

Land management to mitigate soil erosion in the upper Blue Nile River Basin

Overview Of Tottori University's (TU) Research Activities in Ethiopia

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International Workshop

Reducing land degradation and farmers' vulnerability to climate change in the highland dry areas of north-western Ethiopia

Bahir Dar, 21 June, 2016 1

Presentation outline

- Introducing Arid Land Research Center (ALRC)-TU
- Overview of soil erosion problem and its management initiatives
- ALRC-TU thematic research areas and achievements
- ALRC-TU ongoing research activities
- ALRC-TU upcoming research activities
- Final remarks

1 Introducing Tottori University



Tottori Campus
Faculty of Regional Sciences
Faculty of Engineering Faculty of Agriculture etc

Yonago Campus
Faculty of Medicine
University Hospital



Arid Land Research Center and IPDRE of Tottori University

ALRC established in 1990, a Joint Usage/Research Center since 2010



Photo by K.Ota



Photo by K.Ota



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Arid Land Research Center

1949	Research on agricultural development of sand dune areas was commenced.
1958	The Sand Dune Research Institute was established as an annex to the Faculty of Agriculture, Tottori University.
1960s	Development techniques of sand dune areas in Japan were almost completed.
1970s	Overseas researches in drylands were started in Iran, UEA, Egypt, Mexico, and China.
1990	The Institute was reorganized and renamed as the Arid Land Research Center , and designated as a National Joint-use Research Facility by MEXT.
2010	The Center starts serving as a Joint Usage/Research Center in the field of dryland science, approved by the MEXT accompanied with legal change.
2015	International Platform for Dryland Research and Education (IPDRE) was established in Tottori University.

International Platform for Dryland Research Education

International Platform for Dryland Research and Education

“Platform for interdisciplinary research”

“International Platform”

■ International network of dryland research institution

- GNDRI (Global Network of Dryland Research Institution)
- CWANA+ (Central and West Asia and North Africa and neighboring dry areas in Western China, South Asia and Saharan Africa)

■ World's top-level research institution

- ICARDA (International Center for Agricultural Research in the Dry Areas)
- UC DAVIS (University of California, Davis)
- DRI (Desert Research Institution) etc.

IPDRE

Executive Director
(university President)

Vice Executive Director
(Research Trustee)

Executive Committee

Strategic Management Office

- Promoting international joint research
- Accepting world's top-level professor

【Research Project】

Environmental Degradation and Restoration PJ

Agricultural and Rural Development PJ

Regional and Industrial Development PJ

Human Development (society, education and health) PJ

Sand Dune Conservation and Management PJ

【Education Section】

Education Program
(for Japanese student)

Training Program
(for exchange student)

Faculty of
Medicine

Faculty of
Engineering

Faculty of
Agriculture

Faculty of
Regional Science

Center for
International
Affairs

鳥取大学
Tottori University



Based on the ALRC's achievement, IPDRE promote university-wide research focusing on drylands and developing countries

Collaborative ongoing Projects at IPDRE

International Cooperative Institutions

- ◆ Chinese Academy of Sciences, Lanzhou University [1 - (1)]
- ◆ University of Khartoum, Sudan [1 - (1)][2 - (1), (4)]
- ◆ Bahir Dar University, Ethiopia [1 - (3)]
- ◆ Khon Kean University, Thailand [2 - (3), (4), (5)]
- ◆ National Agency for Metrology, Hydrology and Environment Monitoring of Mongolia, Mongolia [1 - (2)][4 - (1)]
- ◆ Jomo Kenyatta University, Kenya [3 - (2)]
- ◆ Mahidol University, Thailand [4 - (2)]
- ◆ Colorado State University, USA [5 - (1)]

Interdisciplinary dryland research through participation of faculties majoring in medicine, engineering, and social science and humanities.

1. Environmental Degradation and Restoration Project

- (1) Salinization Research Group [ALRC × Ag]
- (2) Aeolian Dust Research Group [ALRC × Ag × Engg × Med]
- (3) Soil Erosion Research Group [ALRC × Int'l × Ag]

2. Agriculture and Rural Development Project

- (1) Drought-Tolerant Crop Breeding Group [ALRC × Ag]
- (2) Cultivation Technology and Plant Resource Development Group [Ag × ALRC]
- (3) Irrigation and Water Resources Management Group [Ag × ALRC]
- (4) Veterinary and Animal Science Group [Ag × ALRC]
- (5) Rural Development Group [Ag.]

5 University-wide Research Projects

5. Sand Dune Conservation and Management Project

- (1) Dune Ecosystem and Geomorphology Group [Reg. Sci. × Ag × ALRC]
- (2) Archaeological Artifacts and Human Activities Group [Reg. Sci.]
- (3) Renewable Energy Utilization Group [Reg. Sci. × Engg]

3. Regional and Industrial Development Project

- (1) Water Resources and Energy Management Group [Engg]
- (2) Industrial Development and Promotion Group [RIAC × Engg × Tech]

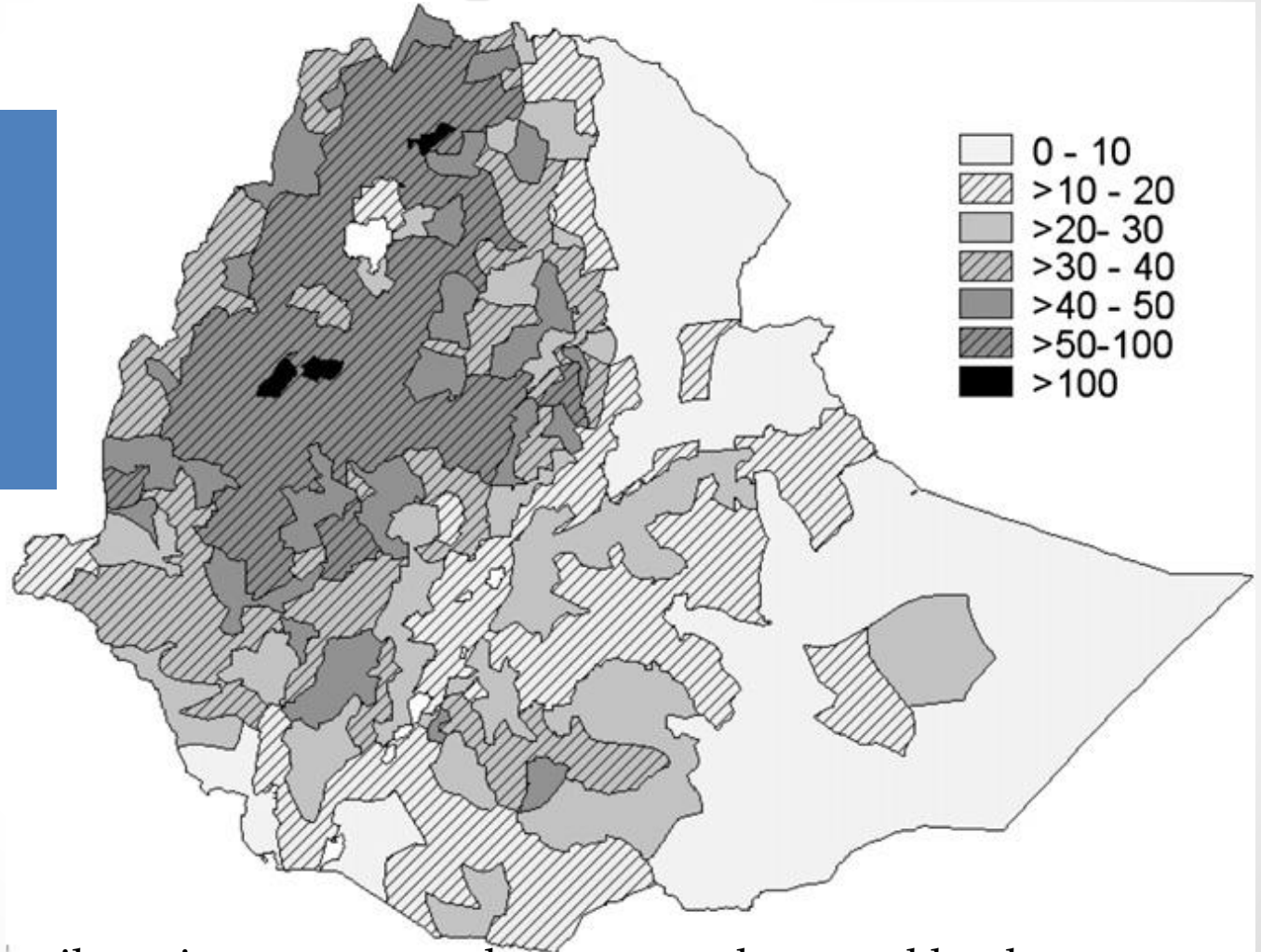
4. Human Development (society, education and health) Project

- (1) Climate Change and Human Health Group [Med × Ag]
- (2) Infection Control and Prevention Group [Med]
- (3) Education for Human Development Group [ALRC × Med × Int'l]

※ (ALRC : Arid Land Research Center) (Reg. Sci. : Faculty of Regional Science) (Med : Faculty of Medicine) (Engg : Faculty of Engineering) (Tech : Technical Department)
 (Ag : Faculty of Agriculture) (Int'l : Center for International Affairs) (RIAC : Organization for Regional Industrial Academic Cooperation)

Overview of land degradation in Ethiopia

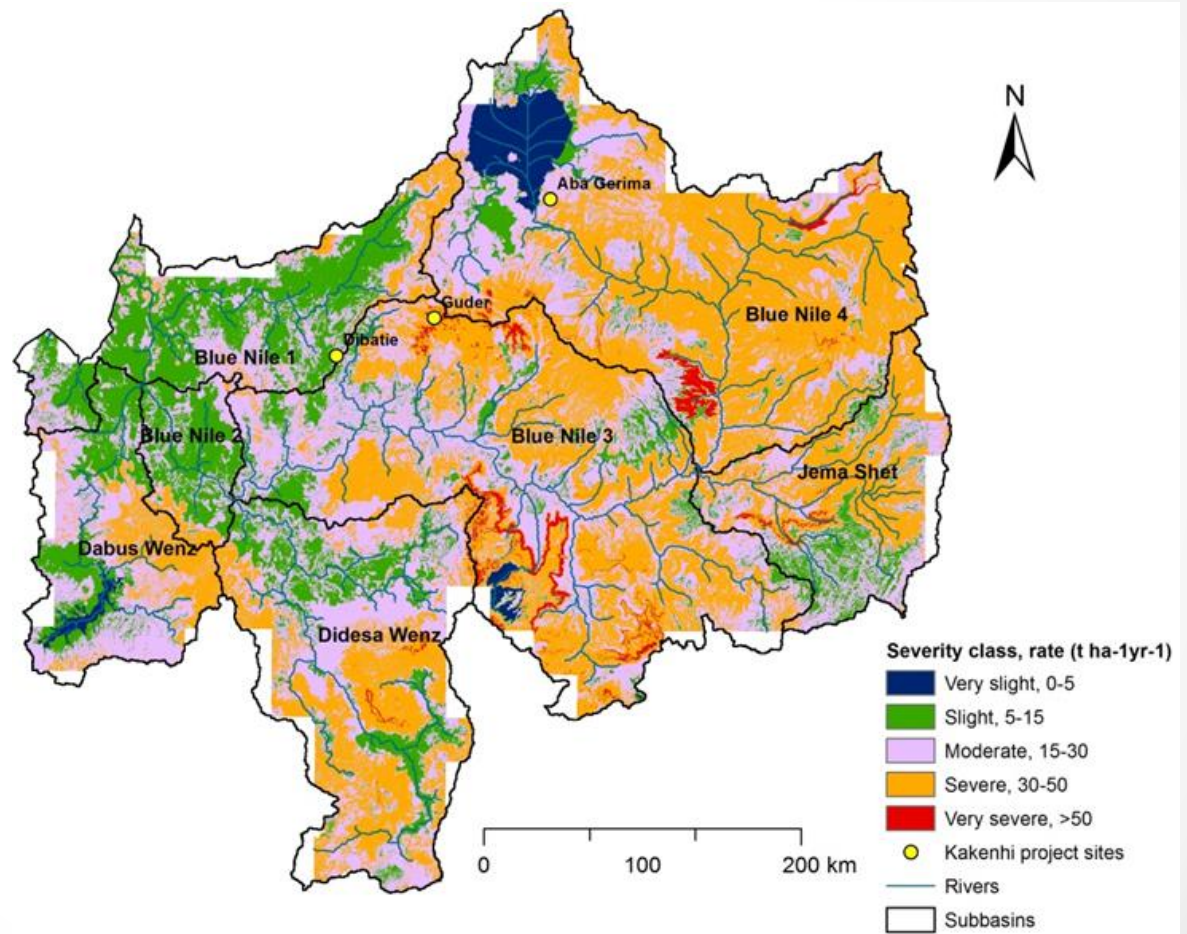
Application of better model in Ethiopia is restricted by data paucity



Ethiopian soil erosion assessment by water under actual land use expressed as plot soil loss (in $t\ ha^{-1}\ yr^{-1}$) (Sonneveld et al., 2011)

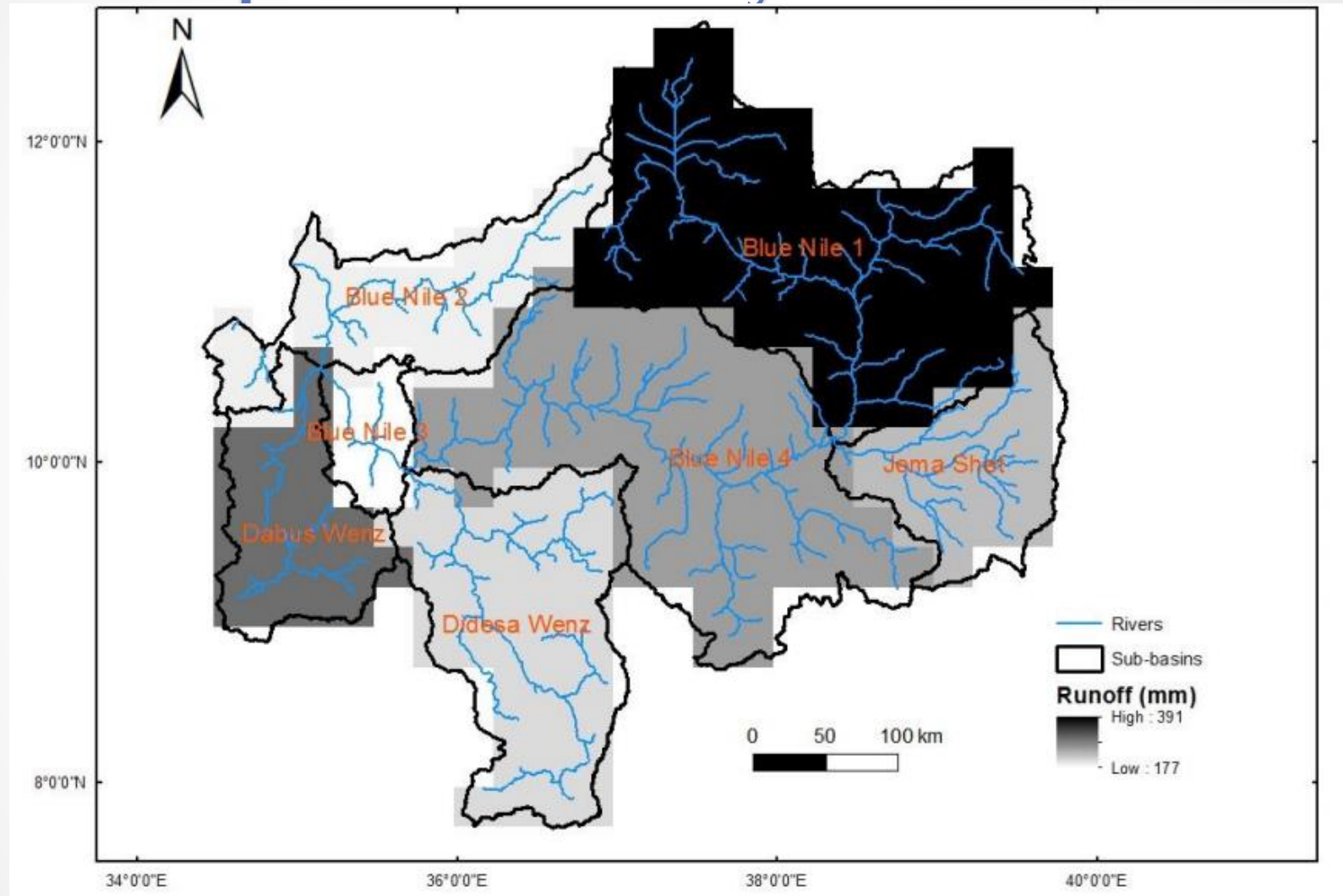
Land degradation in the UBNR basin

Ca. 79% of the basin experiences severe to very severe ($> 30 \text{ t ha}^{-1} \text{ yr}^{-1}$) soil erosion and this is strongly linked to population density



Soil erosion risk map for the Upper Blue Nile River basin (Haregeweyn et al., submitted)

Spatial variability of runoff



Runoff zonation by sub-basin of the Upper Blue Nile basin based on current runoff analysis (Haregeweyn et al., 2016)

Land management initiatives

Characteristics of the different LM initiatives in Ethiopia Haregeweyn et al., 2015

Programs	Period	Main goal
Food Aid	1973–1980	Relief food aid
FFW	1980–1992	Relief food aid; land rehabilitation
Project 2488	1992-2002	
MERET (three phases)	2003–2015	Relief food aid; land rehabilitation, livelihood and capacity development
PSNP	2005–present	Provide transfers to the food insecure; create assets at the community level, facilitate credit and technical support
Community mobilization	1998–present	Participate in public works with an emphasis on land rehabilitation
SLMP (Phase-1)	2008–2013	Watershed management; land certification; land project management
SLMP (Phase-II)	2013–2019	Climate change risk; and greenhouse gas emission reductions



Soil erosion and conservation in Ethiopia: A review

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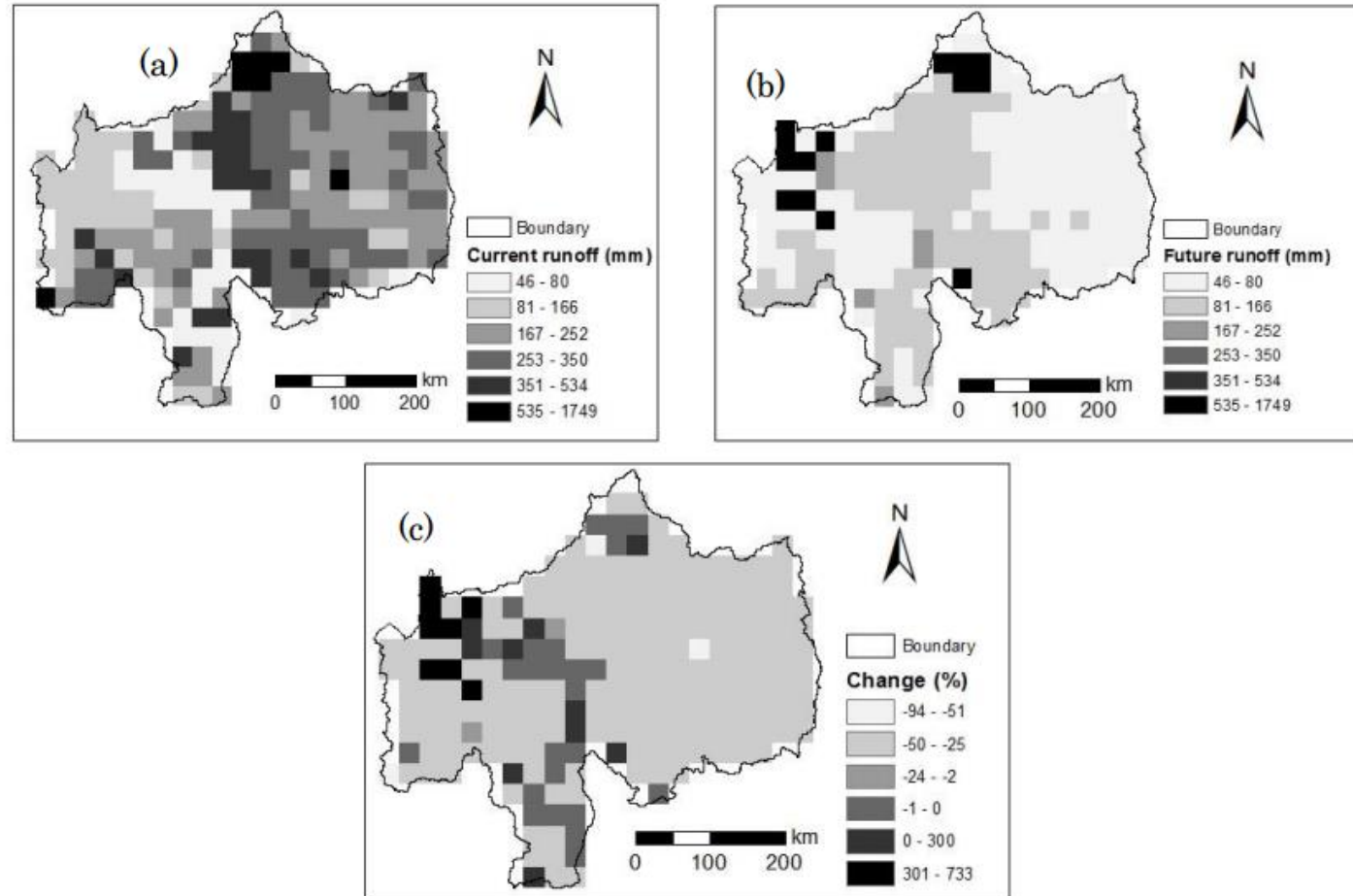
Commonly implemented LM practices

- Specific measures
 - SWC on cultivated and grasslands
 - Check dams in gullies
 - Exclosures
 - Water harvesting



Possible effects of LM activities

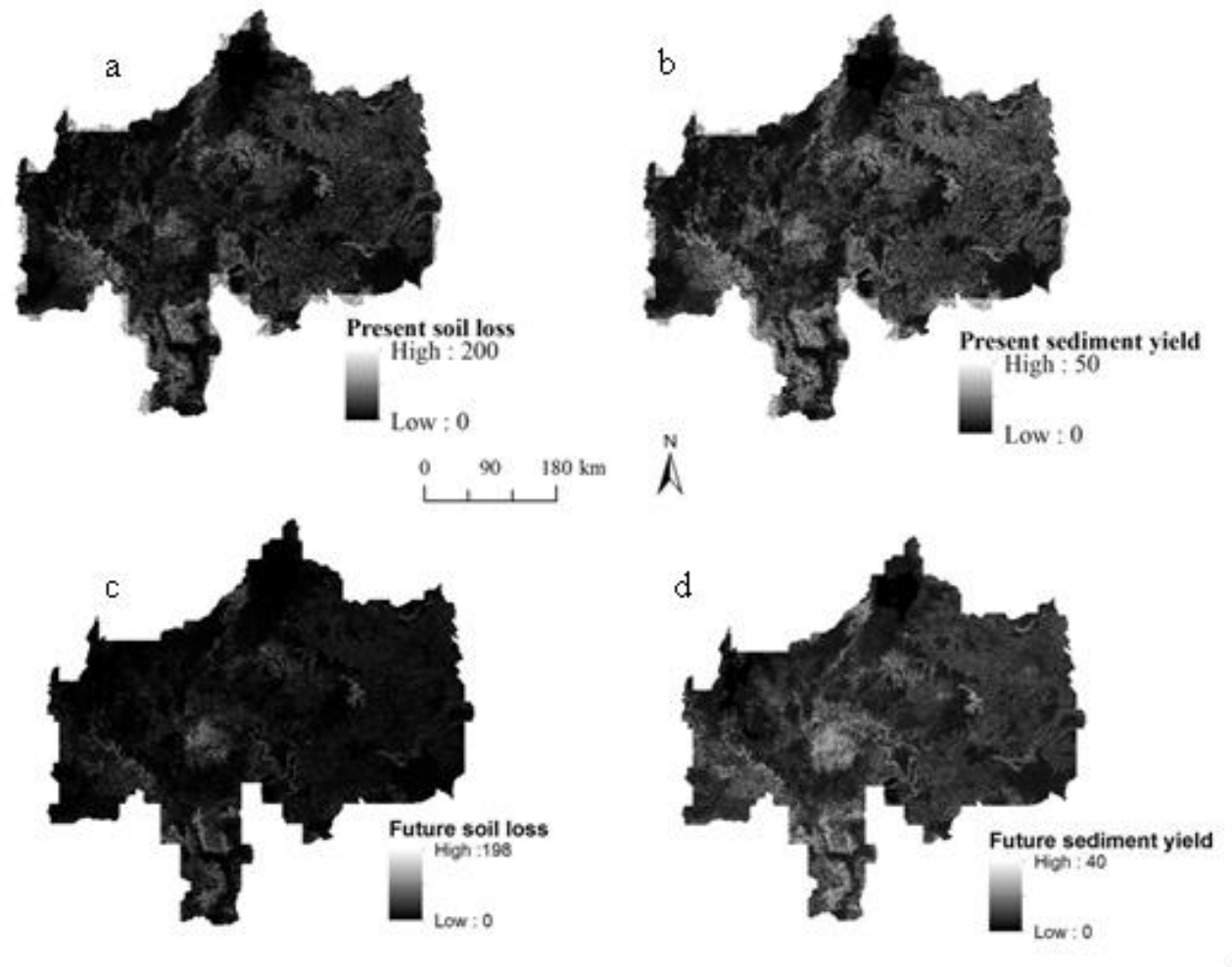
By 2025, total annual runoff yield could decrease by up to 38 % if appropriate basin-wide soil and water conservation interventions and the Grand Ethiopian Renaissance Dam are implemented



Average annual runoff (mm) in the Upper Blue Nile basin (a, current; b, future; and c, change (%)). The change (%) was calculated by dividing the difference from future to the current mean runoff (Haregeweyn et al., 2016).

Possible effects of LM activities

If appropriate soil and water conservation practices targeted ca. 79% of the area with moderate to severe erosion ($>15 \text{ t ha}^{-1} \text{ yr}^{-1}$), the total sediment yield from the basin could be reduced by ca. 61.4%.

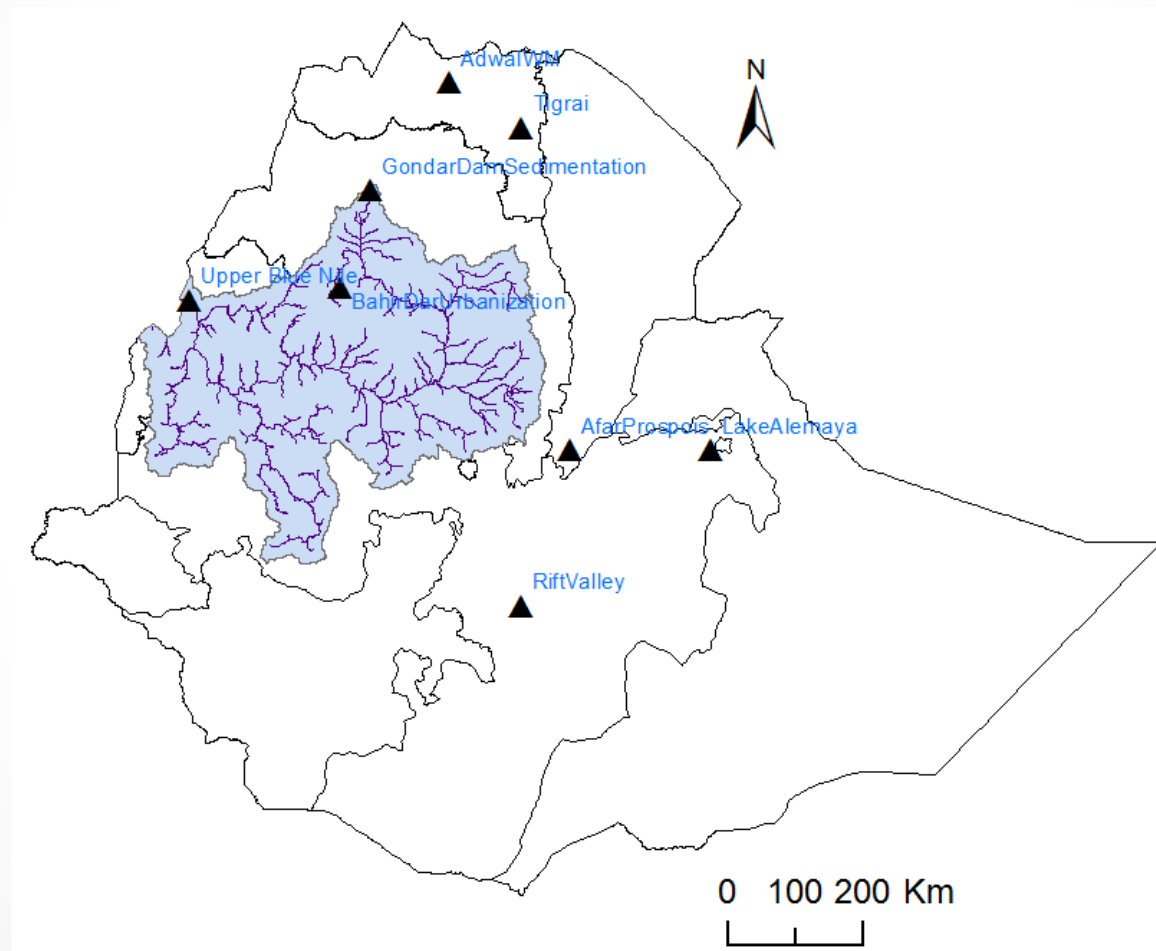


Soil loss and sediment yield maps of the Upper Blue Nile River basin: 6a, present (2016) soil loss; 6b, present sediment yield; 6c, future (2025) soil loss and 6d, future sediment yield

ALRC-TU





























research achievements

ALRC-TU past and present study sites in Ethiopia



ALRC-TU Achievements

- In total of 28 peer-reviewed journal papers or book chapters have been published
- Presented in several conferences (Ethiopia, Tottori, Florida (USA), Sacramento (USA), Calgary (Canada), Brisbane (Australia), Bern (Switzerland) Berlin (Germany), Vienna (Austria),
- Thematic areas
 - Soil erosion processes and controlling factors
 - Reservoir sedimentation rates and factors
 - Hydrologic responses (runoff, water balance)
 - Fertility (soils and sediments)
 - Land use change and impacts (deforestation, urban expansion, invasive species)
 - Agroforestry (forage development)
 - Costs of soil erosion
 - Acceptance, efficiency & profitability of land management practices
- Compiled PDF copy to be made available for free in a CD_ROM

-  Balana_etal_ForestEconomics_2012
-  Elias_etal_AgriculturalScience_2013
-  Elias_etal_AgriculturalScience_2015
-  Elias_etal_AgriSciTech_2016
-  Elias_etal_AppliedSciences_2014
-  Haregeweyn_etal_Bookchapter_2013b
-  Haregeweyn_etal_Bookchapter_2015b
-  Haregeweyn_etal_Bookchapter-2011
-  Haregeweyn_etal_EMA_2013a
-  Haregeweyn_etal_EMA_2015a
-  Haregeweyn_etal_ENM_2012c
-  Haregeweyn_etal_landscape&urban_2012b
-  Haregeweyn_etal_LDD_2013c
-  Haregeweyn_etal_PPG_2015c
-  Haregeweyn_etal_REC_2016
-  Haregeweyn_etal_SoilsSediment_2012a
-  Meshehsa_etal_climatology_2015
-  Meshesha_etal_SedimentResearch_2012b
-  Meshesha_etal_Agric&env_2011
-  Meshesha_etal_Distrometer_Catena_2016
-  Meshesha_etal_HSJ_2014b
-  Meshesha_etal_LDD_2012a
-  Meshesha_etal_RegionalEnvironment_20...
-  Taye_etal_2013
-  Taye_etal_2015
-  Teka_etal_Catena_2013
-  Vanmaercke_etal_ESR_2016
-  Tefera_etal_TropAnimHealthProd_2018

ALRC-TU ongoing research activities in Ethiopia

Kakenhi project

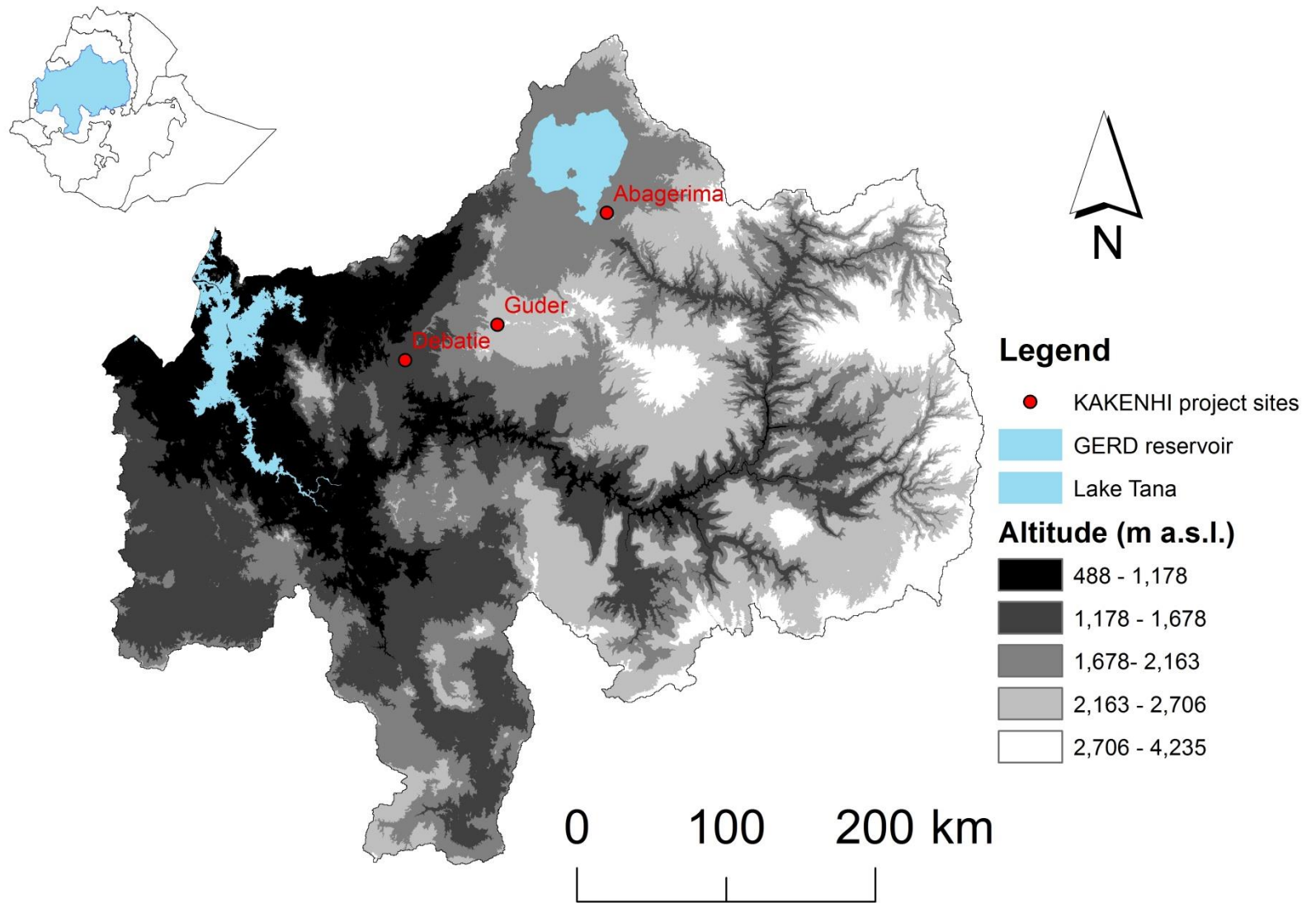


“Land management to mitigate soil erosion in the upper Blue Nile River Basin”

Kickoff meeting,
Bahir Dar,
February 2014

Kakenhi-Ethiopia Project summary

Project title	Land management to mitigate soil erosion in the Blue Nile Basin
Responsible institution	Arid Land Research Center (ALRC), Tottori University, Japan
Partner institutes	Arid Land Research Center (ALRC), Tottori University, Tottori, Japan Bahir Dar University (BDU), Bahir Dar, Ethiopia
Principal investigator	Professor Atsushi Tsunekawa, ALRC, Tottori University, Japan
Local Coordinator	Dr Enyew Adgo, BDU
Project period	October 2013 to March 2018
Source of funding	Grants-in-Aid for Scientific Research (KAKENHI) from Japan Society for the Promotion of Science (JSPS), Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan



Location of the study area: the Upper Blue Nile River basin. Kakenhi project sites are three research stations established in 2013 to monitor and evaluate soil erosion in the upper Blue Nile River Basin in collaboration with Tottori University of Japan and Bahir Dar University of Ethiopia.

Study approach: field experimentation

- Field monitoring runoff and soil loss with runoff plots: experience of KAKENHI-Ethiopia project (Photo: September 2014)



Study approach: watershed level monitoring

- Monitoring runoff and sediment
 - Instantaneous (divers) and discrete (staff gauges) to measure river stage
 - Manual suspended sediment sampling



Topic	Lead-researcher	Title	Status
Sediment budget at plot and watershed scale, the case of Akusty and Kasry watersheds	Addisu Guadie	M.Sc student	completed
Water balance at plot and watershed scale, the case of Akusty and Kasry watersheds	Habtamu Achenafi	M.Sc student	completed
Effect of Acacia decurrens in soil nutrient properties, the case of Akusty and Kasry watersheds	Acham	M.Sc student	completed
Plant nutrient budget at plot and watershed scale: the case of Guder watershed (Awie zone, Ethiopia)	Yeshiwas Shibabaw	M.Sc student	Completed
Socio-economic analysis of soil erosion and land management interventions in the Upper Blue Nile River Basin, northwest Ethiopia	Zerihun Nigussie	PhD student	ongoing
Spatial Analysis of runoff yield in the Upper Blue Nile Basin, northwest Ethiopia	Dagnenet Sultan	PhD student	ongoing
Effects of land management practices on soil and nutrient losses in three selected twin watersheds, Upper Blue Nile Basin	Kindiye Ebabu	M.Sc to PhD	ongoing
Conservation-based forage production in northwest Ethiopia	Firew Tegegne	Visiting Researcher	competed
Rainfall erosivity	Derege Tsegaye	Postdoc	completed
Soil erosion and conservation in Ethiopia	Nigussie H.	Researcher	ongoing

SATREPS Project: ALRC-TU upcoming project in Ethiopia

→ ↻ 📄 www.jst.go.jp/pr/info/info1181/Appendix1.html

[Home](#) > [Press Releases](#) > [Press Release #1181](#) > Appendix 1

Appendix 1

Provisionally Selected Projects for FY2016

Environment and Energy

“Research contributing to the resolution of global-scale environmental issues”

“The Project for Comprehensive Assessment and Conservation of Blue Carbon Ecosystems and Their Services in the Coral Triangle (Blue CARES)”

[Republic of the Philippines/Republic of Indonesia]

(Professor NADAOKA Kazuo; School of Environment and Society, Tokyo Institute of Technology)

“The Project for Development and Implementation of New Damage Assessment Process in Agricultural Insurance as Adaptation to Climate Change for Food Security”

[Republic of Indonesia]

(Associate Professor HONGO Chiharu; Integrated Research Field of Remote Sensing Division, Center for Environmental Remote Sensing, Chiba University)

“The Project for Development of Next-Generation Sustainable Land Management (SLM) Framework to Combat Desertification”

[Federal Democratic Republic of Ethiopia]

(Professor TSUNEKAWA Atsushi; Arid Land Research Center, Tottori University)

SATREPS: Science and Technology Research Partnership for Sustainable Development

Japan Science and Technology Agency (JST),
and the Japan International Cooperation Agency (JICA)

SATREPS-Ethiopia project summary

(a) Title of project	Development of next-generation Sustainable Land Management (SLM) framework to combat desertification
(b) Research period	5 years (April 2017-March 2022)
(c) Funding	Jointly by JST and JICA
(d) Principal investigator	Professor Atsushi Tsunekawa, Arid Land Research Center, Tottori University
(e) Local Coordinator	Professor Enyew Adgo, Bahir Dar University, Ethiopia
(f) Collaborating institutes in Japan	Tottori University Shimane University The University of Tokyo
(g) Counterpart country	Federal Democratic Republic of Ethiopia
(h) Counterpart institutes in Ethiopia	Bahir Dar University Amhara Agricultural Research Institute Water and Land Resource Center Ministry of Agriculture

Work Packages (WPs)

WP 1: Reduction of soil erosion through developing integrated watershed planning tools

- 1-1 Development of a low cost and accurate soil erosion observation system (satellite+radar+field observation +modeling)
- 1-2 Development of a spatial soil erosion model for erosion risk assessment
- 1-3 Development of soil erosion prevention technique

Work Packages (WPs)

WP2: Improving land productivity of different land use systems

- 2-1 Improve productivity of arable land through comprehensive soil fertility management and conservation farming and improved cultivars
- 2-2 Improve productivity of grazing land through improved grazing management systems, selection of forage species, feeding system
- 2-3 Development of land restoration techniques in the degraded hills (SWC +multipurpose tress)

Work Packages (WPs)

WP3: Improve farmers' livelihood through economic and social empowerment

- 3-1 Identification of the root causes of poverty and social disparities
- 3-2 Development of market oriented value chain for additional income and employment opportunity creation
- 3-3 Development of economic and social empowerment techniques through participation of women and youth in SLM

Work Packages (WPs)

WP4: Develop comprehensive watershed management technologies and approach

- 4-1 Development of multiple future scenarios of small watersheds
- 4-2 Development of SLM approach for upscaling
- 4-3 Development of the next generation SLM framework and guidelines

Characteristics of current and future

SLM

	Current SLM	Next generation SLM
Agricultural production system	Traditional cultivation linked system dependent on free grazing. Large amount of soil erosion and low productivity	For reducing soil erosion and improving productivity, implementation of a new cultivation linked system with confinement as its basis
Form of farmers' participation	In most of the cases, legally forced participation and unpaid work	Voluntary participation of farmers through economic incentives
Main purpose	Reduction of soil erosion	In addition to reduction of soil erosion, improving land productivity, improving livelihood, economic and social empowerment
Implementation method	Top down implementation of the project by the administration	Setup a committee where diverse stakeholders participate, and take cooperative approach
Problems and issues	Insufficient soil erosion reduction benefits Lack of sustainability and autonomy	Issue is developing elemental technology (SLM technology) that would translate into land restoration leading to improvement of livelihood and techniques for spreading it (SLM approach)

Summary

- The problems and impacts of land degradation in UBNR basin are multifaceted with far reaching consequences
- Requires integrated approaches and solutions to minimize problems
- The intention to develop next-generation Sustainable Land Management (SLM) framework under the SATREPS project initiative could contribute a great share towards solving this gap.
- Research collaboration on issues of common interest could bring more feasible solutions
 - ICARDA (cross-appointment agreement)
 - ICRISAT
 - CIAT
 - Others?

- Thank you for your attention !!