DEBRE BERHAN UNIVERSITY

College of Agriculture and Natural Resource Sciences

Department of Natural Resource Management

Curriculum for M.Sc. Program in Soil and Water Conservation (SWC)

May 2018

Debre Berhan

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1. Executive Summary

For a two year Master's program in Soil and Water Conservation (SWC) in Debre Berhan University, the curriculum is designed and presented in detail. The program is a two year modular Master's program proposed with a combined two major natural resources management areas namely Soil conservation and Water conservation accompanied by research tool components. The general objective of the program is to produce qualified professionals in the field of SWC to tackle the ever challenging land degradation (critically caused by soil erosion) and climate change in practice. All students attending the program should take the compulsory courses and elective courses if found necessary in semesters I and/or II. The Master's program at SWC is composed of 36 credits in which 30 credit hours are course works and 6 hours is for Master's thesis. After successful completion of the 30-credit-hour coursework, each student is expected to prepare and defend their Master's Thesis Research Proposal at the end of the first year or early at the beginning of the second year. Elective courses may be added conditionally as a bridge or complementary for any identified gaps. The remaining one year is for the thesis research work. The program component is composed of 10 courses, one Graduate seminar, and Thesis work. The first course is in the first semester is Soil and Water Conservation which is focused on the concepts, agents, and mechanisms of soil erosion and their remedial measures. This will introduce and provide background knowledge and tested experiences related to soil and water problems and available technological options to alleviate the problems. In the second course, practical application of Geographical Information System (GIS) and Remote Sensing (RS) through data and information capturing and analyzing for research, planning, and implementation of SWC measures will be practiced. Watershed Hydrology is the third course which is designed to convey the knowledge of watershed, elements in the hydrologic cycle, and ways of quantifying the most important hydrologic parameters in a watershed. Research method and experimental design in soil and water conservation is the fourth course dealing with the methods and procedures of how scientific research in soil and water conservation could be done. The challenge of the era, climate change, is also included as a fifth course dealing with its impact on the soil and water resources along with mitigation measures. In the second semester, the detail of the physical SWC measures will be studied towards their proper design, layout, and construction under the course Design, layout, and construction of SWC structures. Since rain is the major source of erosion as well as the crucial source of development, the option of rainwater management and using for development through irrigation will be studied under the course Rainwater harvesting and irrigation techniques. The three levels of soil erosion estimation, i.e., assessment, experiment, and modeling will be studied under the course Soil Erosion Assessment, Experiment, and Modelling. In order to increase the capacity of the graduates towards effective and efficient planning and management of projects related with SWC, the fourth course, Planning, Execution and Management of Soil and Water Conservation Projects, is included. Management of Problem Soils is another course dealing with the very critically problematic soils like Vertisols, Saline soils, and Sodic soils and the available rehabilitation mechanisms. Students will be equipped with the knowledge of the problems followed by the skill of their management. The graduate seminar coupled with Research method and experimental design, GIS and RS, and Soil Erosion Assessment, Experiment, and Modelling courses provide students with knowledge and skill in the scientific way of literature review writing and presentation through proper research methods in SWC studies. The program can thus accommodate students with undergraduate degrees in Natural Resources Management, Soil and Water Engineering (management), Soil resources and watershed management, watershed management, Water resource and Irrigation management, Water resources and environmental engineering/management, Water Resources engineering/management, and related fields if critically evaluated by the department.

2. Degree Nomenclature

The nomenclature of the degree in the SWC program is:

1. In English: Master of Science Degree in Agricultural Science (Soil and Water Conservation)
2. In Amharic: ‹**የሳይንስ ማስተር ዲግሪ በግብርና ሳይንስ** (**በአፈርና ውሃ ጥበቃ**)

3. The Rationale of the Program

In the agenda 2030, i.e., the Sustainable Development Goal (SDG), one of the critical issues presented boldly under the 2nd, 13, and the 15nth goals are ‘promoting sustainable agriculture and supporting small farmers’, ‘Reducing Green House Gas Emission’, and ‘Reversing Land Degradation’, respectively. Besides, the GTP-II of the country also emphasizes reducing degradation and supplying a sufficient amount of water for irrigation by taking watersheds as a planning focal unit. The dominant cause of land degradation is confirmed to be soil erosion by water and accordingly, the remedy is soil and water conservation. It is obvious that combating land degradation is the bottleneck and the challenges of the globe and will continue in the coming decades. In line with this, the need for qualified manpower in the management of natural resources (soil, water, vegetation) is critical. Accordingly, the "Soil and Water Conservation" program will, therefore, contribute towards these efforts through the provision of research-oriented practical training. The Program is intended to satisfy the urgent professional and research demands of the country and thereby contributing to reverse the present land degradation at large. On the other hand, regardless of the critical problems we have been challenged associated with degradation of natural resources, development programs and activities in the country, particularly at the grass root levels, have been managed by professionals who are graduates of a different area of agricultural sciences. Almost all the professionals at the grass root level are diploma and BSc holders with limited knowledge of research to help the management of soil and water resources. Moreover, in view of the ratio of the total number of extension personnel on duty to the number of farmers in the country, much needs to be done to produce qualified personnel in the field of natural resources management, specifically in soil and water conservation.

The current on-duty professionals in the development sectors lack the capacity to tackle land degradation and soil erosion problems. The problem of land degradation needs more advanced technical knowledge to respond to more complicated land and water resource challenges. Those challenges are beyond the capacity of undergraduate professionals. Therefore, to contribute to the ongoing research, education and extension services of the natural resources management, the program is critically important.

Need Assessment Result

- In both rounds, 2014 and 2018, SWC M.Sc. program got the first higher priority, i.e., 120/181 in 2014; and 40/43 in 2018.

4. Program Objectives and Graduate Profile

4.1. Program objectives and competency profile

The courses of the master program are designed to overcome the lack of capacity to manage the watershed based soil and water resources in an integrated manner. The program is foreseen to strengthen the teaching, research and extension service giving governmental and non-governmental institutions in the country. The attainment of this program will help capacity building in Soil and Water Conservation in all agro-ecological zones of the country. The program undertaking assumes the following set of educational and research objectives:

- Produce effective communicators among experts in natural resource disciplines and also with natural resource economists, environmentalists, planners, and decision makers;
- Augment and strengthen research and development in the fields of Watershed Management since SWC is the first line strategic remedy in degraded watersheds ;
- Nurture awareness current and future professionals with regard to qualification and quantification of watershed degradation along with proper mitigation measures;
- Prepare graduates who are capable of applying science, fundamentals, and logical thinking to study and manage land degradation problems in an integrated manner;
- Provide the candidate professionals with the ability to discover, apply, and disseminate the knowledge required to solve the challenges in a watershed that are related to soil and water problems;
- The graduates, as well as their researches and the results, help to motivate cooperation between the University (DBU), watershed communities, organizations working in the area;
- Prepare graduates who can plan, operate and manage soil and water and related projects integrating the physical, the socioeconomic and the environmental aspects of the projects;
- Produce ethical professional graduates;
- Produce graduates who have leadership, teamwork, and analytical capabilities

4.2. Program Vision

The program of “Soil and Water ” envisions to become a nurturing academic and research program for (i) producing knowledgeable and skilled professionals who upon graduation can effectively and creatively work to challenge the challenging land degradation, (ii) generating and communicating problem-oriented technologies and techniques in SWC, and (iii) ultimately evolve as a center of excellence in Watershed Based Natural Resource Management education and research in the country as well as in the region. More profoundly, the program will strengthen the center of excellence of DBU, i.e., Natural Resource-Based Highland Agriculture.

4.3. Resources

I. Staff Profile

Table 1. Required Staff Profile

Educational Level	Profession	Required number	Remark
PhD	Soil and Water Conservation Engineering	1	On study (will be on duty after a few months)
	Watershed Modeling and management	1	On duty
	Soil Sciences	1	On study (will be on duty after a few months)
	Soil chemistry & Soil Biology	1	Two on duty
TA	BSc in SWC, SoSc	2	All on duty

II. Facilities and material resources

- Laboratories (soil, hydrology, water, open-air laboratories, i.e., watersheds)
- GIS laboratory
- Teaching and learning facilities (ICT)
- Field tools and equipment (Digital camera, GPS, soil color chart, Topographic maps, Video camera etc).
- availability of Books, Journals in DBU library as well as in online sources;
- availability of more than 34-year-old experimental watersheds (Andit Tid, Maybar, Anjeni) from which Andit Tid is 30 km from DBU
- Agricultural Research Center and other testing sites;
- The pool of indigenous knowledge and practices as a learning ground (traditional drainage practice, indigenous SWC);
- The foundation department, NRM, is found in the College;
- Potential running staffs;
- Many degraded as well as developing watersheds accessible.

4.4. Professional and Graduate Profile

4.4.1. Professional Profile

- Using their broad base knowledge in "Soil and Water Conservation", coordinate and implement Integrated watershed-based soil and water-related projects and programs; besides, can mediate cross-sectoral development initiatives;

- Identify soil and water resources related problems, design cost-effective, socially acceptable and environmentally sound projects and programs for mitigation and adaptation.
- Develop, restore and manage various resources such as forests, soil, water, and land resources in an integrated manner;
- Carryout watershed management planning using various tools such as GIS, ground surveying and Remote Sensing (RS), erosion modeling and by Land Use Planning (LUP) principles
- Provide consultancy and advisory services to local communities, investors and development actors working in the areas of Integrated Watershed management, particularly in soil and water-related issues.
- Carryout small to medium scale soil and water-related researches to provide solutions to locally emerging problems.
- Reinforce the reality that maintains and sustain natural resources, and ensures environmental quality.
- Competence in impact evaluation and documenting best practices
- Think critically, communicate, cooperate and solve problems from an interdisciplinary perspective

4.4.2. Graduate Profile

The MSc. graduates of the Soil and Water Conservation program at their graduation will be:

- Competent in the principle and techniques of stocks and distribution of Natural Resources and the opportunities they offer for socio-economic developments and environmental integrity.
- Able to analyze problems encountering watersheds related to degradation, design integrated and environmentally sound solutions by considering policies and legislation, and by coordinating and reconciling the varied interests of different parties through analysis, identification and participation of stakeholders,
- Able to design and implement problem orientated researches and development projects, provide advice for policymakers, teach courses and offer various training programs in SWC areas and provide consultancy.
- Able to apply modern tools and techniques in the management of Watershed Resources and environmental protections, work for continuous refinement and upgrading of existing practices, and become competent entrepreneurs in their fields of experts, and

- Do feasibility studies, plan, implement, monitor and evaluate programs/projects related to land degradation on a sustainable basis,
- Able to work in a multi-disciplinary team to solve SWC related problems.

Job opportunity for the Graduates

- Most Natural Resource related graduates employed in wide open vacancies.
- Universities need a lecturer as well as researcher
- Agricultural research Institutions require researchers
- From Federal to District Agriculture, Natural resource, Irrigation, etc offices
- NGOs, and private consultancy PLCs

5. Admission and Graduation Requirements

5.1. Admission Requirements

Admission requirements for the regular master's degree programs will be like the other study programs of the university. Similarly, the criteria for admission set for full-time master's degree programs are the criteria to be employed for admission to the master's degree program in the continuing education program of the University. The minimum GPA requirement is based on the university criteria. Applicants for the evening program, on the other hand, will be treated in the same way.

5.2. Duration of Study

The duration of study of the postgraduate (MSc.) program in Soil and Water Conservation is two (2) academic years (four semesters) for regular admission.

5.3. Graduation Requirements

According to the rules and regulations of the University, students in this program will be able to graduate if and only if:

- They complete a minimum of 30 Credit hours course and 6 Credit hours master's research thesis.
- They attain minimum CGPA of 3.00 and better on major courses and overall courses, with a minimum of one C grade if the student is failed to achieve at least B grade.

5.4. Medium of Instruction

The medium of instruction for the program is ENGLISH

6. Assessment and Evaluation

6.1. Mode of Assessment

6.1.1. Theoretical Part of the Course Work

The theoretical part of the coursework will be evaluated through writing term papers on the selected topics, project works and assignments, and also by the final examination.

6.1.2. Practical Part of Courses

Since the course needs a series of practical works especially in the open-air laboratories (watersheds), the evaluation will be through laboratory and field exercise reports, practical examinations, as well as written examinations.

6.1.3. Research Projects and Seminars

Intensive research works and seminars will be evaluated based on the quality of the paper presented (content, review, discussion, reference, formatting, etc). Moreover, the method and style of paper presentation are also evaluated accordingly. The final Thesis Research will be evaluated in an open defense session by the board of examiners.

7. Structure of the Master's Program

The proposed Master's program relies on the premise that the SWC is not a single discipline and an individual's task rather it is teamwork. Therefore, the program is designed to include a wide range of disciplines in which participants will become skillful.

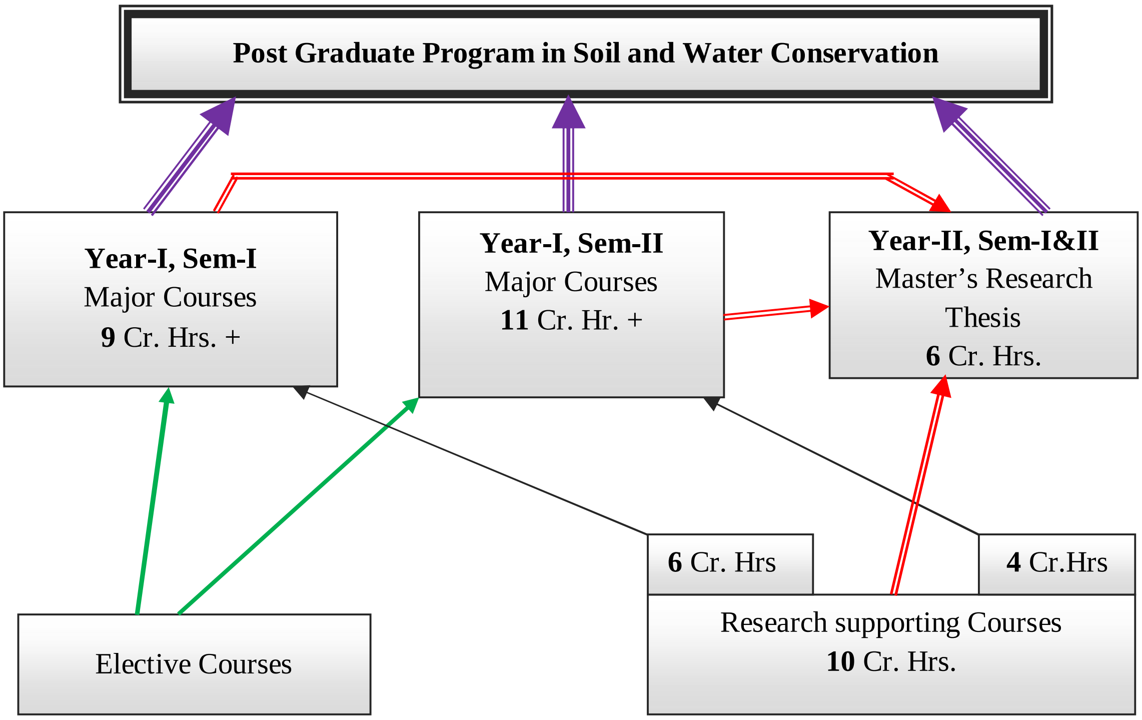

Figure 1 structure of the master's program

7.1. The composition of the Master's Program

The proposed Master's program in SWC is composed of 36 credit hours (or units) with 30 credit hours of coursework and 6 hours of a Master's thesis. A credit hour is equivalent to a course having a one-hour lecture per week for a semester composed of 16 weeks. Accordingly, a 2-credit-hour course will have 2 hours of contact lecture time per week for a 16-week semester excluding the week of the final examination. The general structure of the program is shown in Figure 1.

7.2. Prerequisites

It is assumed that participants in this Master's program have a diverse background and thus the program assumes knowledge regarding watershed management, in general, and soil and water conservation, in particular. The program can thus accommodate students with undergraduate degrees in the soil, water, and natural resources related programs. Those may include Natural Resources Management, Soil and Water Engineering (conservation and management), Soil resources and watershed management, watershed management, Water resource, and Irrigation management, Water resources and environmental engineering/management, Water Resources Engineering/management, etc.

8. Grading system

The grading system of the program is based on the rules and legislation of the University presented below.

For course works									
Mark Interval	[90,100]	[85, 90)	[80, 85)	[75, 80)	[70, 75)	[65, 70)	[60, 65)	[50, 60)	(50,0]
Grade Point	4	4	3.75	3.5	3	2.75	2.5	2	0
Grade label	A+	A	A-	B+	B	B-	C+	C	F
For thesis work									
Mark	[90,100]	[85,100]	[80, 85)	[75, 80)	[65, 75)	<65			
Grade label	A+	A	B+	B	C				
Description	Excellent	Very Good	Very Good	Good	Satisfactory	Fail			

9. List, Distribution, and Description of courses in the Master's Program

9.1. List of Compulsory and Elective Courses

The courses which are identified as compulsory in the SWC postgraduate program are listed in Table 2 as per the year and semester they belong to with the credit hour assigned for each of them.

Table 2. List of compulsory courses in the Master's Program

Year/Sem.	**Code**	**Course**	**Cr. Hrs.**	**Remark**
I/I	SWC 411	Geomorphology	2	Compulsory
	SWC 421	Soil Erosion Assessment, Experiment, and Modeling	3	Compulsory
	SWC 431	Watershed Hydrology and Management	3	Compulsory
	SWC 441	Soil and Water Conservation	3	Compulsory
	SWC451	Indigenous knowledge and practices in SWC	1	Compulsory
	SWC461	Rainwater Harvesting	3	Compulsory
		Semester Total	**15**	
I/II	SWC412	Management of Problematic Soils	2	Compulsory
	SWC422	Climate change, adaptation, and mitigation	2	Compulsory
	SWC432	Design, layout, and construction of SWC structures	2	Compulsory
	SWC442	Research method and experimental design in SWC	2	Compulsory
	SWC452	Application of GIS and Remote sensing for soil erosion and SWC	2	Compulsory
	SWC462	Natural Resource Governance, Socio-economic and Stakeholder Management	2	Compulsory
	SWC472	Planning, implementation, monitoring, and evaluation of SWC projects	2	Compulsory
	SWC482	Graduate seminar in SWC	1	Compulsory
		Semester Total	**15**	
II/I&II	SWC413	Master's Thesis Research	6	Compulsory

Table 3. List of conditional Elective courses

Year	**Code**	Elective **Courses**	**Cr. Hrs.**	**Recommended Semester**
I	SWC 471	Land Evaluation and Land use planning	2	I
	SWC 492	Agro-forestry	2	II
	SWC 4102	Project planning and management	2	II

9.2. Description of Courses

1. Geomorphology

Course	**Geomorphology (2-Cr hr)**	**SWC 411**
Pre-requisite	The highlight of Geology; soil formation;	
Objective	Acquire knowledge on Definition and concepts, systems, processes, agents and types of landforms, and acquire skill on tools of Geomorphology and the practical ways of terrain analysis	
Chapters	**Contents**	**Contact Hrs.**
1	Introduction: Definition and concepts in Geomorphology; the Geomorphic systems; geomorphic materials and processes; Weathering, erosion, transport, deposition	3
2	Subsurface Modifiers: Large and small scale Tectonic structural landforms	3
3	Weathering, Fluvial, and hillslope landforms	3
4	Geologic, climatic, hydrologic (including erosion) and environments affecting the development of landforms.	4
5	Landscape Evolution	2
6	Terrain analysis: Drainage patterns; DEMs and DTMs; landscape evaluation; hazard mapping	8
7	Tools of Geomorphology: Maps (Topographic and Surface Geologic); Photos (Interpretation); Mathematical Models; Experiments; Ground Truth	9
	Total	**32**

Suggested Reference

- Fundamentals of Geomorphology. Second Edition By Richard John Huggett 2007. Routledge Fundamentals of Physical Geography, London, and New York.

2. **Soil Erosion Assessment, Experiment, and Modeling**

Course	**Soil Erosion Assessment, Experiment, and Modeling**	**SWC 421**
Pre-requisite		
Objective	Convey scientific ways of estimating and predicting soil loss rate	
Chapters	**Contents**	**Contact Hrs.**
1	Erosion research: Problems and prospects, Needs for Improved data, The purpose of erosion research, the case in Ethiopia	4
2	Land degradation and Indicators of Soil loss: Rills, Gully, Pedestals, Armour Layer, Plant/Tree Root Exposure, Exposure of Below Ground Portions of Fence Posts and Other Structures, Rock Exposure, Tree Mound, Build up against Barriers, Sediment in Drains, Enrichment Ratio, Soil Texture and Color, Soil and Plant Rooting Depth	8
3	Soil erosion hazard assessment: Soil loss tolerance, Soil erosion hazard assessment,	4
4	Laboratory and field plots: Procedure, USLE, Field plots, Sheet and rill erosion estimating, Gully erosion estimating, catch pits	6
5	Sedimentation for reservoir: Sources of sediment, estimations, reservoir sedimentation, Reduction in Reservoir Capacity	5
6	Modeling Soil Erosion: Concept of Modeling, Fundamentals of Modeling, Modeling soil erosion process, Soil Erosion Models	12
7	Measurement of soil erosion by wind	3
8	Field practice on Soil erosion Assessment and Estimation	6
	Total	**48**

Suggested References

- Modeling erosion, sediment transport, and sediment yield, Edited by Wolfgang Summer and Desmond E. Walling, 2002.
- Field Measurement of Soil Erosion and Runoff, FAO Soils Bulletin 68 FAO Rome, by Hudson, N. W., 1993
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3. Watershed Hydrology and Management

Course	**Watershed Hydrology and Management**	**SWC 431**
Pre-requisite		
Objective	To acquaint and equip the students about hydrological process and analysis of hydrological data required for the design process.	
Chapters	**Contents**	**Contact Hrs.**
1	Hydrologic processes and systems; Why watershed?; Hydrologic problems of small watersheds; Hydrologic characteristics of watersheds	8
2	Measurement and analysis of hydrologic parameters, and stream flow measurement and analysis of data.	6
3	Hydrograph analysis; Unit hydrograph theory; Synthetic and dimensionless hydrograph, the convolution of unit hydrograph.	6
4	The concept of hydraulic flood routing, flood routing (reservoir and channel routing).	6
5	Definition and concept of different types of hydrologic models for simulation of hydrologic problems.	6
6	**Integrated watershed management practices/interventions**:- Size of a watershed for development; watershed delineation techniques; Concept of Integration in watershed management; Principles of watershed management; steps in watershed planning; Multitude of interventions in the watershed development	14
	Total	**48**

Suggested Readings

- Applied Hydrology by Chow VT, David, M & Mays LW. 1988. McGraw Hill.
- Hydrology and Soil Conservation Engineering, by Ghanshyam Das 2000.
- Watershed Management by Hall. Tideman EM. 1996. . Omega Scientific Publ.

4. Soil and Water Conservation

Course	**Soil and Water Conservation**	**SWC 441**
Prerequisite		
Objective	To impart knowledge of the concepts, agents, and mechanisms of soil erosion and their remedial measures through the provision of background knowledge and tested experiences related to soil and water problems and available technological options.	
Chapters	**Contents**	**Contact Hrs.**
1	Concepts, History, and Facts of Land degradation and soil and water conservation	2
2	Mechanics of soil erosion: Mechanics of water erosion, Mechanics of wind erosion, Rainfall erosivity, Wind erosivity, Soil erodibility	6
3	Soil erosion factors, types, stages, and impacts: Factors affecting soil erosion by water, by wind, Geologic erosion, Accelerated erosion, Stages of soil erosion by water, Impacts/problems of soil erosion	6
4	FAO-SWC based Land capability classification	2
5	Biological SWC measures	7
	Physical SWC measures	8
6	Control of wind erosion	3
7	Control of gully erosion	6
8	Field visit	8
	Total	**48**

Suggested References

1. Soil and Water Conservation for Sustainable Agriculture. By Prof. Taffa, 2011
2. Conserving Land, Protecting Water. By Deburha Bossio and kim Geheb
3. Natural Resource Conservation. 9th edition. By Daniel D. Chiras, and John P. Reganold. 2005
4. Hydrology and Soil Conservation Engineering including Watershed management. Second Edition By Ghanshyam Das, 2009

5. **Indigenous knowledge and practices in SWC**

Course	**Indigenous knowledge and practices in SWC**	**SWC 451**
Pre-requisite		
Objective	To provide knowledge of the very critical base of the modern SWC, i.e., indigenous knowledge in SWC,	
Chapters	**Contents**	**Contact Hrs.**
1	**Definition and concepts of Terms:** Knowledge; Indigenous Knowledge; Traditional Knowledge; Indigenous Technical Knowledge; Knowledge Systems	**1.5**
2	**Indigenous Knowledge and Practices in SWC: Global to National context:** To raise soil infiltration capacity; To provide sufficient ground cover in space and time; To stop soil erosion; To control soil transport; To increase soil fertility; To drain excess water from agricultural field; To promote deep percolation of runoff; To identify runoff generation hotspot areas prioritization of conservation measures; To identify erosion hotspot areas for prioritization of conservation measures; To increase soil depth/soil formation; To collect rainwater/runoff for further use; To make improvement on the introduced SWC measures; Ways of group systems the community developed for SWC campaign	**3.5**
3	**Ways of Linking Indigenous Knowledge to Science and vice-versa:** Similarity and Difference between Indigenous Knowledge and Science; The role of changing world to affect Indigenous Knowledge/ is indigenous knowledge static?; Ways of Linking Indigenous Knowledge to Science and vice-versa	**2**
4	**Institutionalizing Indigenous Knowledge and Local Participation:** Who controls indigenous knowledge; Ensuring continuance of Indigenous Knowledge; Recovering Indigenous Knowledge.; Maintaining Indigenous Knowledge; Glocal than Global resource management	**2**
6	**Field survey/review Term paper with presentation**	**4**
	Total	**16**

Suggested references

- Understanding Indigenous Knowledge: Its Role and Potential in Water Resource Management in Bangladesh M. Chadwick, J. Soussan; D. Mallick, and S. Alam.
- Indigenous Knowledge Practices in Soil Conservation at Konso People, Southwestern Ethiopia. Yeshambel Mulat (2013)
- Linking Indigenous and Scientific Knowledge of Climate Change. ClarenCe Alexander et. al. (2011)
-

6. Rainwater Harvesting

Course	**Rainwater Harvesting**	**SWC 461**
Pre-requisite		
Objective	Equip students with the knowledge of available rainwater management technological interventions and the efficient utilization of the harvested water for irrigation	
Chapters	**Contents**	**Contact Hrs.**
1	Introduction: The basis of water harvesting: History and perspectives, Definitions and classification,	4
	Basic categories of water harvesting systems for plant production, Overview of main WH systems	4
2	Water and soil requirements: Water requirements of crops, Water requirements of trees, rangeland and fodder, Soil requirements for water harvesting	6
3	Rainfall-runoff analysis: Rainfall characteristics, Rainfall-runoff relationship, Determination of runoff coefficients	6
4	Design model for catchment: Cultivated area ratio; Crop production systems, Examples on how to calculate the ratio C: Ca, Systems for trees, Systems for rangeland and fodder	6
5	Water harvesting techniques: Site and technique selection	10
6	Irrigation techniques and water use efficiency	4
7	Case study: a review on hydrologic, efficiency and socio-economic perspective of rainwater harvesting and management issues **[**	8
	Total	**48**

Suggested References

- Water from ponds, pans, and dams. 2005 World Agroforestry Centre - Eastern and Central Africa’s Regional Land Management Unit (RELMA in ICRAF)
- Irrigation and Water Resources Engineering, by Asawa, G. L., 2008.
- Micro-irrigation for Crop Production: Design, Operation, and Management, edited by Freddie R. Lamm, James E. Ayars, and Francis S. Nakayama

7. Management of Problem Soils

Course	**Management of Problem Soils**	**SWC 412**
Pre-requisite		
Objective	Students will be equipped with the knowledge of the problem soils and skill of their rehabilitation in order to use all soils for production increment	
Chapters	**Contents**	**Contact Hrs.**
1	Soil as a disperse system: Basic qualities and parameters of soils	4
2	Water movement in soils: in saturated, and in vadose zones	6
3	Water and solute transport in soils: Convection, diffusion, hydrodynamic dispersion	5
4	Breakthrough Curves (BTCs) of different chemicals:	3
5	Problem Soils:- Sources and Rehabilitation: Compacted soils, Biological Soil Crust, Heavy clay soils, Salt-affected soils, Organic soils, Dispersive soils	10
6	Problem soils and rehabilitation: Case studies in the Ethiopia Context, and global perspective	6
	Total	**32**

Suggested References

- Brady, N. C., and R. R. Weil. 2000. Elements of the Nature and Properties of Soils. 12th ed. Printice-Hall Inc, Upper Saddle River, New Jersy. 759p.
- Conklin A.R. 2005. Introduction to Soil Chemistry.
- Dahame A.K. 2006. Organic Farming for Sustainable Agriculture.
- Gustafson A.F. 2003. Handbook of Fertilizers. Agrobios (India
- Gustafson A.F. 2005. Soils and Soil Management. Agrobios (India).

8. Climate Change Impact Adaptation and Mitigation Soil and Water Conservation

Course	**Climate Change Impact Adaptation and Mitigation**	**SWC 422**
Pre-requisite		
Objective	Provide participants with a high-level understanding of climate change impacts and adaptation at global, national and local scales.	
Chapters	**Contents**	**Contact Hrs.**
1	**Atmosphere**: General circulation, composition, and structure of the atmosphere, the role of meteorology in hydrology.	3
2	Precipitation process: Adiabatic process, stability, and instability of atmosphere.	2
3	Climate and climate change: Components, phenomena, radiative forces, energy budget and transport, atmospheric circulation, ocean circulation, land- surface process, carbon cycle.	4
4	Physical processes: Conservation of momentum, equation of state, temperature equation, continuity equation, conservation of mass.	2
5	Climate change-Soil erosion risk-Soil conservation-Carbon dynamics	5
6	Climate Change Impacts, Mitigation, and Adaptation in Agriculture, in Water and Settlements, Disasters	4
7	Climate Models: Introduction to GCM and RCM simulations, SRES, downscaling GCM outputs.	2
8	ENSO: El Nino basic, Tropical Pacific climatology, El Nino mechanism, ENSO indices, predictions, and teleconnections.	3
9	Greenhouse effects and climate feedbacks: global energy model, the greenhouse effect and global warming, climate feedback.	4
10	Climate Model scenarios for global warming: Greenhouse gases. Aerosols forcing, the global average response to GHG warming scenarios on temperature, rainfall, sea, ice/snow, extreme.	3
	Total	**32**

Suggested Books:

- Assessment Report 5, IPCC, WMO, 2014
- Climate change and climate modeling, by David, J., 2011.
- Hydroclimatology, Cambridge University Press, by Shelton, ML, 2009
- Applied Hydrometeorology, by Singh, V. P., and Rakhecha, P, 2009.
- Principles of Soil Conservation and Management, by Humberto Blanco and Rattan Lal, 2008, USA
- Human impacts on weather and climate, by Cotton R and Pielke RA, 2007
- Atmospheric Science- An Introductory Survey, by Wallace, J. M., and Hubbs, P.V., 1977.

9. Design, layout, and construction of SWC structures

Course	Design, layout, and construction of SWC structures	SWC 432
Pre-requisite	**Watershed Hydrology; Soil and Water Conservation**	
Objective	It will acquaint students to have the knowledge and skill of the detail design parameters, layout procedures, and construction material and methods for proper establishment of physical SWC measures.	
Chapters	**Contents**	**Contact Hrs.**
1	Introduction: Basis for design of physical SWC structures, Source of failure, practical evidence	2
2	Design parameters in Physical SWC structures: Rainfall, Soil, slope, Land use Land cover; Runoff estimation cook’s & CN method	6
3	Simple surveying techniques: Water-level, A-frame, Slope determination, Layout of Contour line and Graded line, Spacing between Physical structures, Staggered Positioning	4
4	Technical requirements of basic physical SWC structures: Bunds, Terraces, Trenches, Check dams, water collection structures, Sediment storage dams,	5
5	Construction materials and procedure of basic physical SWC structures: Bunds, Terraces, Trenches, Check dams, water collection structures, Sediment storage dams,	5
6	Drainage structures: Special features, priority setting, the risk of mis-design, layout, and construction	6
7	Design of some Biological SWC measures	4
8	Field practice on Design, layout, and construction of basic physical SWC structures (**Two days**)	
	Total	**32**

Suggested References

- Community-Based Participatory Integrated Watershed Planning Guideline-Vol. I (MoARD, 2005) Ethiopia.
- Community-Based Participatory Integrated Watershed Planning Guideline-Vol. II (MoARD, 2005) Ethiopia

10. Research method and experimental design in soil and water conservation

Course	**Research method and experimental design in soil and water conservation**	**SWC 442**
Pre-requisite		
Objective	Provide students familiarity with the methods and procedures of how scientific research in soil and water conservation could be done	
Chapters	**Contents**	**Contact Hrs.**
1	Introduction to research and scientific reasoning: Definition of research, Types of research, Methods of research, Procedure of research, Criticism of the scientific method, Research, and the experiment	3
2	Research writing: Need for a proposal, Contents of a research proposal, DBU Guidelines graduate thesis research proposal	2
3	Basic concepts in statistics: Introduction and use of statistics in experimentation, Measure of location and spread of statistics, Common probability distributions, Estimation, and hypothesis testing, Significance testing, Comparing the difference of two means	4
4	Experimental design and analysis: Principles of experimental design, Types of experiments, Analysis of Completely Randomized Design (CRD) experiments, Advantages, limitations, and use of CRD experiments, Analysis of variance of CRD experiments, Mean separation techniques, Analysis of Randomized Complete Block Design (RCBD) experiments, Analysis of Latin square Design experiments, Analysis of Factorial Experiments, Design and analysis of split-plot experiments	10
5	Covariance, Correlation, and Regression: Covariance, Correlation, Regression	4
6	Introduction to Geostatistics: Definition of geostatistics, Regionalized variables Vs. random function, Variogram, Kriging	6
7	**Projects for submission and presentation:** Design and construction of erosion (runoff) plots, On-farm experimentation, Research report writing, Statistical software for research	3
	Total	**32**

Suggested References

- Design and Analysis of Experiments, 5th edition. By Montgomery, D.C., 2001
- Development Oriented Research in Agriculture, by Mettrick, H., 1993.
- Statistical methods in Soil and Land Resources Survey, by Webster, R., and Oliver, M. A., 1990.
- Principles of Biostatistics, by Pagano, M. and Gauvreau, K., 2000.
- Field Measurement of Soil Erosion and Runoff, FAO Soils Bulletin 68 FAO Rome, by Hudson, N. W., 1993

11. Application of GIS and Remote sensing for SWC

Course	**Application of GIS and Remote sensing for SWC (3 Cr. Hr)**	**SWC 452**
Pre-requisite	Introduction to computer/basic computer skills	
Objective	Acquire knowledge and kill on data and information capturing and analyzing using geospatial technologies for research, planning, and implementation of SWC measures	
Chapters	**Contents**	**Contact Hrs.**
1.	Introduction to Geospatial Technologies (Remote Sensing, Geographic Information System, and Global Positioning System)	**2hrs**
2.	**Remote Sensing (RS)**	**13hrs**
2.1	Introduction to remote sensing: remote sensing process, components of remote sensing (sensors and platforms)and types of remote sensing (active and passive remote sensing).	2
2.2	Electromagnetic Radiation: EMR interaction with the atmosphere, atmospheric windows and their significance interaction with earth surface material, specular and diffuse reflection surfaces, spectral curves and spectral signature, spectral reflectance curves of water, soil and vegetation.	3
2.3	Satellite Programs and sensors: Classification, description of multispectral scanning-along and across track scanners satellite sensors, resolution types, description of sensors in Landsat, SPOT IRS series.	4
2.4	Satellite Image Interpretations: Basic Principles of image interpretation, visual interpretation, an element of image interpretation, digital image processing, supervised and unsupervised classification.	4
3.	**Geographic Information System (GIS)**	**15hrs**
3.1	Introduction to GIS: components, data types- spatial, attribute and metadata, raster and vector data and their comparison, data abstraction, maps and map scale.	3
3.2	Coordinate system: Datum, geographical coordinate system, projected coordinate system and their need, basic projection types, polyconic and UTM projections.	3
3.3	Data Input and Editing: Raster and vector data formats, georeferencing, data input using scanner and on-screen digitization, input using XY data, data editing, attribute data.	3
3.4	Basic Analysis: Union, Intersection, clip, merge, append, and map algebra.	3
3.5	Spatial analysis: Reclassifications, overlaying, buffering, unions, intersections, DEM, DEM analysis, contour, and cut-fill analysis, process modeling using GIS, IDW, spline and kriging, interpolation techniques.	3
4.	**Global Positioning System (GPS)**	**2hrs**
4.1	GPS and KML: an introduction to the global positioning system, types of GPS, use of GPS and KML format.	2
	Lecture hour	**32**
5.	Applications of Geospatial technologies **(Lab work and field data collection)**	**(16hr*3= 48hrs)**
5.1	How to work with RS, GIS software's and GPS instruments: working with RS software's (e.g. ERDAS imagine), GIS software's (e.g. ArcGIS and QGIS) and handling GPS.	4
5.2	RS, GPS, and GIS applications: LULC classification, floodplain mapping, and zoning, groundwater studies, erosion, sedimentation studies, watershed, and drainages delineation. Finally, group-wisemini-project will be given to	8

	students.	
5.3	Field practice on data capturing using GPS, transferring into ArcGIS, and Analysing	4
	Total	**48hrs**

- ✓ **Note**: Each lab/practical section has 3hrs per week (16contact hrs x 3=48hrs) and 32 lecture hrs, total hrs will 80.
- ✓ **One mini project** is compulsory; it could be either individually or in a group (two students per group). Students have to choose their project title from the above-mentioned application areas.

Suggested References

- Remote sensing and Image Interpretation, by Lillesand, T.M. and Kieffer, 2012.
- Introduction to Geographical Systems, by Chang, K, 2010.
- Fundamentals of Geographical Information Systems, by Demers, M. N., 2009, 4thed.
- Remote Sensing Models and Methods for Image Processing, by Schowengerdt, 2007
- Introduction to Digital Image Processing: A Remote Sensing Perspective, by Jensen, J. R., 1996.
- Fundamentals of remote sensing, a Canada Center for Remote sensing, remote sensing tutorial.
- Principles of Geographic Information Systems by Otto Huisman and Rolf A.de By, 2009.
- Principles of Remote Sensing by Kalus T., Norman K. Gerrit C., and Lucas, 2009
- Introduction to GPS. The global positioning system- El-Rabbany A. - Artech House (2002).
- Fundamentals of Global Positioning System Receivers_ A Software Approach, Second Edition James Bao_YenTsui(auth.), Kai Chang(eds.) - (2005).

12. Natural Resource Governance, Socio-economic and Stakeholder Management

Course	Natural Resource Governance, Socio-economic and Stakeholder Management	SWC 462
Pre-requisite		
Objective	It will provide students the basic aspects of community based natural resources management in view of effective, and equitable governance and stakeholders management	
Chapters	**Contents**	**Contact Hrs.**
1	**Introduction: Community-based Natural Resource Management (CBNRM)** Definition and principles of Community-based Natural resource management; Diverse range of forms of community involvement in natural resource management that have emerged across countries; Foundation of Natural Resource governance, socio-economic, and stakeholder management within the CBNRM	4
2	**Conflicts and Collaborations in Natural Resource management:** Community-based natural resource conflicts; Growing competition over natural resources; Natural resource conflicts and relation to the sustainable livelihoods; Conflicts over watershed resources; From conflict to collaboration; Conflict management	4
3	**Natural Resource Governance (NRG):** Definition, Scope of NR Governance; Forms of NR Governance; Approaches to natural resource governance; NRG and institutional arrangements (Local level NRG Vs Integrated watershed management); Challenges of NRG (accountability, transparency, equity, accessibility, effectiveness, sustainability)	6
4	**Socio-economic aspects in CBNRM:** Natural Resources and their Potential; for Economic and Social Development The Economics of Sustainable Natural Resource Management; The politics of Natural resource management	6
5	**Stakeholder Management in CBNRM:** Identification of stakeholders and their roles in NRG; Stakeholder effectiveness in natural resource management; Approaches in stakeholder analysis	6
6	**Evaluation** approach to the natural resource management and governance	2
7	**CBNRM, NRG, and Stakeholders in the Ethiopian Context**	4
	Total	**32**

Suggested References

- Community management of natural resources in Africa Impacts, experiences and future directions. Edited by Dilys Roe, Fred Nelson and Chris Sandbrook (2009)
- Natural Resources and Pro-Poor Growth: The Economics and Politics OECD (2008)
- Natural Resource Charter. Second Edition, International Monetary Fund (2012)
- Cultivating peace: Conflict and collaboration in natural resource management. Edited by Daniel Buckles (1999)

13.Planning, Execution, and Management of Soil and Water Conservation Projects

Course	**Planning, Execution, and Management of Soil and Water Conservation Projects**	**SWC 472**
Pre-requisite		
Objective	It will assist students to be effective in the face of soil and water projects design, implementation, management, monitoring, and evaluation	
Chapters	**Contents**	**Contact Hrs.**
1	Procedure for the planning of soil and water conservation projects;	3
2	Analysis of watershed problems; Survey and investigation; Calculation techniques of the different watershed parameter;	4
3	Legal, organizational and financial aspects of soil and water conservation projects;	4
4	Economic and financial analyses of soil and water conservation projects; Management of soil and water conservation projects; Project evaluation	6
5	Responsibilities of different operation offices;	4
6	Education, training and peoples participation in watershed development projects;	4
7	Case studies: Review of case studies about SWC and related projects	7
	Total	**32**

Suggested References

- Project Management for Engineering & Construction, 2nd Edition Oberlendera Gorold DBoston 2000
- Engineering Project Management, Lyer New Delhi 2001
- Global project management handbook. Planning organizing and controlling international project, Cleland D. I., and Gareis R. (eds), 2006.
- Project management, A systems approach to planning scheduling and controlling KerzenerH., 2009 10th edition.
- Phase project management, A practical planning and implementation guide, Weiss J. W. and Wysocki R. 1992.