample bulk density (pb), pH, soil organic carbon (SOC), total nitrogen (TN), available phosphorus (AP) and texture of the topsoil. Such properties were investigated with respect to the two main land-uses, forest and agriculture, and three different slope steepness classes, 0-10%, 10-30%, >30%. Descriptive statistics and correlation analyses were undertaken to explore potential dependencies of the obtained soil parameters according to land-use and slope steepness. The study indicates higher SOC and TN as well as higher silt and sand content in forest soils compared to agricultural soils, while solely ρd is lower in the forest soil. Overall increases of SOC, TN, silt and sand content from the gentle to the steep slopes have been observed for all land-uses. In contrast, clay content and ρd seem to increase from steep to gentle slopes on agricultural areas, which might be due to accumulation of particularly fine soil particles eroded from the steep areas. Basic correlations valid for all land-uses and slope steepness have not been detected. Nevertheless, the study suggests slope steepness as a tool to assess the potential drivers of soil depletion in the Ethiopian Highlands.

Keywords: Ethiopian Highlands, land-uses, slope steepness, soil properties

Hydrological and morphological factors at gully heads in the humid Northern Ethiopian Highlands, Birr watershed

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Abstract

In the Ethiopian highlands, gully erosion is severe. Although attempts to prevent gullying, it remains a challenge. Our objectives are to understand better the processes that control gully head cut retreat. The study was conducted in Birr watershed located at South West of Bahir Dar, Ethiopia. Twelve gully heads were selected and monitored from July to October, 2014. We measured gully head morphology, length of recession via pegging technique, soil analysis to determine soil shear strength, physical and chemical properties, water table elevations and catchment physical characteristics. Two active gully head cuts were arrested with stone riprap after regarding at 45^0. The result shows that the maximum rate of head cut retreat was between 0 to 22.5m. There was no head retreat observed from the protected heads compared with unprotected heads. The average short term head cut retreat was much greater than that observed in semiarid highlands of northern Ethiopia. The greater gulley rate of recession in the humid monsoon climate is likely caused by the water table that was above the gully bottom. In August when the soil became saturated, about 45% of head cut migration occurred. Thus the water table contributed to the slumping of gully heads and weakened the strength of the soil cohesion. The soil shear strength test result shows, angle of internal friction was by far greater than the slope of gully heads where heads are located in the periodically saturated flat lands. The width depth ratio showed that the shallow depth heads were controlled by fluvial erosion whereas for the deep gully heads both fluvial and mass wasting due to tension cracks was the main driving force. Both the water table control and protecting the head cuts of shallow gullies plays a key role in reducing the sediment contribution of gully in the humid Ethiopian highlands.

Keywords: Gully erosion, Gully head retreat, Gully morphology, Water table elevation

Catchment management, soil and water conservation

Session 8

Catchment management, soil and water conservation

Monday 28 September

3:30 pm – 6:30 pm

Soil and water conservation effects of stone bunds at different scales – a case study from Gumara-Maksegnit watershed, Lake Tana Basin, Ethiopia

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Abstract

Various soil and water conservation (SWC) interventions across the Ethiopian farmlands are supposed to prevent ongoing land degradation and soil depletion related to rainfall driven soil erosion. Stone bunds are among most extensively applied SWC techniques, whereas various designs and adaptations can be found in different regions of the country. In some cases SWC structures seem adapted to dominant farming techniques or they are designed in addition to general recommendations neglecting the local field conditions. Therefore, in Gumara-Maksegnit watershed in Lake Tana Basin, a field experimental campaign was conducted to evaluate the impact of on-site interventions (graded stone bunds) on surface runoff and sediment yield.

Plot scale experiments considering local stone bund spacing were carried out in 2013. In addition, a tracer experiment was set up to track the dominant pathways of the sediments to a) conclude on spatial sedimentation pattern, and b) to evaluate the impact of the plot experimental design on the observed hill slope processes. The experiments indicate considerable conservation effects (reduction of approximately 60 percent runoff and 40 percent sediment yield at stone bund treatment). Anyhow, it is expected that these values are highly dependent from scale and experimental layout. Over-spilling or percolation of water at the bund may sequentially influence the down-hill fields. Likewise, the effectivity of graded stone bunds is expected to decrease with increasing lateral extent of the field. Thus, for the rainy season 2015 modified monitoring campaign has been planned to investigate different scale effects through adapted experiments considering stone bund cascade effects and cumulative runoff effects along the bunds. Accordingly, these 2015 rainy season results will be presented at the conference.

A decade progress of conservation agriculture-based systems on in situ soil and water conservation and adaptation to climate change in the Ethiopian drylands

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Abstract

Long-term in situ soil and water conservation experiments are rare in sub-Saharan Africa, particularly in Eastern Africa. Conservation agriculture (CA)-based systems aims at building resilience against soil degradation via reducing soil loss and drought by increasing productive green water by reducing runoff and soil evaporation while improving crop yield (1) by minimizing soil disturbance, (2) by retaining crop residue, (3) by using crop rotations and (4) by adding in situ soil and water conservation (SWC) tillage practices (terwah and derdero) in crop fields. We studied the impact of two CA-based systems (derdero+ (DER+) and terwah+ (TER+)) on soil moisture, runoff, soil evaporation, soil loss, water use efficiency and crop productivity in permanently kept plots in northern Ethiopia 10 years (2005-2014) after its inception. The two RCA practices: (i) DER+ is a bed and furrow planting system, where beds remain unploughed, furrows are tilled once at planting time and 30% of crop residue is retained. (ii) TER+ is ploughed once at planting, furrows are made at 1.5 m interval, creating fresh broad beds, and 30% crop residue is retained. These RCA practices were compared against conventional tillage (CT) characterized by a minimum of three tillage operations and complete removal of crop residues. DER+ and TER+ were based on local practices that were modified to comply with conservation agriculture (CA) principles. All plowing as well as the maintenance of the furrows of the permanent raised beds was done using a local ard plow called mahresha. Wheat, teff, barley and grass pea were grown in rotation. Glyphosate was sprayed at 2 l ha^{-1} to control weeds before crop emergence, starting from 2007 with DER+ and TER+. Runoff was collected at the lower end of each plot in calibrated runoff collectors after each runoff event. Soil water content was measured using the gravimetric method at 5 to 6 day intervals. Significantly different ($P<0.05$) runoff coefficients (%) averaged over 10 yrs were 14, 22 and 30 for DER+, TER+ and CT, respectively. Mean soil losses of 10 yrs were 3, 12 and 18 t ha^{-1} y^{-1} in DER+, TER+ and CT, respectively. Soil water storage (0–80 cm soil depth) during the growing season was always highest with DER+ followed by TER+ and CT, whereas the opposite trend was observed for runoff. Although improvements in crop yield were observed, a period of at least three years of cropping was required before they became significant. The grain and straw yield of wheat in 2009 was increased from 1.6 and 3.7 t ha^{-1} with CT to 2.6 and 5.2 t ha^{-1} with DER+, respectively.The experiences presented in this paper from northern Ethiopia indicate that for

smallholder farmers in semi-arid areas, CA-based systems constitute a field rainwater conservation and soil fertility improvement strategy that increase agro-ecosystems resilience to climate change (such as drought) and thus improve crop productivity. Adoption of CA systems (DER+ and TER+) in the study area require further work to improve smallholder farmers' awareness on benefits, to guarantee high standards during implementation and to design appropriate weed management strategies.

Land management in the North-Western Highlands of Ethiopia: Adoption and Impact

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Abstract
Over the last four decades, the government of Ethiopia and a consortium of donors have been promoting different land management (LM) practices in the highlands of Ethiopia to halt land degradation. However, the adoption rate of these practices has been minimal. This is because investments in LM practices are influenced by various institutional, socio-economic and bio-physical factors. The main objective of this research is to investigate the impact of these different factors on investments in LM in the north-western Ethiopian highlands. It gives in particular emphasis on the drivers of the different stages of adoption, on profitability of LM practices, and on land quality, land fragmentation, tenure arrangements and social capital.

We examine the drivers of the different stages of adoption of soil and water conservation (SWC) practices using an ordered probit model. The results indicate that adoption of soil and water conservation (SWC) passes through four major phases: non-adoption/dis-adoption, initial adoption, actual adoption and final adoption. Some socio-economic and institutional factors have a different effect on the respective SWC adoption phases. Final adoption depends mostly on profitability, land-related factors, social capital and perception of erosion problems.

It is also investigated the effectiveness and profitability of three SWC practices (stone bunds, soil bunds and Fanyajuu bunds) using the Universal Soil Loss Equation (USLE) and cost benefit analysis (CBA), respectively. The results show that SWC practices are effective in controlling soil erosion, though the profitability of these SWC methods is dependent on the site where they are used. Fanyajuu and stone bunds are generally profitable under standard conditions (e.g. medium slope and average soil quality and labour costs). However, the study also shows that different underlying assumptions change the CBA results considerably and consequently also change the conclusions regarding circumstances under which SWC measures are or are not profitable.

Moreover, we assesse farmers' perceptions about land quality, land fragmentation and tenure systems and their influence on interrelated LM (Bunds, Compost/Manure and Fertilizer) investments using a multivariate probit (MPV) model. The study shows that investments in LM practices are interdependent. For example, compost/manure and fertiliser are to a certain extent substitutions for each other (often not used together, or used interchangeably by farmers) in the farming system of the study areas. Land quality (e.g. slope and soil fertility status), land fragmentation (parcel size and distance of parcel from homestead) and tenure arrangements influence farmers' investments in LM practices.

In addition, the relationship between the different dimensions of social capital and investments in LM practices is explored. The results shows that the different dimensions of social capital affect LM practices differently. In particular, the cooperation and trust dimensions of social capital are

associated with the intensity of investment in SWC bunds and fertiliser use. The extent of participation in formal institutions has a positive effect on the use of fertiliser and compost.

Furthermore, we evaluated different SWC practices using Multi-Criteria Analysis (MCA) to assess their ecological, economic and social impacts. The study reveals that MCA is an effective evaluation tool that can take into account non- monetary and less quantifiable effects of SWC measures, which is not possible with Cost Benefit Analysis. The results of the analysis indicate that farmers have a range of criteria to evaluate the performance of SWC measures. The relative importance of each criterion in the selection of SWC alternatives depends to a large extent on slope categories.

For enhancing the adoption and impacts of land management, there is a need to increase knowledge about location specific viable LM practices, to promote collective action at watershed level, to pay more attention to farmers' preferences and to improve the capacity and capability of farmers.

Integrated watershed management implementation: Implication for reduce soil erosion, improve crop production and its associated impact in the upstream and downstream communities in Adulala Watershed, Ethiopia

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Abstract

Environmental degradation and its non-realization by the common man have been the biggest recent tragedy of natural resources. Soil erosion and denudation of tree covers are tending to enlarge the area of degraded and west land in dry land watershed areas. It is, therefore, watershed management (WM) is believed as a holistic approach to manage watershed resources that integrate forestry, agriculture, pasture and water management, with an objective of sustainable management of natural resources to reduce environmental degradation. This approach pursues to promote interactions among multiple stakeholders and their interests within and between the upstream and downstream locations of a watershed. Integrated watershed management projects have been implemented in the Adulala watershed for the last years. The experiences showed that participatory community based soil and water conservation (SWC) activities and collective action brought high degree of sustainability and performance of the practices. This had been ratified by the implementation of SWC action research on upstream which in turn reduce the erosion rate and the amount of runoff or flood damages ultimately minimized from downstream at Wonji sugar factory farm and Melkassa Agricultural Research Center (MARC) compound. This, in turn, significantly improved land productivity and biodiversity conservation in the upstream areas and cut the huge costs of flood in the Wonji sugar factory sugar cane farm and MARC area. The cornerstone for these good indicators or success was the effective implementation of different SWC action research as WM and social institutions. Above all, frequent dialogues between practitioners and communities at watershed have had a help in linking the upstream and downstream ecology and improving productivity to improve the livelihoods of the local people and sustainable watershed resource management.

Keywords: Watershed management, soil and water conservation, stakeholders, soil erosion, upstream and downstream community, Ethiopia

Effect of check dams in gullies on runoff response in the headwaters of Tekeze reservoir

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Abstract

In the Highlands of Northern Ethiopia soil and water conservation (SWC) practices, including construction of check dams in gullies, have been implemented for the last three decades. Despite this extensive installation of check dams; their effects on runoff response is not well understood as compared to other SWC practices. Hence, this study examines the effect of check dams on runoff response in gully channels. 90 degree V-notch flumes were installed to measure a wide range of discharges at the upper and lower sides of five gully reaches (two in sandstone lithology: a gully with check dams and vegetation (SCV) and an untreated gully (S); three in limestone: a gully with check dams and vegetation (LCV), a gully with check dams but no vegetation (LC) and an untreated gully (L)). Automatic e+ WATER 100L sensors were installed to monitor runoff depth from 29 August to 17 September 2014 at one min intervals. All gully reaches were standardized to have equal length (50 m) for analysis. In the sandstone area, the study shows longer lag times of runoff to reach the lower part of the channel in the treated gully (SCV) compared to the untreated gully: lag to production of runoff equals 43%, lag to peak runoff equals 57% and lag to end runoff equals 18%. In the limestone area, lag to production of runoff was greater by 29% and lag to end runoff by 52% at LCV than at LC. Check dams and the sediments deposited behind check dams are responsible for the delay of runoff to reach lower part of the gully channels. These delays also prove that the presence of vegetation in the gully channels retards runoff. The reduction of peak runoff discharge between the upper and lower sides of gullies was greater in the gullies with check dam and vegetation (12% − 24%) than in gullies without treatment (4% − 8%). Reduction of runoff volume was also greater in treated gullies than in untreated gullies. It was reduced by 16%, 10% and 9% in SCV, LCV and LC, respectively while it was only reduced by 7% in S and 4% in L gully. This study shows that implementation of check dams combined with vegetation considerably reduced peak discharge and volume of runoff as large portions of water infiltrated in the sediments accumulated behind the check dams. As check dams are implemented in a large part of the gullies in the Tekeze basin, this leads ultimately to improved baseflows and a better spreading of the river discharges into the Tekeze reservoir.

Keywords: Gully control, lag time, Northern Ethiopia, peak runoff discharge, runoff volume, Tekeze basin

The implications of participatory watershed management for reversing land degradation in Ethiopian highlands: The Birr watershed

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Abstract

Soil erosion is a serious problem in the Ethiopian highlands. Conventional erosion control approaches have generally been ineffective in halting this problem. Our study quantified the watershed-scale sediment loss before and after community participatory soil conservation practices were installed on gullies during 2013 and 2014 in the Ene-Chilala sub-watershed of the Birr River watershed. Beginning in 2013 six gullies were rehabilitated by the community and researchers using biological and physical conservation practices such as check dams constructed from gabions, wood and stones to reduce stream flow power; and upland soil conservation measures as part of the large scale soil and water conservation national program financed by the Amhara regional Bureau of Agriculture. In-stream monitoring was conducted at the watershed outlet (Weir-3) and two nested sub watersheds (Weir-1 and Weir-2). The amount of precipitation was recorded by automatic and manual rain gauges. The total precipitation was 1047 mm and 761 mm in 2013 and 2014, respectively. The infiltration capacity of the soil was measured at 18 locations for different slopes and land uses using single ring infiltrometer. The median infiltration

capacity for upland and bottom land was 162 and 8 mm h^{-1}, respectively. The upland median infiltration was not exceeded at any time by rainfall intensities but the saturated bottomland median infiltration was exceeded by rainfall intensity 34% of the time. The total annual runoff including base flow at the watershed outlet was 781 mm and 392 mm in 2013 and 2014, respectively. We measured both upland and gully erosion. The in-stream sediment concentration indicated high sediment concentration in the nested, hilly sub-catchments at the beginning of the rainy season. Subsequently, active gullies on downslope saturated areas were dominant sources of sediment, which caused sediment concentration and sediment yield at the watershed outlet (Weir-3) to exceed those at the upslope catchment outlets (Weir-1 and Weir-2). The annual sediment yield was 75 t ha^{-1} and 10 t ha^{-1} in 2013 and 2014, respectively. Although our study design did not control for other factors influencing erosion, the community participatory rehabilitation of gullies and the upland soil and water conservation works promoted by government are likely causes of reduced sediment loads observed in 2014.

Evaluating indigenous grass species as on-site sediment trapping measures, northwest Ethiopian highlands

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Abstract

Although many studies had been conducted to evaluate the sediment trapping efficacy (STE) of grass species as an on-site sediment trapping measure, still a lot of grass species are availab1e in which their STE is not known. This study was conducted at Debre Mewi watershed, to evaluate the STE of four locally dominant indigenous grass species in northwest Ethiopian highlands desho (Pennisetum pedicellatum), Senbelet (Hyparrhenia rufa), Sebez (Pennisetum schimpri) and Akirma (Eleusine floccifolia) and one exotic but well adapted grass species, Vetiver (Vetiveria zizanioides) using plot experiment. On average, the annual runoff produced were found to be 79; 64.4; 68.6; 71; 74; 74.8 l m^{-2}, which resulted 7; 1.7; 2.9; 3.6; 4.5 and 5.6 kg m^{-2} yr^{-1} of sediment yield on the control, desho, vetiver, senbelet, akirma and sebez plots, respectively. Desho reduced 4 times more sediment than the control plot with 75.6 % STE because of its fast growth and lateral spreading nature. Vetiver and senbelet also reduced 2 times more sediment than the control plot with 59 % and 48.5 % STE, respectively. Because of their slow growth and lateral spreading nature, akirma and sebez showed low STE, 36 % and 20.4 %, respectively. The grass species were found to be important sources of livestock feed in addition to trapping sediment and reducing soil loss. Desho, senbelet, akirma, vetiver and sebez provided 132, 106, 76, 69 and 51 t ha^{-1} yr^{-1} fresh biomass, respectively. The indigenous grass species provided a practical means to reduce sediment yield, therefore, it can be concluded that such indigenous grass species can be used as an on-site sediment trapping measure on tef field in the northwest highlands of Ethiopia.

Keywords: Sediment trapping efficacy, indigenous grass species, on-site sediment trapping measures, northwest Ethiopia

The role of on-farm forest resources as an adaptation strategy to climate change effects to the communities around Mkingu Nature Reserve in the Eastern Arc Mountains

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Abstract

On-farm forest tree planting can play an important role on adaptation as well as mitigation to climate change effects. Yet, little is known about local community's coping strategies to climate change effects around Mkingu Nature Reserve (MNR). We investigated the role of on-farm tree resources as a long-term and sustainable adaption strategy to climatic stress (e.g., decrease and unpredictable rainfall, increased in temperature and drought) to the local communities living around MNR in the Eastern Arc Mountains of Tanzania. Specifically, the study determined the effects of climate change to the peoples' livelihoods and investigated the role of on-farm resources to the climate change adaptation. Field observations, participatory rural appraisal (PRA), focus group discussions (FGDs), key informants' interviews and household questionnaire surveys were used to collect data. Results show that majority (92%) of the respondents were engaged in farming and/or involved in various economic activities such as livestock keeping, fishing, trading of forest products as well as conducting petty business around the reserve. Using the CRAISTAL model, the results revealed that the main effects of climate change to peoples' livelihoods included decrease in agricultural crops, increase in human diseases, increase in natural disasters and reduction in fuels for cooking. Regression analysis shows that households that received the extension services and/or owned livestock were more likely to switch to agricultural drought-tolerant varieties as a response to climatic stress than those without access to these assets. About 57.8% of the respondents planted trees on-farm to their farm as a strategy to climate change effects in their area. It was learnt that crop diversification, irrigation, fishing, conducting petty business, and the use of non timber forest products were among the adaptation strategies to the people living around MNR.

Impact of cover crop on runoff, soil loss, soil chemical properties and yield of chickpea in North Gondar, Ethiopia

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Abstract

Cover crops improve the sustainability and quality of both natural system and agro ecosystem. In Gumara-Maksegnit watershed which is located in the Lake Tana basin, farmers usually use fallow during the rainy season for the preceding chickpea production system. The fallowing period can lead to soil erosion and nutrient losses. On-farm field experiment was conducted in 2014 cropping seasons on the effect of cover crop on runoff, soil loss, soil chemical properties and yield of chickpea in North Gondar, Ethiopia. This study was conducted to evaluate the effect of cover crop and green manure on runoff, soil loss, soil chemical properties and yield of chickpea. The experiment contains four treatments arranged in Randomized Complete Block Design with three replications: 1) Control plot (Farmers' practice: fallowing- without cover crop), 2) Chickpea planted with Di-ammonium phosphate (DAP) fertilizer with 46 k ha-1 P2O5 and 23 k ha-1 Nitrogen after harvesting vetch cover crop, 3) Chick pea planted with vetch cover crop incorporated with the soil as green manure without fertilizer, 4) Chick pea planted with vetch cover crop and incorporated with the soil as green manure and with 23 k ha-1P2O5 and 12.5 k ha-1 Nitrogen. Runoff monitoring system was established during 2014 rainy season. Vetch (Vicia sativa L.) was planted as cover crop at the onset of the rain in June and used as green manure crop. One year preliminary data shows statistically significant (P < 0.05) effect on the number of pods per plant, above ground biomass and grain yield of chick pea. However, there was so statistically significant difference (P > 0.05) on average plant height, average number of branch and hundred seed weight. Similarly, the results indicated that cover crop has a clear impact on runoff volume and sediment loss. In general, this result revealed that the cover crops, especially vetch can be used to improve chickpea grain yield in addition to reducing soil erosion in the watershed.

Effectiveness of soil and water conservation measures in two contrasting environments of the Ethiopian highlands

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Abstract

Excessive runoff resulting from severe land degradation is posing serious on-site and off-site problems in the Ethiopian highlands. Many soil and water conservation (SWC) measures have been implemented since the 1980s and these efforts were mainly concentrated in the north and northeast part of Ethiopia where problems were felt first. However since recent years, the SWC initiatives have been expanded to other parts of Ethiopia such as the northwestern parts where there is relatively better rainfall and agricultural land productivity but with high land degradation activity.

Previous studies concerning the effects of SWC were manly focused on northern Ethiopia and little has been studied in high rainfall region of Ethiopia such as in the northwest. Therefore this study evaluates and compares the effectiveness of SWC measures in these two contrasting watershed environments: on Guder (dry subhumid) in the northwest and May Leba (semiarid) in the north parts of Ethiopia.

It involved one season monitoring of daily runoff from bounded runoff plots (n = 39; area = 150-1000 m^2) treated with or without SWC measures, recording of daily rainfall and runoff, monitoring of seasonal changes in land use practices, vegetation cover and soil characteristics. The plots were replicated over representative land use types (cultivated and vegetated surfaces) and slope ranges (medium and steep). The data were analyzed and interpreted using the runoff coefficient (RC) approach which is computed as percent ratio between runoff and rainfall.

Seasonal runoff from control plots in Guder watershed ranged between 134-451 mm whereas in May Leba between 75 -250 mm. The overall variation in RC between land uses for control plots

in Guder was found to vary between 17-42% and that of May Leba was 10-50%, implying the significant variability of runoff both within and across the two studied environments.

Runoff coefficient (RC) from croplands treated with soil bunds combined with or without biological measures in Guder varied between 14% and 23%, whereas the values from control plots were in the range 18-42%. Vegetated land use types (grassland, Acacia decurrens, eucalyptus plantation and degraded bush land), treated with trench yielded RC values in the range between 12-16% and the values from control plots were in the range 18-42%. In May Leba, RC was found to vary from 6-35% for rangelands (degraded grassland) treated with trench while that of the control plots was 37-50%. The RC for cropland treated with stone bunds combined with or without trench varied from 4-12% and that of the control plots was 10-15%. The overall effectiveness of SWC in reducing runoff ranged between 3-25% and 4-31% for Guder and May Leba watersheds respectively.

Generally, runoff responses within and between land use types in both environments are highly variable over space. So is the effectiveness of the SWC measures. This high variation could be attributed to a combination of several factors such as variation in soils properties (bulk density), land management practices (tillage), surface cover (vegetation and stoniness) and rainfall characteristics (intensity). As more data become available a more detailed analysis is required to understand better the mechanisms of runoff responses in such heterogeneous environments.

Keywords: Semiarid; Dry subhumid; Runoff coefficient; Guder; May Leba; Ethiopia

Land use, land degradation and soil erosion in tropical lake basins

Effects of transnational land deals on peak discharge and sediment transport in the catchments around the Grand Ethiopian Renaissance Dam

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Abstract

Sustainable hydroelectric power development requires protection and conservation of upstream catchments. An interesting case in this regard is the fact that the Government of Ethiopia is constructing Africa's largest hydroelectric power dam, the Grand Ethiopian Renaissance Dam (GERD), on the Blue Nile River while delivering in the same time tracts of land for commercial farming in the closer upper catchments. The dam has an estimated impounding capacity of 74 billion m³ (due completion in 2017). Considering these investments, it is necessary to determine the effects of the commercial farms on peak discharge and sediment in the surrounding of the hydroelectric power dam. Accordingly, this field survey was conducted from February to August 2015 on 20 ephemeral streams in Dangure district so as to compare peak discharges between 5-20 km² catchments draining commercial farmland and others draining land under traditional management. Besides, socio-economic data was collected from 385 households from the study areas. We measured channel characteristics and applied the empirical Manning equation. We presented comparative results on peak discharge among commercial and conventional farming areas, forest, and woodland areas. Results indicate that there is a high rate of deforestation, erosion, stream incision, and gully formation in areas where commercial farming is being practiced. The absence of conservation activities in commercial farmlands contributes to the sediment load that is hazardous to the downstream water body and the livelihood of local people. Failure to shift the livelihood of local people to sustainable land use alternatives contributed to

the increased stream incision and formation of gullies since local Gumuz communities started other unsustainable land use practices. For instance, the large majority of the local households in the study area engaged themselves in renting out of forested lands to domestic commercial farmers through a practice called mofer zement (meaning 'plough campaign') and traditional gold mining. The study concludes that there is urgent need to halt the ongoing massive deforestation and woodland degradation in the GERD basin. It is critically important to apply sustainable land management strategies and work towards alternative forest resource use practices such as ecotourism, forest honey production, and payments for environmental service schemes in the area. If not, increased sedimentation could shorten the intended power harvest lifespan of the Renaissance Dam. Moreover, there is a need to: (i) enforce existing companies to use conservation farming or to offer alternative land elsewhere, (ii) build the capacity of districts and kebelles so that they can apply a well-informed integrated forest land management and rehabilitation practices across the catchments, and (iii) improve the agility and capacity of local communities to shift to other sustainable livelihood alternatives. Otherwise, increased sedimentation could shorten the lifetime of the dam.

Impacts of Land Cover Change on Sediment Load of Lake Tana; a Case of Gilgel Abay Watershed, Blue Nile, Ethiopia

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Abstract

This paper presents watershed level impact of land cover change on sediment yield in Gilgel Abay catchment, Blue Nile Basin, Ethiopia, by using land cover maps of 1986, 2000 and 2014, which cover the past 28 years. Studies on impact of land use land cover change on the hydrology of watershed are essential to understand the existing situation and plan for the future. For this study, recent satellite imagery are collected from USGS and pre-processing steps like layer stacking, mosaicing and sub-setting were applied. Based on the data and ground signatures collected during the field work, classification of the images has done using ERDAS Imagine 2010 version software. Change detection, verification, validation, post-classification and statistical analysis were applied during the analysis. Following the above stages of work, the study identified 8 major land cover classes. According to the result obtained, the analysis of the land cover classification and change detection over a period of years both in a spatial and quantitative way in Gilgel Abbay watershed, indicates that there were a significant change on the land cover types. For instance, cultivated land was increased by 19.6% from the total watershed within 28 years (1986-2014). Whereas, forest and grass land were decreased by 5.6% and 16.5%, respectively. This clearly indicates that grass land and forest land of the watershed was mostly changed to cultivated land. On the other hand, bush and shrub land was increased by about 2.7%. This may be due to the change of forest to shrub and bush land because of deforestation. To see the impacts of these cover changes; stream flow and sediment load was modelled from 1994-2008 for Gilgel Abay using Soil and Water Assessment Tool (SWAT). After calibration using SWAT-CUP Sequential Uncertainty Fitting Version-2 (SUFI-2) algorithms with stream flow and sediment yield, model simulation performance was evaluated and baseline parameters were identified. Nash-Sutcliffe Efficiency (NSE) of 0.77 and 0.58 for stream flow and sediment yield in the calibration period (1996-2004) respectively. In the validation period NSE was 0.75 and 0.51 for stream flow and sediment yield in the validation period (2005-2008). Therefore, the impact assessment result indicated that the mean annual flow decreased by 0.2 % for the past 28 years (increase in surface runoff and decrease in base flow) whereas mean annual sediment load of the watershed increased by 104% for the same period of years. This sediment load figure showed that the load is doubling itself in 2014 as compared to the 1986 mean annual sediment load. Hence with this increasing sediment load transport to the lake due to land cover change Lake Tana will be endanger of becoming dry land.

Keywords: Gilgel Abbay, SWAT, Land cover change

Sediment production from gully erosion in the (semi) humid Ethiopian highlands: the Debre Mawi watershed

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Abstract

Upland soil and water conservation programs in the humid Ethiopian highlands have not been effective in decreasing downstream sediment concentrations, because the primary sources of sediment are the rapidly expanding gullies (up to 10 m in depth) in the periodically saturated valley bottom land and corrective actions have not had the desired effect. As a consequence, the capacity of newly constructed reservoirs, including the Grand Ethiopian Renaissance Dam, will decrease due to siltation. The sediment contribution of gullies, although likely severe, has not been well documented in the humid Ethiopian highlands. To quantify their contribution, the 608 ha Debre-Mawi watershed, 30 km south of Lake Tana, was selected as a study site to estimate the portion of sediment that originates from gully erosion. We calculated sediment loss from gullies both at the individual and at the watershed scale. At the individual scale, we measured soil loss for a gully draining a 17.4 ha sub-watershed, by measuring the change in its dimensions in 2013 and 2014 and by measuring both the discharge and sediment concentration at the upstream and downstream ends of the gully at 10 minutes intervals. At the watershed scale, we estimated the gully soil loss over a nine year period using aerial imagery flown in 2005 and 2013 with a 50 cm resolution. The soil loss mass for each gully in the watershed was calculated by multiplying the digitized gully surface area with its averaged depth, its average bulk density, and a constant with a value of 0.84 that relates gully top width to mean width based on detailed measurements of 13 gullies in 2013. Finally, we tried to reduce soil loss by installing a headcut control structure in deep gully by regrading the gully head and adjacent banks from 85° to 45°, installing a gabion check-dam beneath the headcut and a series of smaller check-dams made of wood at short distances below the headcut and gabion. Based on the individual-scale gully measurements, we found that upland erosion entering the gully in 2013 and 2014 was 180 tons (or 5 t ha^{-1} yr^{-1}) and from the gully was 3100 tons (or 89 t ha^{-1} yr^{-1}). In other words, 95 % of all sediment in the runoff after the gully originated from the gully and only 5% sediment was contributed from the

uplands. At the watershed scale, average soil loss of the nine year period was 100 t ha^{-1} yr^{-1}, confirming the severity of the gully erosion in the Debre-Mawi watershed. The gully head control structure was only partially successful in treating the headcut and shows that in the humid Ethiopia highlands, where the soil saturates periodically, arresting head cuts is more difficult than in semi-arid areas and expensive. Thus, since upland soil and water conservation practices are limited in effectiveness when gullies are in the valley bottom lands, designing measures to treat deep gullies in cost effective ways in a humid monsoon highland should be a priority in future research in order to reduce sediment loads in rivers.

Keywords: Gully erosion; Sediment production; Siltation; Sediment delivery ratio; Debre Mawi watershed

Contributions of peak sediment events to annual loads and the effects of Best Management Practices on peak loads in the sub-humid Ethiopian highlands: The Debre Mawi watershed

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Abstract

Intense rainfall/runoff events produce large proportion of suspended sediment concentrations and sediment load responses. With an aim to mitigate land degradation problems in Ethiopia, soil and water conservation projects are being massively implemented. The effect of these conservation measures in reducing sediment in streams have never been quantified due to unavailability of sediment data. In a quantitative evaluation to quantify the contribution of intense event/daily sediment loads to annual sediment loads and effect of conservation measures in reducing erosion, we monitored three nested experimental sub-watersheds and a 95 ha main watershed in the sub-humid Ethiopian highlands, Debre Mawi watershed for four consecutive years. The contribution of the largest 10–minute events and peak daily sediment loads to annual sediment loads and the effect of Best Management Practices (BMPs) on peak sediment transport processes were evaluated. The contribution of the largest event loads reached up to 22% of the total annual sediment loads. The peak event sediment loads reached up to 11 t ha^{-1}. The contribution of the largest daily sediment load events to annual loads is up to 86%. For the two largest daily sediment load events, the contribution reached up to 95%. The total sediment loads of the two largest daily sediment load events ranged from 40-68 t ha^{-1}day^{-1} indicating that most of the annual sediment loads are transported with in one or two intense daily sediment load events in the (sub) humid Ethiopian highlands. Comparison of peak sediment loads before and after the implementation of BMPs indicates that conservation practices such as soil bunds, stone faced soil bunds and stone bunds substantially reduced the contribution and magnitude of peak sediment loads. The sediment trap efficiency of the BMPs can be further improved by making ditches deeper than existing practice of 50 cm depth in the Ethiopian highlands.

Keywords: Peak sediment loads, Debre Mawi watershed, Ethiopian highlands, Best Management Practice.

Influence of the landscape context on stand structure and spatial patterns of the agroforestry dum palm tree in the Republic of Benin (West Africa)

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Abstract

Hyphaene thebaica Mart. (dum palm) is an agroforestry tree with high ecological and economic value, but currently its populations are harvested excessively, which is likely to increase in future. This study assessed the current status of the species with regard to increasing landscape modification and human pressure in Benin. We compared structure of adult dum palm trees and regenerations in farmlands versus Biosphere Reserve of Pendjari (BRP). In addition, spatial patterns and sex ratio of the species were compared between both land use types. Results showed that mean diameter and density of the trees and seedlings were significantly higher (P<0.001) in BRP than in farmlands. However, no significant differences were noticed for trees height and density of juveniles (P>0.05). Spatial point pattern analyses revealed differences in the spatial structure of dum palm stages. The pair correlation function showed globally a random distribution for all palm stages albeit with a weak aggregation between 0–10 m in farmlands. In the BRP, a strong aggregated distribution is observed for seedlings between 0-5 m whereas all other palm stages showed globally a random distribution. Moreover, no association was observed for palm stages and between palm stages and trees except for females and seedlings in the BRP. The sex ratio was not globally different from 0.5 in both land use types. We conclude that in spite of the land-use impact, dum palm tree is still well preserved. However, rapid land-use intensifications may lead to increasing pressure on the species populations in the future.

Keywords: Conservation, distribution, Hyphaene thebaica, point pattern analysis, sex-ratio

Vegetation Dynamics in Nech Sar National park, South Ethiopia Rift Valley

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Abstract

Set in the Southern Ethiopia Rift valley, Nech Sar National park, has extraordinary landscapes. The park shows important land cover changes over the years. The primary aim of this study was to understand the land use/land cover changes that occurred between 1976 and 2013 in Nech Sar National park (NSNP) and determine the intensity of the spatial and temporal changes of the habitat. The study examines the historical land use/ land cover changes and the possible causes using GIS and Remote sensing. The NSNP consists of nine land cover classes (Lake Abaya; Lake Chamo; Open grassland; Riparian and Groundwater forest; Bushy shrubby grassland; Wooded grassland; Dense bush land; Bare land, cultivated and heavily degraded land; and Wetlands). Landsat images with a 30m resolution of 1976, 1986, 2000, 2005, 2011 obtained from NASA and United States Geological Survey (USGS) were used. The intensity of changes through time was analyzed using three level analysis suggested by Aldwaik and Pontius (2012). The study results show that the land cover of NSNP underwent major changes since 1976. Bare and cultivated land; wooded grassland; wetlands; riparian and groundwater forest and open grassland have showed major net changes. The two major tropical lakes, Lake Abaya and Lake Chamo show dramatic change since 1976. Lake Abaya has net gained of 220 ha due to inflow of high sedimentation from the uplands and the outflow of the lake has been blocked by levees. However, Lake Chamo has decreased with 139 ha due to diversion of its tributary rivers for irrigation. Bare and cultivated lands have net increased with 4382 ha, and wooded grassland with 1713 ha. Open grassland has net decreased with 1402 ha and riparian and ground water forests have net decreased with 1556 ha. The riparian and groundwater forests near the Sermale river showed substantial decrease over the years. The wetlands also showed a net decrease with 2148 ha over the years. The intensity of changes were much faster from 2005-2011 than the time interval of 1986-2000. The general increase in bare, cultivated and heavily degraded lands and woodlands at the expense of wetlands, open grasslands, riparian and groundwater forest has negatively affected the survival of wildlife and the international value of the park. Therefore, the management plan strategy and its action should be prioritized based on the activity and intensity of changes of landscape.

Keywords: land-use/cover change, land cover dynamics, NechSar National Park, GIS and remote sensing, degradation, vegetation cover

Sediment deposition in tropical lakes and endorheic basins

Session 10

Sediment deposition in tropical lakes and endorheic basins

Tuesday 29 September

10:45 am – 12:00 pm

Sediment budget of Lake Tana and the role of lacustrine plains

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Abstract

Overbank sedimentation on river floodplains can result in a significant reduction of the suspended sediment load transported by a river and thus represents an important component of the catchment sediment budget. This study attempts to quantify the amount of sediment stored on the floodplains, transported to the lake, delivered out of the lake and stored into Lake Tana annually in order to establish a sediment budget for Lake Tana Basin, Ethiopia. In 2012 and 2013, suspended sediment concentration (SSC) and discharge measurements were made at 13 stations, of which the two are at lake outlets. Based on the land cover and rainfall seasonality, the yearly data have been divided into five periods and five different sediment rating curves were established for each of the 11 river monitoring stations. Mean monthly SSC was also calculated for the two outlets. The effects of the floodplain on river sediment load were investigated using the upstream and downstream sediment load observations of the Gilgel-Abay, Gumara, Rib and Megech Rivers. As a result, the gross annual sediment load transported to Lake Tana from both gauged and ungauged rivers was ca. 2.62 million tons, dominantly from Gilgel-Abay (29%) and Gumara (21%) catchments. Using the developed relationship of the annual sediment yield (SY) with catchment area and mean annual rainfall, ungauged rivers contribute 996,968 tons. This eye-catching figure is due to the absence of floodplains along the ungauged rivers. The result based on the upstream and downstream sediment observations also shows that 482,363 tons or 32 % of the gross sediment transported from rivers crossing the floodplains is deposited in the lacustrine plains annually. The lacustrine plain bordering Gumara River takes the lion share of total sediment deposited on floodplains (71%), likely due to having a meandering river that crosses a wide and low gradient lacustrine plain. This figure indicates that the lacustrine plain also serves as sink of sediment, which was softly touched in earlier studies. The analysis also revealed that ca. 1.09 million tons sediment annually leave the lake through the two outlets. The estimated annual sediment deposited in Lake Tana is about 1.04 million tones or 0.28 mm yr^{-1} with a calculated suspended sediment trap efficiency (T_e) of 49%. Furthermore, SSC and sediment yield are generally lower towards the end of the rainy season than at the start for the same runoff discharge. The reason behind is that the soil in cultivated fields were bare and loose due to frequent ploughing and seedbed preparation at the beginning of the rainy season, as a result the level of SSC recorded is very high mostly in July and sometimes in August. Later on in the season, increased crop and vegetation cover leads to a decrease in the sediment supplies (exhaustion effect). Based on the established sediment budget and its calculated components, one

can conclude that the expected lifetime of Lake Tana is relatively higher than the output of earlier studies. In case bedload is also taken into account, T_e is even more, the lake is expected to fill up earlier, and the sediment budget is quite different.

Keywords: Sediment budget, Sedimentation, Floodplain, Lake Tana Basin

A comprehensive sediment yield database and map for Africa

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Abstract

While several studies compiled and analyzed measured contemporary catchment sediment yield (SY, [t/km²/y]) values for various regions of the world, Africa remains strongly underrepresented in these studies. We therefore conducted a review on published SY data for Africa, explored the spatial variability of these SY data and examined which environmental factors explain this variability. We collected SY data, measured during at least one year, for 682 African catchments across the continent (> 8340 catchment-years) from 84 publications and reports. Catchment areas ranged from 0.02 km² to > 3,800,000 km². Observed SY values range between 0.2 and 15,699 t/km²/y (median: 160 t/km²/y, average: 634 t/km²/y).

Correlation and partial correlation analyses showed that spatial variation of SY in Africa is mainly explained by differences in seismic activity, topography, vegetation cover and annual runoff depth. Other factors such as lithology, catchment area or reservoir impacts showed less clear correlations. Based on these findings we propose a simple regression model that allows simulating the observed regional patterns of SY in Africa fairly well. This model predicts an average SY of 42 t/km²/y for the entire African continent, a value that corresponds closely to earlier estimates of the sediment output of the African continent to oceans.

The fact that SY shows the strongest correlation with seismic activity, while climatic variables explain little of the observed variation can be considered surprising as Africa is relatively inactive in terms of seismic activity and is characterized by a very large climatic variability. This suggests that processes such as tectonically related rock-fracturing and earthquake-triggered landslides may have a stronger influence on contemporary SY-values than previously assumed.

Sediment Supply to the Semi-endorheic Raya Graben (Northern Ethiopia)

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Abstract

Sediment yield relies on bio-physical and hydro-climatic factors that control erosion and sediment delivery in drylands. Sediment supply for the last six decades in the semi-endorheic Raya graben bottom (northern Ethiopia) was measured as aggradation thickness under road bridges of known age. In order to quantify vegetation cover in the escarpment, NDVI was analyzed from Landsat imagery of 2000. Extreme daily rainfall and mean total rainfall of the rainy season (July and August, 2013 and 2014) for the catchments draining to the bridges were mapped using the cokriging geospatial interpolation method, based on daily rainfall data in 21 stations (elevation ranging from 1432 – 3579). A modified rational method was used to estimate peak discharge for the ungaged catchments based on event-based empirical precipitation and discharge measurements made in two rivers (Etu and Hara) in 2013 and 2014. Results show that the annual deposition thickness at the bridges built in 2011 (average = 13.2 cm/year, n = 3) is the highest in contrast to that at the bridges built in 1951 (average = 1.7 cm/year, n = 6). This is perhaps related to the increasing trend of precipitation and then runoff in the study area and intermediate sediment removal. At the bridges built in 2002 (n = 21) there was 72.5 ± 64.4 cm/year thickness of sediments deposited; these data were used for further analysis to link sediment volume and catchment characteristics. The results show that catchment area ($R^2 = 0.80$, p < 0.0001) and calculated peak discharge ($R^2 = 0.78$, p <0.0001) were positively correlated with sediment volume in the graben bottom. Whereas mean total precipitation of the rainy season (July & August) had a weak positive correlation significant at the 90% confidence interval ($R^2 = 0.20$, p = 0.1), there was an inverse relationship between NDVI of the catchments in 2000 and sediment volume under the bridges ($R^2 = 0.26$, p = 0.05). Hence, in order to reduce the sediment supplies in the floors of the Raya graben and similar grabens, increasing the vegetation cover in the escarpment is of a primary condition.

Keywords: Sediment supply, graben bottom, peak discharge, extreme precipitation, Rift Valley

Quantification of discharge and sediment transport in the Lake Tana Bain, Ethiopia

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Abstract

Soil erosion decreases the soil fertility of the uplands and causes siltation of the Lakes and reservoirs in the Ethiopian highlands, but very few measurements exist. In Lake Tana, the largest lake in the highlands, sediment concentrations has been increasing and although bathymetric surveys and many water balance studies of the Lake have been carried out, the sediment load from its watershed has not been determined. The objective of this study is to quantify the sediment load generated by the major rivers flowing into Lake Tana. We employed the parameter efficient distributed model (PED) to estimate the sediment load, which has predicted the discharge and sediment concentration relatively well in the monsoonal climate of Ethiopia.

The PED model parameters are calibrated using gauged river discharges in the periodically measured sediment data for determining the sediment rating curves for the main rivers in the Lake Tana watershed. The calibrated model parameters are then used to predict the sediment load for the period (1994-2009). The results show that on average about 2,800 t/km^2 sediment is removed from the gauged part of the Lake Tana watersheds annually. Based on the calculated sediment loads contributed to Lake Tana obtained from the bathymetric surveys and assumptions made about the sediment load from the ungauged part about 65% to 85% of the generated sediment transported is trapped before it reaches lake Tana and most likely within the floodplains found around the periphery of the Lake and the delta at the river outlet into the lake.

Biogas production from lake bottom sediments -
Studies of lake bottom sediments from forest management areas: potential for biogas production

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Abstract

In forest management and irrigation activity areas, sediments are accumulated in lakes through drainage system might be a cause for biodiversity loss and human health problems. One possible solution will be removal of lake bottom sediments and further usage in biogas production. The aim of the study was to investigate the potential for lake bottom sediments in production of biogas. In this study, lake bottom sediments were collected in order to study the potential for biogas production from two lakes (likokanta and Kutunjärvi lakes). Total gas production showed similar fluctuation in all of the experimental reactors, without any substantial differences in comparison to the control reactor. Maximum gas values were observed when feeding up to 50 % lake bottom sediment to 50 % straw horse manure mixture - beyond this they started to decrease, except for the control substrate (100% straw – horse manure). Methane content for Likokanta lake, Kutunjärvi lake and control samples showed almost the same values around 50%. When the amount of lake bottom sediments in the feed increased above 50 %, the methane percentage started to decrease, impairing biogas process. Pretreated Kutunjärvi lake showed the lowest methane percentage values observed throughout the experiment. The mean methane production per volatile solids using Likokanta lake materials with straw horse manure, treated and untreated Kutunjärvi lake materials with straw horse manure are 157.8, 208.9 and 182.2 ml/g Volatile Solids respectively. In addition, total solids, volatile solids, C/N ratio, alkalinity and volatile solids was analyzed. The result showed that, pretreatment has a slight positive effect on the gas production. In the future, assessment of cost and benefits is needed for utilizing lake bottom materials to production of biogas.

Keywords: biogas, anaerobic digestion, pretreatment, Lake Bottom materials, sediments.

Poster sessions

Poster sessions

Saturday 26 September

10:00 am - 10:30 am

4:15 pm – 4:45 pm

Major influence of the African Great Lakes on the hydrological cycle and atmospheric dynamics

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Abstract

Although the African Great Lakes are important regulators for the East African climate, their influence on atmospheric dynamics and the regional hydrological cycle remains poorly understood. We aim to assess this impact by conducting a regional climate model simulation which resolves individual lakes and explicitly computes lake temperatures. The regional climate model COSMO-CLM, coupled to a state-of-the-art lake parameterization scheme and land surface model, is used to dynamically downscale the COSMO-CLM CORDEX-Africa evaluation simulation to 7 km grid spacing for the period 1999-2008. Evaluation of the model reveals good performance compared to both in-situ and satellite observations, especially for spatio-temporal variability of lake surface temperatures and precipitation. Model integrations indicate that the four major African Great Lakes almost double precipitation amounts over their surface relative to a simulation without lakes, but hardly exert any influence on precipitation beyond their shores. The largest lakes also cool their near-surface air, this time with pronounced downwind influence. Furthermore, Lake Victoria has profound influence on atmospheric dynamics and stability as it induces cellular motion with over-lake convective inhibition during daytime, and the reversed pattern at night. Overall, this study shows the added value of resolving individual lakes and realistically representing lake surface temperatures for climate studies in this region.

Stream flow and sediment export from tropical catchments influenced by papyrus wetland encroachment

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Abstract

During the past decades, land use change in the Lake Victoria basin has significantly increased the sediment fluxes to the lake. These sediments as well as their associated nutrients and pollutants affect the food and water security of millions of people in one of Africa's most densely populated regions. Adequate catchment management strategies, based on a thorough understanding of the factors controlling runoff and sediment discharge are therefore crucial. Nonetheless, studies on the magnitude and dynamics of runoff and sediment discharge are very scarce for the Lake Victoria basin and the African Rift region.

We therefore conducted runoff discharge and sediment export measurements in the Upper Rwizi, a catchment in Southwest Uganda, representative for the Lake Victoria basin. Land use in this catchment is characterized by grazing area on the plateaus, banana cropping on the slopes and Cyperus papyrus L. wetlands in the valley bottoms. Due to an increasing population pressure, these papyrus wetlands are currently encroached and transformed into pasture and cropland. Seven subcatchments (358 km² - 2120 km²), with different degrees of wetland encroachment, were monitored during the hydrological year June 2009 - May 2010.

Our results indicate that, due to their strong buffering capacity, papyrus wetlands have a first-order control on runoff and sediment discharge. Subcatchments with intact wetlands have a slower rainfall-runoff response, smaller peak runoff discharges, lower runoff coefficients and significantly smaller suspended sediment concentrations. This is also reflected in the annual area-specific suspended sediment yields (SY): subcatchments with encroached papyrus wetlands have SY values that are three to seven times larger compared to catchments with intact papyrus vegetation (respectively $106 - 137$ ton km^{-2} y^{-1} versus $34 - 37$ ton km^{-2} y^{-1}). We therefore argue that protecting and rehabilitating these papyrus wetlands should be a corner stone of catchment management strategies in the Lake Victoria basin.

Keywords: Runoff, suspended sediment yield, riparian vegetation, gully, riverbank erosion, Uganda

Evaluating effects of Historical climate change and land use/cover change on Catchment hydrology of Gumara watershed, Upper Blue Nile basin, Ethiopia

Gashaw Gismu

Abstract
Climate and land cover change are very important issues in terms of global context and their responses to environmental and socio-economic drivers. The dynamic of these two factors is currently affecting the environment in unbalanced way including watershed hydrology. In this paper individual and combined impacts of climate change and land use land cover change on hydrological processes were evaluated through application of the model Soil and Water Assessment Tool (SWAT) in Gumara watershed, Upper Blue Nile basin Ethiopia. The regional climate; temperature and rainfall data of the past 40 years in the study area were prepared and changes were evaluated by using Mann-Kendall trend test. The land use/cover data were obtained from land sat image and processed by ERDAS IMAGIN 2010 software. Three land use/cover data of 1973, 1986, and 2013 were prepared used for base map, model calibration and change evaluation respectively. So as to evaluate the individual effects of climate change and land use/cover change on stream flow separately, we have simulated the flow by changing climate and LULC accordingly. The high flow of the catchment for these two decades was extracted in simulated flows and analyzed by using Annual Maximum (AM) model and the low flow was evaluated by seven day sustained low flow model. Both temperature and rainfall showed increasing trend; and then the extent of changes were evaluated in terms of monthly bases by using two decadal time periods; 1973-1982 was taken as baseline and 2004-2013 was used as change study. The trend test has also showed that there is increasing trend of observed stream flow of the catchment. The efficiency of the model was determined by Nash-Sutcliffe (NS) and Relative Volume error (RVe) and their values were 0.66 and 0.72% for calibration and 0.64 and 1.23% for validation respectively. The impact of climate change was higher than that of land use land cover change on stream flow of the catchment; the flow has been increasing by 16.86% and 7.25% due to climate and LULC change respectively, and the combined change effect accounted 22.13% flow increment. The overall results in this study has indicated that climate change has more effect for high flow than low flow; and the land use land cover change showed more significant effect on low flow than high flow of the catchment. From the result we conclude that the hydrology of the catchment has been altered because of changes of climate and land cover of the study area.

Keywords: Climate, LULC, SWAT, Gumara, Blue Nile, Ethiopia.

Environmental challenges vis a vis opportunities: The case of water hyacinth in Lake Tana, Blue Nile basin of Amhara Region, Ethiopia.

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Abstract

Water hyacinth is an aquatic plant which can live and reproduce floating freely on the surface of fresh waters or can be anchored in mud. A single plant under ideal conditions can produce 5,000 seeds and 250 offspring in 50-90 days, and cover an area of 600 sq metres in a year. It is now considered a serious threat to biodiversity: infestations of this weed are reaching crisis proportions in important freshwater bodies of our region. Investigation of water hyacinth was conducted from October 27, 2011 to November 3, 2011 by interdisciplinary expedition groups in Lake Tena. A total of 24 sites were delineated using geographical positioning system (GPS) during investigation of water hyacinth incidence along the whole periphery of Lake Tana. This is causing environmental, economic, and social problems and accumulated damages. A local community is at risk of losing out on its livelihood following infestation of the country's largest water body, Lake Tana by water hyacinth, Eichhornia crassipes. Several efforts have been done to control and eradicate the weed since, November, 2011, via collaborated approaches; ARARI, BU, EPLUA, BOA. Around January, 2011, there was campaign plan to remove manually from the infected areas of the lake; unfortunately it was not successful because the surrounding community was not cooperated due to less awareness about the invasive weed. Even though, the incidence and depth of water hyacinth infestation in Lake Tana is still at its infant stage, because except the North and to some extent North-east direction, the other parts of Lake Tana were devoid of the water hyacinth. Due to its fast expansion rate and if not controlled as soon as possible, water hyacinth will cover the lake, surrounding wetlands, tributary rivers and rice farms entirely; this dramatically impacts water flow, blocks sunlight from reaching native aquatic plants, and starves the water of oxygen, often killing fish (or other life in the water). The plants also create a prime habitat for mosquitoes, the classic vectors of disease, and a species of snail known to host a parasitic flatworm which causes schistosomiasis (snail fever). Hydroelectric power, transportation and irrigation schemes will be definitely victims by this invasive weed. Of all other control systems such as chemical usage, biological control, mechanical control and manual control systems, manual control system which was conducted by the previous campaign coordinated by EPLAU are the right way of controlling system. Because it is safe and cost effective for the time being and most infested areas has shown positive result, that population density is highly diminished and other biodiversities has been reestablished. On the other hand, when looked from a resource angle, it appears to be a valuable resource with several unique properties. The use of water hyacinth for animal feed in developing countries could help solve some of the nutritional problems that exist in these countries. Using as an opportunity, proper and large-scale utilization of the water hyacinth like livestock feed and biogas could serve as a positive approach to the control of water hyacinth.

Water footprint and virtual water trade to develop equitable water policy in trans-boundary basin: a case study for Nile

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Abstract

In most of water scarce region of arid and semiarid countries water resources management is controversial issue. Inadequate water management problem may leads to water scarcity which can be the cause for conflicts. The virtual water concept which is the volume of water used in the production of good or service together with the water footprint could provides an appropriate strategy to support best possible water management option. This paper will provide an analysis of these two concepts for water policy development. Thus, the objective of this study will be to estimate the water footprints of major agricultural products and the volumes of virtual water trade between nations to develop water policy. The AQUACROP model used in this study will computes daily soil water balance, crop water requirements, actual crop water use, and crop yield. The study will quantify the water footprint of consumption of Nile basin countries through bottom-up approach. The study will further breakdown of the national WF of consumption into internal and the external water footprint and calculate the virtual water trade among of the NB countries. The global standard for water footprint assessment developed by the water footprint network will be used. Nile basin countries of water policy will be assessed, analyzed and incorporated in to policy. The output of water foot print of agricultural products and virtual water trade in relation to agricultural products of Nile basin countries will be used for better water policy development in trans-boundary river basin management.

Development of synthetic unit hydrograph for watersheds in Lake Tana sub-basin, Ethiopia

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Abstract

This study was undertaken in four gauged and two ungauged watersheds to estimate coefficients and unit hydrographs (UH) parameters in Lake Tana sub-basin. Twenty nine rainfall-runoff events were used and accordingly, twenty nine UH for one hour duration were developed. Out of these UHs, twenty five were used for calibration and the remaining for validation of Snyder's model. Then, non linear regression analysis were computed to assess the association between watershed characteristics and coefficients and UH parameters. The result showed best single predictor of peak time coefficient (Ct) was found to be watershed area (Ad), for peak discharge coefficient (Cp) it was drainage density (Dd), and for base time coefficient (Cb) it was main stream channel slope (Sl). For UH parameters, the best single predictor of peak discharge (Qp) was found to be fineness ratio (Fr), stream length (L) for time to peak (tp), watershed area (Ad) for base time (Tb). Highest R2 change came about when composite term HKR was added for Ct, Gray for Cp, and sinuosity (S) for Cb. For UH parameters composite term Murphy was added for tp and Tb, and drainage density (Dd) for Qp. Statistical and visual comparison between predicted and observed date revealed that calibrated Snyder's model was suitable for study region under hydro-meteorological similar watersheds and watershed characteristics within the range of model simulation. Therefore, it could be a grant to estimate the required UH parameters for ungauged watersheds in the region. UH parameter tp (1.60 and 1.31 hr), Qp (18.06 and 13.92 m3 s -1), and Tb (6.87 and 8.86 hr) were estimated for Ambagenen and G/mariam watersheds, respectively. These could be recommended as input parameters during construction of hydraulic structures and hydrological study of the watersheds. However, further studies are needed to be carried out with large number of automatic rainfall data for each watershed including more number of gauged watersheds.

Keywords: Unit Hydrograph; Parameters; Coefficients; Watershed; Lake Tana sub-basin

Climate Change Impact on Sediment Yield in the Upper Gilgel Abay Catchment, Blue Nile Basin Ethiopia

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Abstract

According to Inter Governmental Panel on Climate Change (IPCC) future projections, precipitation and temperature will increase over eastern Africa in the coming century. This chapter presents basin level impact of climate change on sediment yield in Upper Gilgel Abay catchment, Blue Nile Basin, Ethiopia, by downscaling HadCM3 global climate model using Statistical Downscaling Model (SDSM). IPCC recommended baseline period (1961-1990) was used for baseline scenario analysis. Future scenario analysis was performed for the 2020s, 2050s and 2080s. Globally, HadCM3 model is widely applied for climate change studies and it consists A2 (medium-high emission) and B2 (medium-low emission) scenarios. Impact assessment on sediment yield was done by Soil and Water Assessment Tool (SWAT) hydrological model. SWAT model performance in simulating daily sediment yield for the study area was satisfactory with Nash-Sutcliffe Efficiency (NSE) of 0.58 and 0.51 for calibration and validation periods, respectively. Mean annual changes of precipitation and temperature (maximum and minimum) was applied to quantify these impacts. The result of downscaled precipitation and temperature reveals a systematic increase in all future time periods for both A2 and B2 scenarios. These increases in climate variables are expected to result in increase in mean annual sediment yield of 11.3%, 16.3% and 21.3 % for A2 scenario and by 11.0%, 14.3% and 11.3% for B2 scenario for 2020s, 2050s and 2080s, respectively. This increase in sediment yield is double the increase in stream flow due to climate change for all time periods. Future work need to consider also impact of land use change on the catchment for future sustainable development plan.

Keywords: IPCC, climate change, HadCM3, SWAT, Upper Gilgel Abay, A2 and B2 scenarios, SWAT, Blue Nile basin

Spatial variability of top soil moisture and crop performance under different soil and water conservation structures in the semi-arid Ethiopian highlands

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Abstract

Plant available soil moisture is the most limiting factor to crop and livestock productivity in arid and semi-arid climatic zones. Soil and water conservation (SWC) programs in the Ethiopian highlands have been given top priority to fight land degradation and also to increase soil moisture content (SMC) for improving rain-fed crop production. Positive effects of introduced SWC structures in reducing soil erosion, and increased ground water recharge have been documented. However knowledge on the effects of SWC structures on spatial variability of SMC and crop performance is limited. Therefore, the objectives of this study are 1) to understand the effects of land use types and slope gradients on spatial variability of SMC 2) to analyze spatial variability of SMC and crop responses when different SWC structures are applied and 3) to find out if SMC, grain and biomass yield varies within a plot at different locations with respect to SWC structures.

The study was conducted at Mayleba catchment located in Tigray at ca. 40 km to the west from the regional capital Mekelle. SMC were monitored for 21 large runoff plots installed at cropland and rangeland sites and treated with different SWC structures: stone bunds, trenches and stone bunds with trenches and a control plot (without SWC structures). Plot sites were selected on gentle (5%), medium (12%) and steep (16%) slope gradients for both land use types. SMC of the top soil (10 cm) for all the plots on cropland were monitored using Theta-Probe installed around (1m up and 1m down slope of a SWC structure) and at the middle between two successive SWC structures and complemented with manual sampling, whereas only manual sampling and laboratory analysis of gravimetric SMC is done for rangeland plots. SMC and crop performances were monitored during the growing season in 2011 and 2012. The data was statistically analyzed using SAS ® 9.2 to determine the differences in topsoil moisture content between plots with different SWC structures.

The results show that spatial variability of SMC is higher during the rainy seasons than during the dry season. SMC is higher for cropland compared to rangeland for comparable slope gradient and soil types. Within the cropland higher moisture content is observed for gentle slope compared to medium and steep slopes. Installed SWC structures influence average top soil SMC but means were not statistically different. On average SMC is 3-5% higher around the SWC structures compared to SMC in the middle between the two successive SWC structures. The SWC structures retain surface runoff and enhance infiltration around the structures and increase SMC, as a result the SMC remains higher around SWC structures for about two months after the rainy season. Vigorous wheat performance has been observed at 1m upslope location (accumulation zone) compared to other locations. Grain and biomass yield is significantly different ($P<0.000$) among the locations with respect to SWC structures, however, there is no difference in wheat yield ($p=0.843$) due to different SWC structures. Taking 5.5% land losses due to the installation of

SWC structures, an average of 36% wheat yield increase over a control plot has been observed due to installation of different SWC structures.

Predicting Spatial and Temporal Soil Moisture Distribution in an Agricultural Field of Gumara-Maksegnit Watershed, North Gondar, Ethiopia

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Abstract

A Soil Moisture study was conducted within Gumara-Maksegnit watershed found in the Northern part of Lake Tana, Ethiopia. This was aimed to predict moisture contained in 1meter soil profile spatially and temporally in the drying process of the 2013 from wet to dry period in small rainfed agricultural field mainly covered with cereal and legume crops. A Weekly soil moisture content (v/v) with calibrated PR2/6 profile probe, topographic information with a spatial resolution of 5 by 5 meter measured using GPS and water level, a soil texture in two soil depth ranges, crop growth information and representative soil bulk density were measured in the study period i.e. 30July 2013 to 9November 2013. Physically based hydrological model called Soil-Plant-Atmosphere-Water (SPAW), developed by E. Saxon, 2006; was used to predict the temporal change of soil moisture considering the basic soil properties and agro-climatologic information together with crop data. Co-kriging, in ArcGIS 10.2 (ESRI), was applied to predict the spatial distribution of soil moisture considering slope as a secondary variable and the temporally predicted soil moisture as the main variable. Consistency of the models was checked using coefficient of determination (R^2), root mean squared error (RMSE) and Nash Suitcliff Efficiency (NSE) with values 0.74, 0.71 and 9.5mm/m respectively.

Keywords: Soil moisture, SPAW, co-kriging, spatial and temporal, drying process, soil water storage, slope

Spatial and Temporal Simulation of Groundwater Recharge for Geba Catchment, Northern Ethiopia Using WetSpa

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Abstract

A physically based, spatially distributed and with GIS framework coupled watershed model called WetSpa has been used to determine the spatial and temporal variation of recharge in Geba catchment, Northern Ethiopia covering an area of about 4,248.7km^2 by combining elevation, soil and landuse data to create all spatial parameter maps and the hydrometerological (Precipitation and PET) and discharge data (at the basin outlet). Geba basin has a highly variable topography ranging from 1000 to 3, 280 m and an average slope of 42.3% or 23°. Climatologically, it is with high temperature; with mean minimum and maximum temperature of temperature of 6.5°C and 32°C respectively; a mean annual precipitation of 681mm and with a distinct wet and long dry seasons. Point rainfall data from seven stations were interpolated using Thiessen Polygon method. The point PET data were calculated using the Penman Monteith from temperature, humidity, radiation; sunshine hours and wind speed at the above seven meterological stations and interpolate using the same thiessen polygon as rainfall. The only discharge data available and taken as discharge input as both calibration and validation is the one from the basin outlet.

About eleven kinds of land cover types have been identified which latter grouped to 8 based on the WetSpa landuse classification system. Among them, the cropland, grassland and shrubs are the dominant. Land use based parameters derived using the default hydraulic parameters of each land use type. It is classified in 6 soil types on which clay and clay loam alone are covering about 73% of the total study area and its based parameters have been derived using default values of WetSpa.

The model was simulated on daily basis for about nearly four years (January 1, 2000 to December 18, 2003). It resulted in fair agreement of measured and simulated stream flow hydrographs when observed visually and from model performance indicators (bias=-2.54%, NS= 69.83%, NSL=74.78% and NSH =83.26%). It was also validated and a close performance value observed.

According to the water balance calculation, about 3.76% of the total precipitation is intercepted by the plant canopy; 87.51% infiltrates to the soil (out of which 13.02% percolates 2.74% laterally flow and 84.24% evapotranspired from the root zone), and 7.22% looses as surface runoff.

The mean annual recharge value varies from about 45mm (in 2003) and 207.5mm (in 2001) which on average accounts 98.6mm per year for the whole study area. On monthly basis, August is maximum (72.52mm) and December is the lost (with 0.08mm). The mean annual groundwater

recharge spatially varies from 0 to 371 mm. About 21% of Geba is with recharge amount of >120mm and 1% with less than 5mm.

Curve number and runoff coefficients for different soil and water conservation treatments on semi-humid tropical highlands, Blue Nile basin.

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Abstract

To control soil erosion and reduce its effects, soil and water conservation (SWC) practices have been implemented in many parts of Ethiopia. The most widely implemented SWC practices include soil/stone bunds, grass strips, Fanyajuu terraces and others. However their effect on hydrological response such as runoff has not been evaluated sufficiently. Many research studies have demonstrated the potential of the Natural Resources Conservation Service (NRCS) curve Number (CN) and runoff coefficients (RC) methods for runoff estimation, mainly based on values obtained from text books. However, these values were developed elsewhere and were rarely calibrated against the measured rainfall-runoff (storm-events) data.

Therefore this study assesses to what extent runoff estimations using CN and RC values were comparable and the values obtained from tables are applicable to the Ethiopian highland situation. Daily rainfall, and runoff from 18 plots (30m x6 m) and river-flow stage at every 10-minute at the outlet of the catchment using divers were recorded during rainy season (July, August and September) of the year 2014 in Guder watershed of the north western drysub-humid highlands of the Blue Nile basin, Ethiopia. We analyzed event and seasonal runoff CN and RC. Representative land use types such as cultivated and vegetated land use types (grassland, acacia decurrens, eucalyptus plantation and degraded bush land) under 5-35% slope category were used in this study. The effect of scale in runoff and curve number response was investigated for control runoff plots and was compared with the runoff form the untreated Akuisty sub-watershed (343 ha).

Overall seasonal CN for the studied land uses varied from 86 to 93.3. The largest seasonal CN was 93.3 obtained from control plot, in cultivated land with 15%slope, and minimum CN of 86 was observed in the grazing land at 15% slope treated with trench. Seasonal RCs was much higher for cultivated land with 15% slope (0.16< RCs < 0.34) compared with 5% slope (0.06< RCS < 0.11). The two parameters, CN and RC, clearly show the effect of structure on runoff response. There was a strong linear relationship between the two coefficients (CN and RC;$r^2 =$

0.7; n=66). The SWC structures and land use type strongly affected the variation of RCs and CN, and this effect was much larger on acacia decurrens with trench and on cultivated lands treated with soil bund and biological measures. Plot and catchment daily runoff response varied from 0.07-30 mm and from 1.79-33 mm respectively. RCs and CN of Akusity watershed was about 43% and 95 whereas for the untreated plot was 34% and 92 respectively. The variability of runoff response between the plot and catchment shows the scale dependence of runoff processes.

The use of storm-runoff CN-values method significantly differs (at 5 % Level) from SCS table value. Over all mean CN value obtained from storm-runoff data was higher than by 8% from tabulated value. We conclude that runoff prediction using CN values obtained from tables underestimates the runoff in the steeper dry sub humid areas.

The Opening of Sand Quarries in Dschang City (West-Cameroon, Central Africa): Source of Land and Lake 8 Degradation

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Abstract

The urbanisation in some Cameroon cities is facing the lack of building materials. Since in this country, to securing their purchasing power, some people are obliged to self-employed. The natural patrimony becomes the main target. In Dschang city, Department of Menoua (West-Cameroon) numerous sand quarries are opened to that end. Among these quarries those of Tutsang quarter interest us in this work.

The first quarry has been opened on a granito-gneiss hill located precisely between 05°26'02''N and 10°03'55''E and, culminating at about 1,417 m. The second quarry is close to the first one and it has been opened on the slopes of a granito-gneiss landform between 05°26'10''N and 10°03'59''E.

Close to both quarries is found one natural lake called Lake 8, precisely between 05°26'08''N and 10°03'54''E. Since the process of the sand production needs enough waters, the lake is used to that end. During the process, waters are pumped upstream and on their return they drain a part of clay materials in the lake. Throughout the rainy season, torrents carry to the lake loose materials deposited after the opening of quarries. This progressive accumulation of materials damaged the water quality of the lake and destroys aquatic fauna that has been fostering in the pass, the fishing activity led by craftsmen to ensure their livelihood. Moreover, clays has reduced over time the lake's surface. In the past, the lake's area was around 24,000 m^2, nowadays it is about 4,641 m^2.

The land degradation is perceptible on both sites. The destruction of vegetation cover (made up of grasses and sporadic trees) that constituted habitat of several animal species is attributed to the opening of quarry. The topography of the hill is uneven; accordingly, there are sporadic occurrence of landslides hazard that sometimes cause the death of workers. Concerning the building materials, especially the sand, the supply remains below demand. Consequently, the conquest of green space for new quarries in the Dschang city is ongoing.

In view of the fact that the opening of sand quarries leads to the destabilisation and destruction of ecosystems, Dschang city decisions makers must implement a better land use policy to protecting and preserving some sites of ecological interest. They must dredge the Lake 8 for giving it his

previous storage capacity. They have to create more jobs to overcoming the growing unemployment rate in the city and sensitize the sand quarry workers about the importance of ecosystem in the struggle against climate change. Moreover, policymakers must send all citizens who want to build houses to Santchou (Mbô plain) (around 25 km distant from Dschang) where a natural sand is extracted from major streams.

EVALUATING POTENTIAL IMPACTS OF CLIMATE CHANGE ON SURFACE WATER AVALIABILITY OF UPPER AWASH SUB-BASIN, ETHIOPIA

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Abstract

Climate changes alter regional hydrologic conditions and results in a variety of impacts on water resource systems. Such hydrologic changes will affect almost every aspect of human well-being. The economy of Ethiopia mainly depends on agriculture, and this in turn largely depends on available water resources. The aim of this study is to assess the impacts of climate change on surface water availability of upper Awash River basin by using Soil and Water Assessment Tool (SWAT) hydrological model and Regional climate model. This study presents the results on downscaling of large scale atmospheric variables simulated with regional climate model (RCM) to meteorological variables at local scale in order to investigate the hydrological impact of a possible future climate change scenario for three Bench mark year 2020s, 2050s and 2080s under A1B emission scenario from ECHAM5 model. Bias-correction methods have been developed to adjust RCM climate variables. Average annual maximum temperature changes for the upper Awash sub-basin were 2020s: 0.53 °C, 2050s 1.18 °C, and 2080s: 1.87 °C relative to the historical climate. Average annual minimum temperature change for were 0.58°C, 0.82 °C and 2.14 °C in 2020, 2040 and 2080 respectively. Basin-average annual rainfall based on the CCLM downscaling were 2.4, -2.14 and -10.109% for future periods of 2020s, 2050s and 2080s respectively. The annual reduction of stream flow for Upper Awash sub-basin for A1B scenario is 2.46 %and 18.14% in 2050s and 2080s respectively. But for the time period of 2020s the stream flow increased by 4.9% for A1B scenario The simulated flow at: 2050s and 2080s with scenario from RCM shows reduction of runoff by 1.52% and 3.52% in the sub-basin and it is directly related to the reduction and increment in precipitation, but the annual runoff increase in

2020s by 8%. Model result shows that about 44.36% of annual rainfall contributes to stream flow as surface runoff. The paper also includes potential strategy recommendations to communities, policy and decision makers for measuring and enhancing effective adaptation option for future climate change. Further, development initiatives at community level in study areas should put more emphasis on water harvesting to ensure water storage for future agricultural production.

A novel approach to map water holding capacity and nitrogen availability

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Abstract

Population growth and climate change increase the pressure on our natural resources. In many parts of the world, the increasing pressure causes unsustainable land use. This can result in land degradation, ending up with reduced crop productions. To address the impact of land degradation on crop production, environmental models are often used. These models require three dimensional data of different soil properties. Conventional soil surveys provide qualitative descriptions of soil variability and quantitative descriptions of representative soil profiles. An alternative, more cost effective, approach is digital soil mapping (DSM), resulting in quantitative, continuous maps of soil properties. Digital soil mapping (DSM) is able to predict spatial variability of soil properties by interpolating a limited number of soil observations (variables) using a range of correlated environmental variables (covariates). However, the application of DSM in environmental models is hampered by the large number of soil properties and by the soil variation over depth. We developed a novel approach dealing with these problems. Like in standard DSM, the novel approach makes use of a limited number of field observations. However, instead of interpolating individual soil properties, a limited number of land qualities are first derived from the individual soil properties. This study is performed at the Nyando-Katuk Odeyo (Kenya) research site of the CGIAR research program on Climate Change, Agricultural and Food Security (CCAFS). For this area, water and nitrogen are the most constraining factors for crop growth. Therefore, we developed maps of the water holding capacity and nitrogen availability. A SWOT (strengths, weaknesses, opportunities and threads) analysis gives an overview of the usability of these land quality maps for environmental models. This approach results in more efficient land evaluation than the standard DSM based on individual soil properties.

Modelling soil redistribution and gully head retreat in the Lower Nyando catchment (Kenya)

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Abstract

The Lower Nyando catchment (657 km^2) faces serious problems with soil erosion and land degradation. Fertile topsoil erosion and deep gully erosion threaten local people by crop production losses and loss of land, houses and infrastructure. Because sediments and nutrients are washed into the downstream Lake Victoria, this lake has problems with eutrophication and lake level increase. In Lower Nyando, climate change will result in higher and more frequent peak flows. To predict erosion and gully head retreat under changing climatic conditions, the effect alternative management has on soil erosion is analysed. The predictions and analyses are done using the Landscape Evolution Model LAPSUS. The results show that in an average year 9.91 ton/ha erosion takes place in the total catchment, with the highest erosion rates at the mid-altitudes where the gullies start incising. Climate scenarios for 2020, 2050 and an extreme year showed increases of respectively 3%, 6% and 14% in total erosion. Gully head retreat increased with rates ranging from 15% to 49% for future climate scenarios. Further deforestation of the area increased the total erosion with 8%. Increase upstream vegetation cover decreased the total erosion with 4% and planting of dense shrubs around the gully decreased gully head retreat with 67%. These kind of modelling studies are important for the implementation and adaptation of management practices, because it spatially estimates the impact of soil erosion as well as on- and off-site effects of mitigation strategies.

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Abstract:

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Keywords: A1B, climate change, RCM, SWAT, Surface Water.