DEMOCRATIC AND POPULAR REPUBLIC OF ALGERIA
MINISTERY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH

TRAINING OFFER
L.M.D.

ACADEMIC MASTER

Educational establishment	Faculty / Institute	Department
University of Tlemcen	Panafrican Institute of Water and Energy (including climate change)	Water

Field	Branch	Specialty
Science and technology	Hydraulique	Master of Science (MSc) in Water Engineering

Head of education domain team: Hadjoui Abdelhamid

الجمهورية الجزائرية الديمقراطية الشعبية
وزارة التعليم العالي و البحث العلمي

عرض تكوين

ل. م . د

ماستر أكاديمي

المؤسسة	الكلية/ المعهد	القسم
جامعة أبوبكر بلقايد - تلمسان	المعهد الأفريقي للطاقة والمياه	المياه

الميدان	الشعبة	التخصص
علوم و تقنيّات	الري	ماستر علوم في هندسة المياه

مسؤول فرقة ميدان التكوين : حجوي عبد الحميد

SOMMAIRE

The context

The Pan African University (PAU) project is the culmination of the efforts of the African Union to contribute to the revitalization of higher education and research in Africa, by nurturing quality and exemplifying excellence. The strategic vision of the PAU is the development of institutions for excellence in key areas of Science, Technology, Innovation, Social Sciences and Governance, which would constitute the bedrock of an African pool of world class higher education and research. This would usher in a new generation of African leaders with capacity to optimally harness available human and material resources, imbued with a common vision of a peaceful, prosperous and integrated Africa. The PAU is designed as a process of joint implementation of the Plan of Action for the Second Decade of Education for Africa (2006-2015) and the Consolidated Plan of Action for Science and Technology in Africa (CPA) (2006-2011).

Much work has been done since the project began in 2008, involving Member States, the higher education community in Africa and beyond, and a wide range of development partners. Following recommendations from the fourth ordinary session of the conference of Ministers of Education of the African Union (COMEDAF IV) in November 2009, and an extra-ordinary COMEDAF IV in May 2011, the Summit of Heads of State and Government of the African Union took decisions in July 2010 {Assembly/AU/Dec.290(XV)} and July 2011 {Assembly/AU/Dec.373(XVII)} approving the PAU concept, the thematic fields, their allocation to the five geographic regions, as well as allocation of four of the themes to four member states. Competitive technical bidding resulted in selection of specific institutions in each of the host countries, as follows:

i. Basic Sciences, Technology and Innovation (PAUSTI) hosted by Jomo Kenyatta University of Agriculture and Technology (JKUAT) in Kenya for Eastern Africa

ii. Life and Earth Sciences (including Health and Agriculture) (PAU-LESI) hosted by University of Ibadan in Nigeria for Western Africa

iii. Governance, Humanities and Social Sciences (PAU-GHSS) hosted by University of Yaoundé II in Cameroon for Central Africa

iv. Water and Energy Sciences (including climate change) (PAU-WES) hosted by University of Tlemcen in Algeria for North Africa

v. Space Sciences will be hosted in a country in Southern Africa.

In November 2012, an Interim Rectorate has taken the lead in steering and implementing the project. Meanwhile, the PAU Statutes have been approved during the January 2013 AU Summit of Heads of State and Government in Addis Ababa, Ethiopia. The project has gained tremendous momentum.

The first three PAU institutes in the East, West and Central have already been operationalized and have admitted students in a limited number of programmes during the 2012/2013 academic year.

The Pan African University's Institute on Water and Energy including Climate Change (PAUWES) will enter the academic sphere and launch two Master level programmes in the field of Water and Energy in the 2013/2014 academic year. The PAUWES Institute will be located at the University of Abou Bakr Belkaid, Tlemcen, Algeria, and will be one of the five thematic hubs constituting the Pan African University (PAU).

Work has begun on drafting PAUWES curricula. In this exercise, a group of international experts from AU member states and leading academic institutions were invited to participate in a curriculum planning process that started with a workshop at the University of Abou Bakr Belkaïd,

Tlemcen, Algeria, in September 2012. After the workshop, the Lead Coordinators were responsible for finalizing the curricula and involving additional experts as coordinators of curriculum modules, who drafted the course descriptions of the single modules.

Two interlinked curricula for Master programmes in Water and Energy Science have been developed with a number common core and elective courses. Both of the programmes contain an engineering track as well as a governance track.

The PAU Interim Rectorate in cooperation with the Commission of the African Union has scheduled a workshop to finalise and validate these selected curricula from 18th to 20th February 2013 in Addis Ababa, Ethiopia. Apart from the technical imperatives, this workshop is also designed to help build a collective appreciation of the PAU as one institution in multiple locations; and of the common PAU vision.

CONTEXT AND RATIONALE

The mission of the PAU is to exemplify excellence in African higher education, research and community services, in order to position African Higher Education as a driver for social and economic development, and attainment of Africa's collective vision - through the following functions:

1. Teaching and research at the post-graduate level in key areas

2. Developing and retaining world-class human resources in areas essential to Africa's development

3. Stimulating fundamental and applied research of the highest quality in areas critical to African technical, economic and social development

4. Supporting institutional capacity-building to enhance global competitiveness and African relevance of Africa's Higher education

5. Accelerating the exchange of research results within networks

6. Creating a distinctive African higher education space, able to attract the best resources globally, including from the African Diaspora

7. Enhancing Africa's contribution to the global knowledge economy.

The PAU represents an explicit acknowledgement by the political leadership of Africa of the indispensable place of a revitalised and re-oriented system of higher education and research in Africa's 21st century development agenda. The African university has the privileged burden of producing skilled human resources for providing public services, managing the economy and improving the livelihoods of their people; responding to development needs while also pushing the frontiers of knowledge and contributing to the global knowledge pool; enabling African nations to engage in scholarly and scientific commerce with other nations. This it cannot adequately do while still perpetrating old models, curricula and research paradigms.

For PAU to be a world-class university, it must be challenged to produce African-centered knowledge with global appeal and reach, which, together with carefully selected knowledge developed by across the globe, should form the basis of education at all levels and in all fields in Africa. It must be challenged to produce graduates of highest level and quality; skilled and knowledgeable not just in technical and scientific know-how, but also in appropriate attitudes that compel them to contribute to Africa's human resource base rather than join Africa's brain drain. It must be challenged further to derive new definitions for ourselves and by ourselves, and for global concepts in the spheres of education and knowledge production, industrialization, environmental management, politics, economic development and community services.

The organization of higher education and research in Africa will do well to depart from traditional confining silos of mono-disciplines and develop inter-disciplinary and transdisciplinary approaches that recognise the connectivity of knowledge and knowledge systems. All Africans need to posses some basic shared common knowledge about Africa and its position in the world- shared African history, geography and values. Furthermore, African education systems need to produce in all graduates a culture of creative thinking, entrepreneurship and innovation. This is necessary if knowledge and knowledge products are to meaningfully contribute to an integrated, peaceful and prosperous Africa. Linkages with society and industry need to be nurtured through the education system, to avoid the traditional practice where education seemed to alienate Africans from their communities; and where graduates have to be re-trained to be suitable for jobs in industry; where the educated and semi-literate youth together fill the growing queues of unemployed and dis-enchanted masses.

Africa is therefore on the threshold of new curriculum development paradigms that give expression to African renaissance and contribute to the collective vision: strengthening Africa's position as a generator and not only consumer of global knowledge and culture; and ensuring that the products of Africa's education system are relevant concerning the kind of society we want, the development vision and the employment market.

In the process of developing the PAU curricula, conversation will be engaged with the corporate sector, industry and civil society. It is not enough to have a curriculum comparable to the best in the world if the graduates will be alienated from their society. It is therefore important to ensure that for the PAU, there is a common vision to guide every PAU programme, process and activity. The PAU will also need to create a distinctive 'brand' that demonstrates the attractiveness and added value of this institution. This is necessary if PAU is to attract the best human and other resources from around the world, and be sought after by young African intellectuals. It is the branding that will also serve to attract corporate/private sector involvement in PAU programmes.

Issues that need to be taken into account in curriculum development therefore include the following:

1. Relevance to Africa's development vision, and to the needs and opportunities offered in the corporate and social sector for innovation, employment and job creation

2. Improved contribution of higher education institutions to education quality enhancement, particularly teacher education and curriculum and educational materials development

3. The promotion of generic and subject specific competences to ensure employability of the graduates

4. The promotion of endogenous knowledge production and management

5. The pan African dimension of the PAU

6. The development of dialogue, networks, cooperation, collaboration and partnerships between African Higher Education and public, civil society and corporate sectors;

7. The building of partnerships and networks among African institutions and organizations, and with those in the South and North

8. Improvement of institutional leadership, including management and governance of institutions

9. Building inter-disciplinarity across subjects to produce well-rounded citizens.

It is also important to keep in mind the broad issues of mutual recognition of qualifications, credit transfer and collective benchmarking for quality assurance.

This includes, *inter alia*:

1. Ensuring articulation, both horizontal and vertical, between programs and institutions offering similar programs

2. Establishing benchmarks for curricula, program delivery and equivalences

3. Coordination of the management of mechanisms essential to accreditation and mutual recognition of diplomas to facilitate comparability and compatibility

4. Agreements around recognition of prior learning.

I – Identification of the Master

1 – Localisation :

Faculty (or Institute) : Panafrican Institute of water and Energy (inc Climate Change)
Departement : Water
Section :

2 – Coordinators :

- Head of education domain team:

(Professor or Associate Professor) :

Full name: **Abdelhamid Hadjoui**
Degree: **Professor**
☎ : **043 28 56 85** Fax : **043 28 56 85** E - mail : hadjoui_ab@yahoo.fr
Enclose a brief CV in Appendix (maximum 3 pages)

- Head of education branch team

Full name: **Benseddik Madani**
Degree: **Professor**
☎ : **043 28 56 85** Fax : **043 28 56 85** E - mail : m_bessedik@mail.univ-tlemcen.dz
Enclose a brief CV in Appendix (maximum 3 pages)

- Head of education speciality team

Full name: **Cherki Brahim**
Degree: Professeur
☎ : 0773415166 Fax : 043 28 56 85 E - mail : b.cherki@gmail.com
Enclose a brief CV in Appendix (maximum 3 pages)

3- Partners *:

- **Algerian Academic partners :**
  - U. Tlemcen, USTO, U. MOstaganem, U. Mascara, U. Bechar, USTHB, ENP, U. Adrar.
  - Other Algerian Universities.

- International Partner:

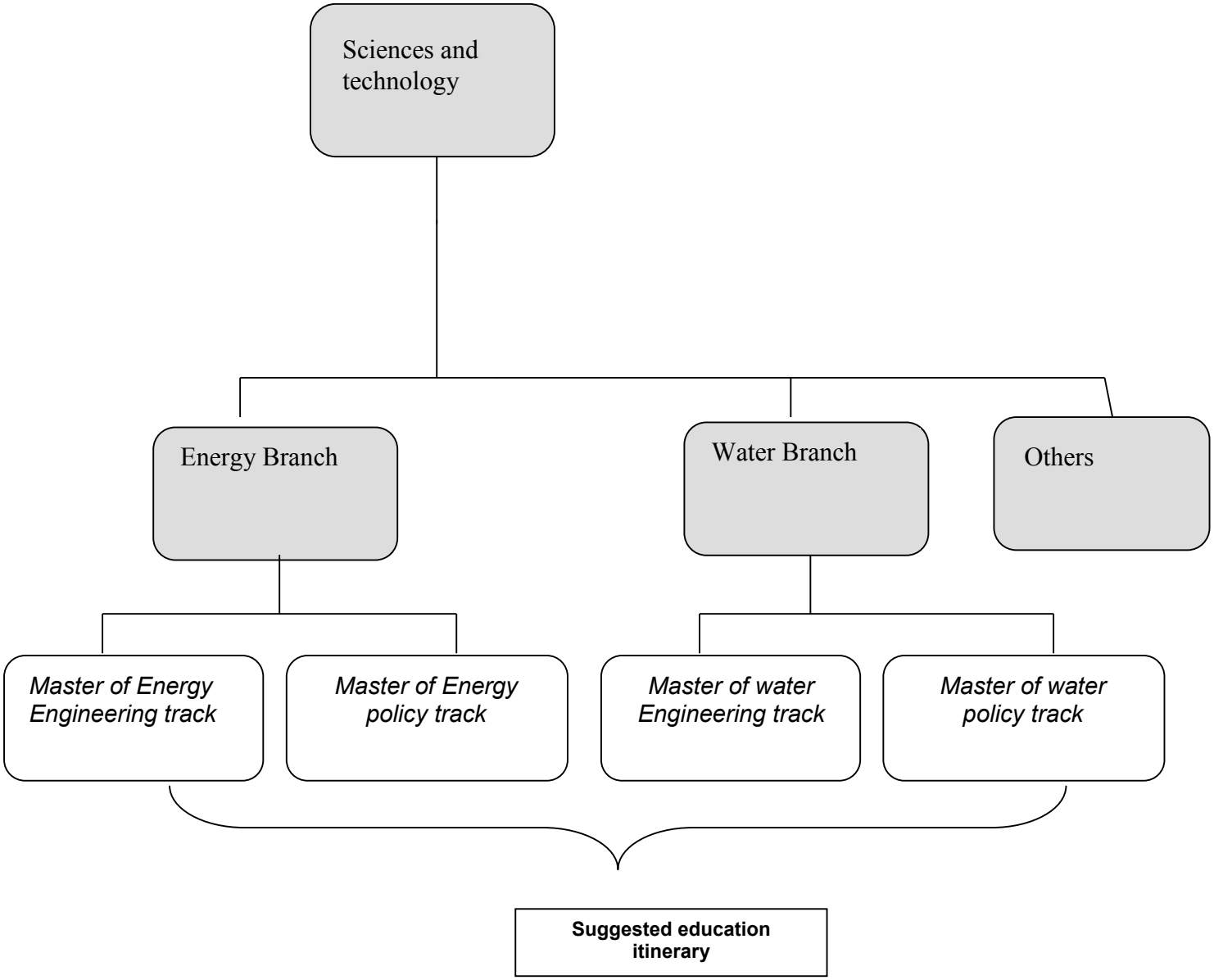
- AUC (African Union Commission for Human Ressources, Science and Technology)
- GIZ (German Technical cooperation),
- DAAD (German Academic Exchange Service).

4 – Context and objectives of the training

A – General organization of the training: Position of the project

If several masters are already proposed or supported at the establishment level (same team training or other training teams), enter in the following diagram, the position of the project as compared to other education itinerary.

Due to the particularity of the African Institute of Energy and water under the authority of the African university and subject to the Algerian higher education rules, the architecture of the suggested itinerary does allow a bridge only between suggested itineraries of energy and water divisions within the Pan-African Institute for Energy and water.



B – Admission requirements *(indicate the type of license specialty, which can give access to education, offered Master)*

The Master of Science in Water Engineering is open to all candidates with disciplinary background in science, engineering or related fields.

Candidates should have license degree or equivalent diploma and they will be selected by an international selection committee.

C – Objectives of the Master *(competencies targeted, knowledge acquired after the training, maximum 20 lines)*

The Master in Water Engineering aims to give practical and academic training in advanced areas of water and its management in a vision of a sustainable development. This training can provide all the information needed to monitor this field of knowledge. It also gives the ability to operate, exploit and save water resources. This training is dedicated to both, students motivated by research and development projects in the water sector, and to students interested in the agricultural and industrial sectors.

D – Profiles and targeted competencies *(maximum 20 lines):*

At the end of this Master course, the candidate should be able to:

1. Design Projects in water fields: Study, Realization, Exploitation, Safety and Standards, Economic evaluation, etc...
2. Deal with Water management.
3. Evaluate Different Aspects related to the environmental impact (climate change, pollution, dryness, etc) of the water system.
4. Integrate scientific research programs.

E- Development prospects for the regional and national employability

- Companies working in the water field in Africa.
- Agriculture and different Industries involving water in their processes (food, chemical, and almost all industrial fields).
- Consultancy relating to water (wastewater treatment, drinking water system, etc...) and their impact on the environment.

F – Post studies: links and possible orientation

Due to the particularity of the African Institute of Energy and water including climate change, under the authority of the African university and subject to the Algerian higher education rules, the architecture of the suggested itinerary does allow bridges only between suggested itineraries of energy and water divisions within the Pan-African Institute. Students enrolled in the PAUWES can switch to other similar specialties within other Universities in Africa.

G – Indicators for monitoring project

- Quality of courses contents– Evaluation sheet Student/teacher of the course
- Success rate of students.
- IT resources and educational platform
- Internship and employability rate and enterprises feedback
- Selection rate of student during admission

5 – Human Resources

A : Supervising potential (expressed as the number of students that can be take charge) : **20**

B : Supervising team :

B-1 : Internal team : All the following positions are open to an international application.

Field	Degree	Rank	Type of intervention *
Long term positions			
Professor and Chair in Integrated Water Resource Management	**PhD**	TO BE IDENTIFIED AFTER RECRUITMENT	Lectures + Tutorials + thesis Supervising
Lectureship in Water Policy	**PhD**		Lectures + Tutorials + thesis Supervising
Lectureship in Water Engineering	**PhD**		Lectures + Tutorials + thesis Supervising
Lectureship in Sanitation and Water Treatment	**PhD**		Lectures + Tutorials + thesis Supervising
Lectureship in Water for Agriculture	**PhD**		Lectures + Tutorials + thesis Supervising
Lectureship in Methods of Water Engineering	**PhD**		Lectures + Tutorials + thesis Supervising

Short term positions			
African History	**PhD**	TO BE IDENTIFIED AFTER RECRUITMENT	Lectures+ Tutorials
Human Rights and Gender	**PhD**		Lectures+ Tutorials
Academic Writing	**PhD**		Lectures+ Tutorials
Communication, Marketing, and Networking	**PhD**		Lectures+ Tutorials
Project Design and Management	**PhD**		Lectures+ Tutorials
Entrepreneurship and Intrapreneurship	**PhD**		Lectures+ Tutorials
Hydrogeology	**PhD**		Lectures+ Tutorials
Water Economics	**PhD**		Lectures+ Tutorials

*** = Lectures, tutorial (TD), Practical work (TP), Supervising of training, Supervising of thesis project, others**

B-2 : External team :

The external courses could be ensured by invited professors from Algerian universities, African universities and from other partners.

B-3: Synopsis of human resources:

Rank	Internal	External	Total
Professors	**6**	**3**	**9**
Associate Professor			
Senior lecturer			
Lecturer			
Assistant lecturer			
Other (short term lecturers)	**8**		**8**
Total	**14**	**3**	**17**

B-4 : Permanent Staff support (indiquer les différentes catégories)

Rank	Number
Laboratory Engineer	2
Laboratory Technician	5

6 – Facilities, equipments and laboratories

The laboratories and the list of equipment, given hereafter, were identified by the GIZ experts and university of Tlemcen staff.

A- Pedagogical laboratories and Equipments: Sheet existing educational facilities for the training envisaged PW (1 sheet per laboratory)

Name of laboratory: Hydraulics and fluid mechanics

Maximal number of students: 10

N°	Equipment	Number	observations
01	Ultra Sonic Flow Through		
02	Flow Through (magnetic-inductive) system		
03	Ultrasonic bath		
04	Vortex-Shaker		
05	Shaker		
06	Flow Cell		
07	Pressure probes		
08	Mini-Propeller		
09	Transport cart		

Name of laboratory: Water quality analysis

Maximal number of students: 10

N°	Equipment	Number	observations
01	Mobile Fiber optics Fluorometer for trace measurements		
02	Spectrophotometer and thermostat		
03	Gas chromatograph (GC-FID/ECD)		
04	Programmable Sampler		
05	TurboVap II / Workstation		
06	All systems include auto sampler, pumps, computer if applies, programs, etc.		
07	Ion chromatograph		
08	Digital Timer		
09	AutoTrace		
10	Expert Plus 2 / Tool Box		
11	pH Measuring Instrument and electrodes		
12	portable oxygen-meter with electrode		
13	Redox measuring instruments		
14	Conductivity Meter		
15	Turbidity Meter		
16	Data Logger for pH, Redox and Conductivity		

Name of laboratory: Waste Water treatment technologies

Maximal number of students: 10

N°	Equipment	Number	observations
01	BOD determination		
02	Sedimentation Cones		
03	Centrifuge with Accessories		
04	Floc Tester 6 places		
05	Autoclave		
06	TOC		
07	Flow Injection Analysis (PO4, NO3-, NO2-, NH4+)		
08	Rotary Evaporator		
09	Magnetic Stirrer		
10	Carbolite AAF11/3 / Muffle Furnace		
11	Test Sieves		
12	Drying Cabinet		
13	Cooling Circulator		
14	Microwave Digestion		
15	Ultra Pure Water System		

Name of laboratory: Water in agriculture

Maximal number of students: 10

N°	Equipment	Number	observations
01	Test field for irrigation and soil tests		
02	GPS Equiment		
03	Meteorological Station		
04	Field Storage Equipment		
05	Field Fluorometer		
06	Field Equipment		
07	Field Photometer Hach		
08	Drainage Measurement		
09	Survey Equipment		
10	Cable, Pipes and Accessories		
11	MP1 / Immersion Pump		
12	SP14 / Immersion Pump		
13	150 m Frame for drilling equipment and pumps		

Name of laboratory: Hydrology, hydrogeology and soil mechanics

Maximal number of students: 10

N°	Equipment	Number	observations
01	Test field for hydrology and practical Hydrogeology		
02	Generator		
03	AC generator		
04	Frequency transformer		
05	Portable Multimeter		
06	Electric contact gauge		
07	Sampler surface water		
08	Vacuum Pump system & Vacuum Filtration		
09	Vacuum Pump		
10	Tubes, connection kit for above pumps		
11	Peristaltic Pump		

Name of laboratory: Computer lab

Maximal number of students: 20

N°	Equipment	Number	observations
01	PC	10	

B- Land internship and career enterprise:

Place of land internship	Capacity of students	Duration of internship

C- Research Laboratories to support the proposed training:

Responsible of laboratory: **Professor Ghomari Fouad**
Laboratory accreditation ref :
Date : Advice of laboratory head:

D- Research projects to support the training proposed:

Title of research project	Ref	Duration of project	
		Starting date	Ending date

E- Documentation facilites:

Common space of the university of Tlemcen (central library of the university, library of the faculty).

F- Personal Working space and ICT:

Center of e- learning, IT space of the university.

II – Organization of the semesters teaching

(Please submit the records of 4 semesters)

1- Semester 1:

Teaching unit	Load per semester Volume	Load per Week				Coefficient	ECTS	Evaluating mode	
		Lectures	Tutorials	Practical Class	Personal Work			Tutorials	Practical Class
Fundamental Unit									
African and Global Context									
African Water Resources and Scenarios	45	1,5		1,5	3	2	4	*	*
Water Flow Engineering									
Fluid Mechanics	45	1,5		1,5	3	2	4	*	*
Hydrology	45	1,5		1,5	3	3	5	*	*
Water Quality and Sanitation									
Water Quality	45	1,5		1,5	3	2	4	*	*
Management of Water Resources									
Introduction to Integrated Water Resource Management	45	1,5		1,5	3	2	4	*	*
Methodological Unit									
Research and Project Management									
Project Design and Management	30	1,5		0,5	2	2	3	*	*
Discovery Unit									
African and Global Context									
African History	45	3			3	2	4	*	*
Transversal Unit									
Skills									
Academic Writing	22,5	1,5			3	1	2	*	*
Total Semester 1	322,5	13,5	0	8	23	16	30		

2- Semester 2:

Teaching unit	Biannual Hourly Volume	Weak Hourly Volume				Coefficient	ECTS	Evaluating mode	
	14-16 weeks	Lectures	Tutorials	Practical Class	Personal Work			Tutorials	Practical Class
Fundamental Unit									
Water Flow Engineering									
Hydraulics	45	1,5		1,5	3	3	5	*	*
Hydrogeology	45	1,5		1,5	3	3	5	*	*
Water Quality and Sanitation									
Sanitation and Water Treatment	67,5	1,5	1,5	1,5	4,5	3	6	*	*
Management of Water Resources									
Soil Conservation	45	1,5		1,5	3	3	5	*	*
Methodological Unit									
Research and Project Management									
Research Methods for Water Engineering	30	1,5		0,5	2	2	3	*	*
Discovery Unit									
African and Global Context									
Human Rights and Gender	45	3			3	2	4	*	*
Transversal Unit									
Skills									
Communication, Marketing,and Networking	22,5	1,5			2	1	2	*	*
Total Semester 2	300	12	1,5	6,5	20,5	17	30		

3- Semester 3:

Teaching unit		Biannual Hourly Volume	Weak Hourly Volume				Coefficient	ECTS	Evaluating mode	
		14-16 weeks	Lectures	Tutorials	Practical Class	Personal Work			Tutorials	Practical Class
Fundamental Unit										
Management of Water Resources										
Water Economics		67,5	1,5	1,5	1,5	4,5	3	6	*	*
Management of Water Uses (AoC)										
E: Water for Agriculture 1: Irrigation Techniques and Drainage	**Electives courses**	45	1,5		1,5	3	3	5	*	*
E: Water for Agriculture 2: Irrigation Project Design		45	1,5		1,5	3	3	5	*	*
E: Water Quality and Sanitation 1: Water Quality and Environmental Health		45	1,5		1,5	3	3	5	*	*
E: Water Quality and Sanitation 2: Networks versus Decentralized Solutions		45	1,5		1,5	3	3	5	*	*
E: River Basin Management 1: Management of Extremes (Draughts and Flooding)		45	1,5		1,5	3	3	5	*	*
E: River Basin Management 2: Management of Transboundary Water Resources		45	1,5		1,5	3	3	5	*	*
Methodological Unit										
Methods and Tools										
Physical Instrumentation and Measurement		45	1,5		1,5	4	2	4	*	*
Applied Numerical Analysis and Modeling		45	1,5		1,5	4	2	4	*	*
Discovery Unit										
Methods and Tools										
Geographical Information Systems		45	1,5		1,5	4	2	4	*	*
Transversal Unit										
Skills										
Entrepreneurship and Intrapreneurship		22,5	1,5			3	1	2	*	*
Total Semester 3		315	10,5	1,5	9	25,5	16	30		

E: Elective courses, the student must select 2 courses among the 6 proposed

4- Semester 4:

Field : Science and technology
Trach : Master of Science (MSc) in Water
Specialty : Engineering

Internship attested by a memory and a defense: Thesis

	VHS	Coeff	Crédits
Personal work	375h	14	14
Internship in enterprise or research entity	75h	10	10
Seminars	15h	6	6
Others (to precise)			
Total Semester 4	465h	30	30

5- Summary:

TU / VH	FUT	MTU	TTU	DTU	Total
Lectures	270	90	67,5	112,5	540
Tutorials	45	0	0	0	45
Practical class	270	60	0	22,5	352,5
Personal work	585	180	120	150	1035
Others: Thesis	375	75	0	15	465
Total	1545	405	187,5	300	24 37,5
Credits	72	24	6	18	**120**
% credits for each TU	60%	20%	5%	15%	100%

- **Recommendations of regional conference**

III – Organization of teaching units

(One table for each unit)

Name of teaching unit: African and Global Context
Track: Engineering
Specialty: Master in Water
Semester: 1

Total hourly volume distribution of the TU and its modules	Courses (lectures) : 22,5h Tutorial : Practical classes : 22,5h Personal Work or contribution : 45h
Coefficients and credits allocated to the EU and its modules	**FU1-1 : African and Global Context** credits: 4 Module 1 : African Water Resources and Scenarios Credits : 4 Coefficient : 2
Evaluation mode	final exam, term paper and problem sets
Descriptive of modules	**African Water Resources and Scenarios:** The course confers knowledge about • the African water resources and their characteristics and their uses, • the range of issues African countries face when dealing with their water resources • the policy approaches developed to deal with the issues and the various plans to improve their use and situation and • the range of relevant climate change and socio-economic scenarios and their effect on African water resources and their use. Students will be qualified • to analyse the typical constellations of African water resources and their uses, • to identify the issues resulting from these constellations • to assess the existing and proposed policy options qualitatively with respect to their adequacy given the existing societal objectives, under the variations due to the water scenarios.

Name of teaching unit: Water Flow Engineering
Track: Engineering
Specialty: Master in Water
Semester: 1

Total hourly volume distribution of the TU and its modules	Courses (lectures) : 45h Tutorial : Practical Classes: 45h Personal Work or contribution : 90h
Coefficients and credits allocated to the EU and its modules	**FU1-2 : Water Flow Engineering** credits: 9 Module 1 : Fluid Mechanics Credits : 4 Coefficient :2 Module 2 : Hydrology Credits : 5 Coefficient : 3
Evaluation mode	problem sets, quizzes, mid-term exam , final exam; homework assignments, field report
Descriptive of modules	**Fluid Mechanics:** The teaching of this course is to enable students to understand the various theories of fluid mechanics. **Hydrology:** • Understand the basic principles of river hydrology and hydraulic processes • Understand the concepts of hydrology and gain an understanding of hydrological methods used in Waters resources management, • mastering of the statistical analysis of hydrological data • understand the concepts of modeling in hydrology and learning.

Name of teaching unit: Water Quality and Sanitation
Track: Engineering
Specialty: Master in Water
Semester: 1

Total hourly volume distribution of the TU and its modules	Courses (lectures) : 22,5h Tutorial : Practical Classes: 22,5h Personal Work or contribution : 45h
Coefficients and credits allocated to the EU and its modules	**FU1-3 : Water Quality and Sanitation** credits: 4 Module 1 : Water Quality Credits : 4 Coefficient : 2
Evaluation mode	final exam, homework assignments, lab report, participation
Descriptive of modules	**Water Quality and Sanitation:** • To understand the types of organic and inorganic substances of natural and anthropogenic origin that are present in natural water, drinking water, municipal and some types of industrial wastewater. • To understand the physical and chemical processes that occur when those waters are used, mixed with other waters, or interact with soil, sediments, atmosphere and infrastructure. • To get an overview of the role of microorganisms in natural and anthropogenic environments, understand microbial diversity of aquatic ecosystems and aquatic nutrient cycles. • To get an overview of symptoms, pathways of transmission, disease burden and prevention of major water born diseases. • To understand health and environmental risks caused by natural or anthropogenic contaminants and get to know basics of microbial interactions with humans with focus on water borne pathogens. • To understand the principles and being able to use most important analytical methods for the determination of chemical compounds present in water samples and get practical experience with basic experimental working techniques used in microbiology.

Name of teaching unit: Management of Water Resources

Track: Engineering
Specialty: Master in Water
Semester: 1

Total hourly volume distribution of the TU and its modules	Courses (lectures) : 22,5h Tutorial : Practical Classes: 22,5h Personal Work or contribution : 45h
Coefficients and credits allocated to the EU and its modules	**FU1-4 : Management of Water Resources** credits: 4 Module 1 : Introduction to Integrated Water Resource Management Credits : 4 Coefficient : 2
Evaluation mode	final exam, homework assignments, lab report, participation
Descriptive of modules	**Introduction to Integrated Water Resource Management:** • To understand the overall processes involved in IWRM beginning with data collection, data analysis, system description, and then moving to consensus building, communications, education, monitoring and assessment • To provides a brief historical background and overview of IWRM and gives an overview of the various aspects of IWRM, from integration, capacity building to applications and case studies • To identify relevant aspects of IWRM in hydrologically sensitive regions • To develop innovative concepts, methods and technologies • To be able through modelling and system analysis as basis to investigate and implement IWRM initiatives

Name of teaching unit: Research and Project Management
Track: Engineering
Specialty: Master in Water
Semester: 1

Total hourly volume distribution of the TU and its modules	Courses (lectures) : 22.5h Tutorial : Practical Classes: 7,5h Personal Work or contribution : 30h
Coefficients and credits allocated to the EU and its modules	**MU1 : Research and Project Management** credits: 3 Module 1 : Project Design and Management Credits : 3 Coefficient : 2
Evaluation mode	Case study, Group work, Written final examination
Descriptive of modules	**Project Design and Management:** • Conducting in-depth analysis of geographical, environmental, political, and institutional landscape of a development challenge • Selection and identification of appropriate projects/ interventions for addressing the challenges • Ability to facilitate collaborative and participatory approaches to project design and knowledge of commonly used techniques such as SWOT analysis, stakeholder mapping and problem and objective analysis • Ability to collate and synthesize relevant information into a logical and cohesive project proposal; • Ability to develop and implement effective work plans for project staff and participants • Ability to integrate knowledge gained from monitoring and evaluation systems into the project design and revision of project objectives or activities • Ability to analyse projects by working with spreadsheets, and understand the risks inherent in the projects and develop risk management measures • Use of commercial project management software packages and an appreciation of their limitations.

Name of teaching unit: African and Global Context
Track: Engineering
Specialty: Master in Water
Semester: 1

Total hourly volume distribution of the TU and its modules	Courses (lectures) : 45h Tutorial : PW: Personal Work or contribution : 45h
Coefficients and credits allocated to the EU and its modules	**DU1 : African and Global Context** credits: 4 Module 1 : African History Credits : 4 Coefficient : 2
Evaluation mode	Written exam, Seminar Presentations, Research Essay, Research Paper
Descriptive of modules	**African history:** At the end of the course, a student are expected to: • understanding African historical experiences and realities; • demonstrate knowledge of indigenous Africa; • demonstrate good understanding of the impact and role of imperial global designs on Africa; • To demonstrate critical oral and written communication skills necessary in articulation of African and pan-African issues; • Apply relevant theoretical tools in interrogating the African reality; • To demonstrate a good grasp of historically- informed strategies of solving current African problems and challenges.

Name of teaching unit: Skills
Track: Engineering
Specialty: Master in Water
Semester: 1

Total hourly volume distribution of the TU and its modules	Courses (lectures) : 22,5h Tutorial : Practical Classes: Personal Work or contribution : 45h
Coefficients and credits allocated to the EU and its modules	**TU1 : Skills** credits: 2 Module 1 : Academic Writing Credits : 2 Coefficient : 1
Evaluation mode	Written Assignments
Descriptive of modules	**Academic Writing:** This course will introduce students to the standards and the practice of academic writing. After successful participation in the course students will be able to: • Structure academic texts • Apply the standards of academic writing in their respective fields • Apply best practices of writing style (in technical subjects) • Apply different standards for citation and references

Name of teaching unit: Water Flow Engineering
Track: Engineering
Specialty: Master in Water
Semester: 2

Total hourly volume distribution of the TU and its modules	Courses (lectures) : 45h Tutorial : Practical Classes: 45h Personal Work or contribution : 90h
Coefficients and credits allocated to the EU and its modules	**FU2-1 : Water Flow Engineering** credits: 10 Module 1 : Hydraulics Credits : 5 Coefficient : 3 Module 2 : Hydrogeology Credits : 5 Coefficient : 3
Evaluation mode	homework assignments, quizzes, mid-term exam, final exam, field report
Descriptive of modules	**Hydraulics:** The course is designed to give the engineering student a solid understanding of hydraulics (open channel hydraulics and flows under pressure), particularly in steady, gradually varied flow, and a basis for the design of free surface systems. After attending this course, a student will be able to describe the various types of flows in open channels, the velocity distribution across and along the channel and hydraulic jumps. Technical lecture (Flows Under Pressure) uses modelling: concepts and methods of computational assisted design are widely used in the projects. Teaching is focused on acquiring or updating knowledge of basic hydraulics lectures include, tutorials, visits and especially technical projects (case studies based on solving real and complex problems). **Hydrogeology:** This course is aimed at providing the student with a comprehensive introduction to the most important topics in groundwater hydrology/hydrogeology. The teaching

	format consists of the presentation of key concepts followed by problem-solving and laboratory practice. This course will prepare students to analyze ground-water flow processes taking into account aquifer properties, basic hydraulic factors, geologic controls, and their temporal and spatial interactions. Mastery of concepts relies on quantitative analysis. Upon completion of the course the student should be able to: • Explain basic water chemical & physical parameters; • Distinguish between confined & unconfined aquifers from data; • Draw groundwater flow nets to scale from provided data; • Apply Darcy's Law to groundwater flow and geological material interpretation; • Use & interpret pumping data for groundwater flow applications; • Distinguish between continuous and discontinuous media • Plot & interpret Ternary & Piper Diagrams for water quality analysis. • Use proper sampling & water analytical techniques for water quality analysis

Name of teaching unit: Water Quality and Sanitation
Track: Engineering
Specialty: Master in Water
Semester: 2

Total hourly volume distribution of the TU and its modules	Courses (lectures) : 22,5h Tutorial : 22.5h Practical Classes: 22,5h Personal Work or contribution : 67,5h
Coefficients and credits allocated to the EU and its modules	**FU2-2 : Water Quality and Sanitation** credits: 4 Module 1 : Sanitation and Water Treatment Credits : 4 Coefficient : 2
Evaluation mode	participation, quizzes, field report, presentation and final paper
Descriptive of modules	**Sanitation and Water Treatment:** *Drinking Water Treatment* • To understand global and African situation in regard to the issues of water resources and drinking water and its relation to health, resource conservation and environmental protection • To know scientific, technical and engineering principles of drinking water abstraction, distribution and use and factors affecting their efficiency, costs, sustainability and acceptability • To understand centralized, decentralized and household water treatment systems including desalinisation and being able to plan simple reliable concepts considering local socio-cultural conditions and local availability of human and material resources • To be able to critically evaluate alternative solutions considering multiple criteria • To be able to critically evaluate sustainability of existing projects and apply sustainability principles to planning of the new projects • To understand the sector development policy and the role of African states and multilateral organizations

	Sanitation • To understand global and African situation in regard to the issues of excreta, wastewater and solid waste disposal and comprehend the connection between these processes and health, resource conservation and environmental protection • To know technical fundamentals and principles of operation of major technologies and processes of liquid and solid waste disposal relevant to rural and urban areas in Africa and being able to critically evaluate them considering multiple criteria • To get insight in new developments of sanitation technologies and concepts that aim at protecting and conserving resources. • To learn the concept of community participation and its role in enabling successful implementation of a project and its sustainability on a long term. • To understand social and cultural aspects as well as equity principles and their implications to environmental sanitation planning. • To understand the sector development policy and the role of African states and multilateral organizations

Name of teaching unit: Management of Water Resources
Track: Engineering
Specialty: Master in Water
Semester: 2

Total hourly volume distribution of the TU and its modules	Courses (lectures) : 22,5h Tutorial : Practical Classes: 22,5h Personal Work or contribution : 45h
Coefficients and credits allocated to the EU and its modules	**FU2-3 : Management of Water Resources** credits: 5 Module 1 : Soil Conservation Credits : 5 Coefficient : 3
Evaluation mode	final exam, term paper and problem sets
Descriptive of modules	**Soil Conservation:** The course confers knowledge about • the issues facing soil erosion and sedimentation, their determinants and modelling, • the land use and technical options to control and the socio-economic factors influencing soil erosion and sedimentation and • their implications for water storage, for the nutrient and carbon processes in soil and water so that students will understand them. The students will be qualified • to analyse the individual and collective decision-making processes on the farm and watershed level influencing soil and water conservation in the African context, • to derive policy proposals to solve problems related to soil and water conservation reform and to assess existing policy and • to assess the quality of related scientific research and assess research gaps. Furthermore the students will be qualified • to judge the problems and the perspectives for the improvement of the status of national policies and projects related to soil and water conservation in African countries, • to perform well as a water professional on a national level, in international organizations and as consultants.

Name of teaching unit: Research and Project Management
Track: Engineering
Specialty: Master in Water
Semester: 2

Total hourly volume distribution of the TU and its modules	Courses (lectures) : 22.5h Tutorial : Practical Classes: 7,5h Personal Work or contribution : 30h
Coefficients and credits allocated to the EU and its modules	**MU2 : Research and Project Management** credits: 3 Module 1 : Research Methods for Water Engineering Credits : 3 Coefficient : 2
Evaluation mode	Case studies, Group work, Research proposal
Descriptive of modules	**Research Methods for Water Engineering:** - Introduction to research methods: - Designing Idea in Research (Questions and Hypothesis, Qualitative and quantitative methods - Data collection and Analysis : - Design and Structures of experiments - Research and Strategies - New generation of instruments and tools: - Writing Strategies and Ethical Considerations Validation of results and marketing strategy: publication, visibility, patenting, innovation and technological transfer

Name of teaching unit: African and Global Context
Track: Engineering
Specialty: Master in Water
Semester: 2

Total hourly volume distribution of the TU and its modules	Courses (lectures) : 45h Tutorial : PW: Personal Work or contribution : 45h
Coefficients and credits allocated to the EU and its modules	**DU2 : African and Global Context** credits: 4 Module 1 : Human Rights and Gender Credits : 4 Coefficient : 2
Evaluation mode	Written Exam and Continuous assessment
Descriptive of modules	**Human Rights and Gender:** Student will be able: • to identify human rights issues • to address human rights issues • Assess the effectiveness of various forms of addressing human right issues • By the end of the course the learner will: • be able to appreciate fundamental and contemporary theories of gender • be able to relate development scholarship to contemporary gender realities and issues • be well acquainted with the various skills for critical analyses of the role of gender in development

Name of teaching unit: Skills
Track: Engineering
Specialty: Master in Water
Semester: 2

Total hourly volume distribution of the TU and its modules	Courses (lectures) : 22,5h Tutorial : Practical Classes: Personal Work or contribution : 30h
Coefficients and credits allocated to the EU and its modules	**TU2 : Skills** credits: 2 Module 1 : Communication, Marketing,and Networking Credits : 2 Coefficient : 1
Evaluation mode	Written reports, oral presentations, written examination
Descriptive of modules	**Communication, Marketing,and Networking:** Introduction to networking. Why network. Types of networks: social, professional and business networks, use of social media and ICT. Sources of contacts for networking. Face-to-face and electronic networking, donor supported and self-sustaining networks, voluntary, membership and profit-making networks. Typical weaknesses and strengths, dos and don'ts, managing expectations, sustainability, institutional issues in networking.

Name of teaching unit: Management of Water Resources
Track: Engineering
Specialty: Master in Water
Semester: 3

Total hourly volume distribution of the TU and its modules	Courses (lectures) : 22,5h Tutorial : 22.5h Practical Classes: 22,5h Personal Work or contribution : 67,5h
Coefficients and credits allocated to the EU and its modules	**FU3-1 : Management of Water Resources** credits: 6 Module 1 : Water Economics Credits : 6 Coefficient : 3
Evaluation mode	final exam, final paper and problem sets
Descriptive of modules	**Water Economics:** The course confers knowledge about • the economic principles and economic tools applicable to water policy issues pertaining to water resources issues prevalent in African countries and • the determinants of water demands and water supply projects for storage and bulk conveyance. The students will be qualified • to apply the economic tools to specific problems in the African context, • to derive policy proposals to solve water resource related problems and to assess existing policy proposals and • to assess the quality of related scientific research and assess research gaps. Furthermore the students will be qualified • To judge the problems and the perspectives for the improvement of the status of national water policies and projects in African countries, • To perform well as a water professional on a national level, in international organizations and as consultants.

Name of teaching unit: Management of Water Uses (AoC)
Track: Engineering
Specialty: Master in Water
Semester: 3

Total hourly volume distribution of the TU and its modules	Courses (lectures) : 45h Tutorial : Practical Classes: 45h Personal Work or contribution : 90h
Coefficients and credits allocated to the EU and its modules	**FU3-2 : Management of Water Uses (AoC)** credits: 10 Module 1 : E: Water for Agriculture1: Irrigation Techniques and Drainage Credits : 5 Coefficient : 3 Module 2 : E: Water for Agriculture 2: Irrigation Project Design Credits : 5 Coefficient : 3 Module 3 : E: Water Quality and Sanitation1: Water Quality and Environmental Health Credits : 5 Coefficient : 3 Module 4 : E: Water Quality and Sanitation 2: Networks versus Decentralized Solutions Credits : 5 Coefficient : 3 Module 5 : E: River Basin Management 1: Management of Extremes (Draughts and Flooding) Credits : 5 Coefficient : 3 Module 6 : E: River Basin Management 2: Management of Transboundary Water Resources Credits : 5 Coefficient : 3
Evaluation mode	Quizzes, final paper (based on project), presentation.

Descriptive of modules	**Water for Agriculture1: Irrigation Techniques and Drainage:** The goal of the drainage course is to provide learners with the knowledge and skills required to assess, plan and design agricultural surface and sub-surface drainage works. At the completion of the course the students should be able to: • Understand crop water needs; • Manage soil moisture to promote desired crop response; • Evaluate irrigation; • Optimize the use of available water supplies; • Minimize irrigation induced erosion; • Decrease non-point source pollution of surface and groundwater resources; • Manage salts in the crop root zone; • Choose the appropriate and effective techniques of irrigation to the crop. • understand tile drainage design. • Design, test, and analyze agricultural irrigation systems and their components (gravity irrigation, sprinkler irrigation, trickle irrigation). **Water for Agriculture 2: Irrigation Project Design :** At the end of this course, the student should be able to study a full irrigation project namely collecting the data and information necessary for the project, design and sizing of all components of the irrigation system, the estimate of the cost, the benefits and environmental impact assessment of the project. **Water Quality and Sanitation1: Water Quality and Environmental Health:** The course objective is to understand the emissions and transport pathways of point and diffuse pollution from urban areas, agriculture and geogenic sources into the aquatic environment. Furthermore, transport, retention and degradation processes within the receiving water bodies will be introduced. Students will learn to view water bodies (for example:river basins) as integrated systems and how to analyse, quantify and evaluate the sources of pollution as a basis for the planning of mitigation measures. Students will be able to choose the right treatment technology for a given sanitation problem.

	Water Quality and Sanitation 2: Networks versus Decentralized Solutions: The students will learn the main principles of the design of water networks for water supply and waste respectively storm water collection. Based on water flow) they will be able to use the knowledge of design of centralized systems. Compared to the centralized solutions the students will be confronted with alternative decentralized options. **River Basin Management 1: Management of Extremes (Draughts and Flooding):** The course confers knowledge that students will understand • The causes and occurrences of droughts and floods under the different African climate regimes and river basins • The hydrology and hydraulics of extremes • The role of the watershed • The effect on the affected population and the resulting damages • The technical and land use related options to minimize the effects. The students will be qualified • To assess the risks of extremes for a given African river basin • To assess the existing approaches of dealing with the extremes by the local population • To evaluate governmental options to further reduce the risks of extremes from a technical. Economic and social perspective. **River Basin Management 2: Management of Transboundary Water Resources:** This course aims to • develop an understanding of the challenges encountered in managing transboundary water resources especially in africa, • knowledge of legal principles upon which transboundary management of water resource is based, • approaches and methods for managing transboundary water resources, • to identify and evaluate twr management problems, and propose possible solutions.

Name of teaching unit: Methods and Tools
Track: Engineering
Specialty: Master in Water
Semester: 3

Total hourly volume distribution of the TU and its modules	Courses (lectures) : 45h Tutorial : Practical Classes: 45h Personal Work or contribution : 120h
Coefficients and credits allocated to the EU and its modules	**MU3 : Methods and Tools** credits: 8 Module 1 : Physical Instrumentation and Measurement Credits : 4 Coefficient : 2 Module 2 : Applied Numerical Analysis and Modeling Credits : 4 Coefficient : 2
Evaluation mode	lab report, final exam (take-home)
Descriptive of modules	**Physical Instrumentation and Measurement:** The goals of the course are to better make measurements, understand the physical principals of the parameters and to use those measurements in any research project to: better evaluate their use and their spatial variability, to make better use of them in the evaluation, planification or in the management of water. **Applied Numerical Analysis and Modeling:** • Provide the student with an understanding of the basic concepts, computer implementation and water models; • Guide the student in developing a critical eye for computational matters; • Impart the basic skills needed to use finite element method to solve numerical problems • Skills in applying methods to predict applied situations

Name of teaching unit: Methods and Tools
Track: Engineering
Specialty: Master in Water
Semester: 3

Total hourly volume distribution of the TU and its modules	Courses (lectures) : 22,5h Tutorial : PW: 22,5h Personal Work or contribution : 60h
Coefficients and credits allocated to the EU and its modules	**DU3 : Methods and Tools** credits: 4 Module 1 : Geographical Information Systems Credits : 4 Coefficient : 2
Evaluation mode	final exam. problem sets (exercises on GIS projects)
Descriptive of modules	**Geographical Information Systems:** At the end of the course, the student will be: • able to design a GIS application, • able to understand how are the various and multi sources data are structured in a GIS software • to know the potential analysis that can be done in various situations to produce useful information to support decision making in planning, monitoring and management of resources (water, forests, soil, lands) and infrastructures (drinking-water systems, a network of roads and tracks, ...) • Be able to choose the type of GIS software to operate according to its needs, • aware of the problems associated with the information flow and the reliability of data used in a GIS for the success of its operations

Name of teaching unit: Skills
Track: Engineering
Specialty: Master in Water
Semester: 3

Total hourly volume distribution of the TU and its modules	Courses (lectures) : 22.5h Tutorial : Practical Classes: Personal Work or contribution : 30h
Coefficients and credits allocated to the EU and its modules	**TU : Skills** credits: 2 Module 1 : Entrepreneurship and Intrapreneurship Credits : 2 Coefficient :1
Evaluation mode	Written assignment, Group project
Descriptive of modules	**Entrepreneurship and Intrapreneurship:** *Introducing the Entrepreneurship/ Intrapreuneurship persepective* *Entrepreneurial/intrapreneurial mindset, motivation and behavior* *Market and Customer Understanding* *How to manage challenges and risk taking* in entrepreneurial uncertainties? *Business modelling and planning* *Intrapreneurship*

IV – Details of modules

(One table for each module)

Title of Master: Master in Water, Engineering Track

Semester 1: African Water Resources and Scenarios

Teacher Responsible of TU: A1

Teacher responsible of module: A1

Objective of the course (teaching)

The course confers knowledge about

- *the African water resources and their characteristics and their uses,*
- *the range of issues African countries face when dealing with their water resources*
- *the policy approaches developed to deal with the issues and the various plans to improve their use and situation and*
- *the range of relevant climate change and socio-economic scenarios and their effect on African water resources and their use.*

Students will be qualified

- *to analyse the typical constellations of African water resources and their uses,*
- *to identify the issues resulting from these constellations*
- *to assess the existing and proposed policy options qualitatively with respect to their adequacy given the existing societal objectives, under the variations due to the water scenarios.*

Recommended background knowledge

Module Content:

The course presents a survey of the water resources of Africa, covering surface and groundwater. Their hydrological characteristics are summarized as well as the range of their uses. The variety allocation of water resources to the various uses is shown and the cases of multi-functionality and conflicting uses are demonstrated. The status of sustainability is evaluated. The existing visions, policy goals and plans for the African water resources are illustrated on a continental, river basin and national scale.
The tools of scenario development are analysed for expected climate change effects as well as for socio-economic changes and their applicability to African water resources is demonstrated. Their usefulness as tool for anticipating emerging issues in water resources planning is shown.

Evaluation mode: final exam, term paper and problem sets

References *(books, papers, reviews,….).*

- UN Economic Commission for Africa, 2006, African Water Development Report, Addis Ababa
- UN Economic Commission for Africa, 2008, The Africa Water Vision for 2025: Equitable and Sustainable Use of Water for Socioeconomic Development, Addis Ababa

- United Nations Economic Commission for Africa, African Climate Policy Centre, 2011, Climate change and water resources of Africa: Challenges, Opportunities and impacts, Addis Ababa
- United Nations Economic Commission for Africa, African Climate Policy Centre, 2011, Agricultural water management on the context of climate change, Addis Ababa
- UNEP .2010. “Africa Water Atlas”. Division of Early Warnning and Assessment (DEWA). United Nations Environment Programme (UNEP). Nairobi. Kenya
- Sharma, P.N. et al. 1996, African Water Resources- Challenges and Opportunities for Sustainable Development, World Bank Technical Paper, Washington, D.C.
- Goulden, M., Conway, D., & Persechino, A. 2009. Adapting to climate change in international river basins in Africa: a review. Hydrological Sciences , 54,5: 805-828.

Title of Master: Master in Water, Engineering Track

Semester 1: Fluid Mechanics

Teacher Responsible of TU: A3

Teacher responsible of module: A3

Objective of the course (teaching)
The teaching of this course is to enable students to understand the various theories of fluid mechanics.

Recommended background knowledge
Basics of calculus, differential equations, linear algebra.

Module Content:
1. Fundamental concepts (The characteristics of fluids, Properties of fluids, The perfect gas, Compressibility, Viscosity, Surface tension, Basic characteristics of fluid flow)
2. Fluid statics (Variation of pressure with position in a fluid, The measurement of pressure, Hydrostatic thrusts on submerged surfaces, The stability of bodies in fluids, Equilibrium of moving fluids)
3. Laminar unidirectional flow (Steady laminar flow in circular pipes , Steady laminar flow through an annulus, Steady laminar flow in parallel planes, The measurement of viscosity)
4. Fundamentals of turbulent flows (Turbulent Couette flow, Velocity distribution in turbulent Couette flow with given Reynolds number, Turbulent pipe flow, Velocity distribution in turbulent in a turbulent pipe flow resulting from the Blasius friction law, Location of a pipe leakage, Cooling of superheated stream by water injection)
5. Hydrodynamic lubrication (Bearing with step slider, Friction torque transmitted by the shaft to the journal, Slider load in squeeze flow: comparison between different slider geometries)
6. The flow of an ideal fluid (The stream function, Circulation and vorticity, Velocity potential, Flow nets, Combing flow patterns, Basic patterns of flow, Combination of basic flow patterns , Elementary aerofoil theory)
7. Flow with a free surface (Types of flow in open channels, The steady-flow energy equation for open channels, Steady uniform flow, The boundary layer in open channels, Flow in closed conduits only partly full, Simple waves and surges in open channels, Specific energy and alternative depths of flow, The hydraulic jump, The occurrence of critical conditions, Gradually varied flow, Oscillatory waves)

Evaluation mode: homework assignments, field report, final exam

References *(books, papers, reviews,….).*

• MASSEY B. 1998: “Mechanics of fluids”. Seventh edition, Stanley Thornes.
• SPURK J. H. 1997: “Fluid mechanics. Problems and solutions”. Springer.
• Granger, R.A. 1985, Fluid Mechanics, CBS College Publishing, New York.
• Streeter, V.L. ,Wylie, E. Benjamin 1998, Fluid Mechanics , McGraw-Hill, London.

Title of Master: Master in Water, Engineering Track

Semester 1: Hydrology

Teacher Responsible of TU: A5

Teacher responsible of module: A5

Objective of the course (teaching)

- *Understand the basic principles of river hydrology and hydraulic processes*
- *Understand the concepts of hydrology and gain an understanding of hydrological methods used in Waters resources management,*
- *mastering of the statistical analysis of hydrological data*
- *understand the concepts of modeling in hydrology and learning.*

Recommended background knowledge

Module Content:

I. Introduction (The hydrologic cycle, System concept, Hydrologic system model, Hydrologic model classification, The development of hydrology)
II. Watershed Morphometry (Definition, Study of form, Study of stream networks, Relief study)
III. Atmospheric water (Atmospheric circulation, Precipitation, Rainfall, Evaporation and evapotranspiration, Climate study)
IV. Subsurface and surface water (Unsatured flow, Infiltration, Sources of stream flow, Stream flow hydrograph)
V. Hydrologic measurement (optional for policy track) (Measurements of surface water, Hydrological measurement system)
VI. Hydrologic Analysis (Hydrologic statistics and Frequency analysis, Modeling in hydrology)

Evaluation mode: problem sets, quizzes, mid-term exam , final exam; homework assignments (optional for policy track to reflect lower credits)

References *(books, papers, reviews,….).*

- Chow, Ven/Maidment, David/Mays, Larry 1988: Applied hydrology, McGraw Hill.
- Hydrology : an introduction / Wilfried Brutsaert, Cambridge Univ. Press, 2010
- Modern hydrology and sustainable water development / S. K. Gupta, : Wiley-Blackwell, 2011
- Tracers in hydrology / Christian Leibundgut; Piotr Maloszewski; Christoph Külls, Chichester. Wiley-Blackwell, 2009
- Fundamentals of hydrology / Tim Davie, London [u.a.] : Routledge, 2008
- Geographic information systems in water resources engineering / Lynn E. Johnson, Boca Raton, CRC Press

Title of Master: Master in Water, Engineering Track

Semester 1: Water Quality

Teacher Responsible of TU: A4

Teacher responsible of module: A4

Objective of the course (teaching)

- To understand the types of organic and inorganic substances of natural and anthropogenic origin that are present in natural water, drinking water, municipal and some types of industrial wastewater.
- To understand the physical and chemical processes that occur when those waters are used, mixed with other waters, or interact with soil, sediments, atmosphere and infrastructure.
- To get an overview of the role of microorganisms in natural and anthropogenic environments, understand microbial diversity of aquatic ecosystems and aquatic nutrient cycles.
- To get an overview of symptoms, pathways of transmission, disease burden and prevention of major water born diseases.
- To understand health and environmental risks caused by natural or anthropogenic contaminants and get to know basics of microbial interactions with humans with focus on water borne pathogens.
- To understand the principles and being able to use most important analytical methods for the determination of chemical compounds present in water samples and get practical experience with basic experimental working techniques used in microbiology.

Recommended background knowledge

Module Content:

The course is divided in three parts. The first part covers general concepts of the problems related to organic and inorganic substances of natural or anthropogenic origin in aquatic systems such as lakes, rivers, dams, oceans, groundwater, drinking and wastewater. The basics of thermodynamics, acid-base, precipitation-dissolution, coordination and oxidation-reduction reactions, that are necessary to understand the environmental behaviour of such compounds, is provided. The second part of the course covers general concepts of environmental microbiology with the specific focus on aquatic systems including quantification of microbial processes, energy fluxes in microbial ecosystems, microbial diversity and nutrient cycles. The focus of the second part will be on the key waterborne pathogens, their transmission, life cycle, survival and growth in natural environment, drinking and wastewater systems and disease burden. The third part of the course is organized as a laboratory practicum which demonstrates important analytical methods gives insights in application of state-of-the-art microbiological tools.

Evaluation mode: final exam, homework assignments, lab report, participation

References *(books, papers, reviews,….).*

- Mark M. Benjamin, Water Chemistry, Waveland Pr. Inc, 1 edition, 2010
- Francois M.M. Morel and Janet G. Hering, Principles and applications of Aquatic Chemistry, Wiley-Interscience, 1st edition, 1993
- Michael T. Madigan, John M. Martinko, David Stahl, David P. Clark, Brock Biology of Microorganisms, 13th edition, Benjamin Cummings, 13 edition, 2010
- David Sigee, Freshwater Microbiology: Biodiversity and Dynamic Interactions of Microorganisms in the Aquatic Environment, Wiley, 2004
- Duncan Mara and Nigel J. Haran, Handbook of Water and Wastewater Microbiology, Academic Press

Title of Master: Master in Water, Engineering Track

Semester 1: Introduction to Integrated Water Resource Management

Teacher Responsible of TU: A1

Teacher responsible of module: A1

Objective of the course (teaching)

- To understand the overall processes involved in IWRM beginning with data collection, data analysis, system description, and then moving to consensus building, communications, education, monitoring and assessment
- To provides a brief historical background and overview of IWRM and gives an overview of the various aspects of IWRM, from integration, capacity building to applications and case studies
- To identify relevant aspects of IWRM in hydrologically sensitive regions
- To develop innovative concepts, methods and technologies
- To be able through modelling and system analysis as basis to investigate and implement IWRM initiatives

Recommended background knowledge

Module Content:

This course provides an introduction to the fundamental concepts and practice of Integrated Water Resource Management, skills and knowledge required to understand and manage water resources. It introduces students to the technical, economic, social and environmental complexities of water resources management so that they will be able to appreciate the importance of IWRM approach for sustainable development. It will provide the students with context and a view of water use and management by presenting some examples of integrated water resource plans already implemented in various parts of the world. The general principles of IWRM will be visualized as three interlocking and interdependent areas: the hydrologic cycle, watershed and land-use features and the economics, social interactions and institutions involved. There are external impacts such as global climate change, water transfer between watersheds and others.

Evaluation mode: final exam, homework assignments, lab report, participation

References *(books, papers, reviews,….).*

- UNESCO (2009): IWRM Guidelines at River Basin level. Part 1 and part 2.1
- van Hofwegen, P. (2004): Capacity-building for water and irrigation sector in management with application in Indonesia. FAO Water Reports 26. Rome: FAO.
- Mkandawire, T., Mulwafu, W. (2006): An analysis of IWRM capacity development needs in Malawi. • In: Physics and Chemistry of the Earth. 31 (2006) 738-744.
- Alaerts, G.J. (2009): Knowledge and capacity development (KCD) as tool for institutional strengthening and change. • In: Alaerts, G.J. and Dickinson, N (Eds.) Water for a changing world • Developing local knowledge and capacity. Delft.

• Gumbo, B., Foster, L., Arntzen, J. (2005): Capacity building in water demand management as a key component for attaining millennium development goals. • In: Physics and Chemistry of the Earth 30 (2005) 984-992.

Title of Master: Master in Water, Engineering Track

Semester 1: Project Design and Management

Teacher Responsible of TU: A7

Teacher responsible of module: A7

Objective of the course (teaching)

- *Conducting in-depth analysis of geographical, environmental, political, and institutional landscape of a development challenge*
- *Selection and identification of appropriate projects/ interventions for addressing the challenges*
- *Ability to facilitate collaborative and participatory approaches to project design and knowledge of commonly used techniques such as SWOT analysis, stakeholder mapping and problem and objective analysis*
- *Ability to collate and synthesize relevant information into a logical and cohesive project proposal;*
- *Ability to develop and implement effective work plans for project staff and participants*
- *Ability to integrate knowledge gained from monitoring and evaluation systems into the project design and revision of project objectives or activities*
- *Ability to analyse projects by working with spreadsheets, and understand the risks inherent in the projects and develop risk management measures*
- *Use of commercial project management software packages and an appreciation of their limitations*

Recommended background knowledge

Module Content:

The course aims at imparting to the students knowledge of theories and commonly used processes of project cycle management and Logical Framework Approach (LFA), and will cover the tools and techniques for identification, analysis, design, implementation, monitoring and evaluation of sustainable development of energy programs and projects.

Evaluation mode: Case study, Group work, Written final examination

References *(books, papers, reviews,….).*

- David Potts (2005) Project Planning and Analysis for Development, Viva Books Private Limited
- Mantel J, et. al. (2011) Project Management, Wiley India
- Nicholas (2011) Project Management for Business and Technology, PHI
- Chandra Prasanna (2011) Projects: Planning, Analysis, Selection, Financing, Implementation, and Review, TMH

Title of Master: Master in Water, Engineering Track

Semester 1: African History

Teacher Responsible of TU: *A7*

Teacher responsible of module: *A7*

Objective of the course (teaching)

At the end of the course, a student are expected to:

- *understanding African historical experiences and realities;*
- *demonstrate knowledge of indigenous Africa;*
- *demonstrate good understanding of the impact and role of imperial global designs on Africa;*
- *To demonstrate critical oral and written communication skills necessary in articulation of African and pan-African issues;*
- *Apply relevant theoretical tools in interrogating the African reality;*
- *To demonstrate a good grasp of historically- informed strategies of solving current African problems and challenges.*

Recommended background knowledge

Module Content:

1. Introduction-Decolonial Epistemic Perspective in African History
2. Ancient African Civilizations and kingdoms
3. History of 'Indigenous Africa'
4. Africa in snares of global Imperial Designs
5. African agency : Responses to Colonialism and Decolonization
6. The Nationalist Project and the National Question
7. New African Consensus in rebuilding PAN African Institutions in the 21st Century

Evaluation mode: Written exam, Seminar Presentations, Research Essay, Research Paper

References *(books, papers, reviews,….).*

Frantz Fanon, ***The Wretched of the Earth***, New York: Penguin, 1968.
Aime Cesaire, ***Discourse on Colonialism***, New York: Monthly Review Press, 1972.
Walter D. Mignolo, 'Epistemic Disobedience, Independent Thought and Decolonial Freedom,' in ***Theory, Culture and Society***, 26 (7-8), 2009: 1-23.

Mueni wa Muiu and Guy Martin, ***A New Paradigm of the African State: Fundi wa Africa***, New York: Palgrave Macmillan, 2009. [Chapter 2, pp. 23-47].
Christopher Ehret, ***The Civilizations of Africa: A History to 1800***, Charlottesville, VA: University Press of Virginia, 2002.
Joseph Harris, ***Africans and Their History,*** New York: Penguin Books, 1987.
Nehemia Levtzion, ***Ancient Ghana and Mali***, New York: Africana Publishing, 1980.
Olufemi Taiwo, ***How Colonialism Preempted Modernity in Africa***, Bloomington and Indianapolis, 2010.
Bernard M. Magubane, ***The Making of a Racist State: British Imperialism and the Union of South Africa, 1873-1910***, Trenton, NJ: Africa World Press, 1996.
Chinweizu, ***The West and the Rest of Us: White Predators, Black Slaves and the African Elite,*** New York: Vintage Books, 1975.
Valentine Y. Mudimbe, ***The Invention of Africa: Gnosis, Philosophy and the Order of Knowledge,*** London: James Currey, 1988.
Valentine Y. Mudimbe, ***The Idea of Africa,*** Bloomington and Indianapolis, IN: Indiana University Press, 1994
Jideofor Adibe (eds.), ***Who is an African? Identity, Citizenship and the Making of the Africa-Nation,*** London: Adonis & Abbey, 2009.
Sabelo J. Ndlovu-Gatsheni, *'Do 'Africans' Exist? Genealogies and Paradoxes of African Identities and the Discourses of Nativism and Xenophobia,* ***African Identities,*** 8 (3), August 2010: 281-295.
Walter D. Mignolo, ***The Darker Side of Renaissance: Literacy, Territoriality, and Colonization,*** Ann Arbor: University of Michigan Press, 1995
Walter D. Mignolo, ***Local Histories/Global Designs: Essays on the Coloniality of Power, Subaltern Knowledges and Border Thinking,*** Princeton: Princeton University Press, 2000.
Samir Amin, ***Eurocentrism: Second Edition,*** New York: Monthly Review Press, 2009.
Walter D. Mignolo, 'Delinking: The Rhetoric of Modernity, the Logic of Coloniality and the Grammar of Decoloniality,' ***Cultural Studies,*** 21(2/3) March/May 2007: 449-514.
Anibal Quijano, 'Coloniality and Modernity/Rationality,' ***Cultural Studies,*** 21 (2/3), March/May 2007: 168-178.
Anibal Quijano, 'The Coloniality of Power and Social Classification,' ***Journal of World-Systems Research,*** *6 (2), Summer/Fall 2000: 342-386.*
Bonaventura de Sousa Santos, 'A Non-Occidentalist West? Learned Ignorance and Ecologies of Knowledge,' *in* ***Theory, Culture and Society,*** 26 (7/8), 2009: 103-125
Samir Amin, ***Delinking: Towards a Polycentric World,*** London & New York: Zed Books, 1990.
Walter Rodney, ***How Europe Underdeveloped Africa,*** Washington, DC: Howard University Press, 1981.

Title of Master: Master in Water, Engineering Track

Semester 1: Academic Writing

Teacher Responsible of TU: A7

Teacher responsible of module: A7

Objective of the course (teaching)

This course will introduce students to the standards and the practice of academic writing. After successful participation in the course students will be able to:

- *Structure academic texts*
- *Apply the standards of academic writing in their respective fields*
- *Apply best practices of writing style (in technical subjects)*
- *Apply different standards for citation and references*

Recommended background knowledge

Module Content:

The course will in its first part focus on the connections between research process, academic writing and the structure of academic texts. In the second part students will be introduced to grammar and style for academic purposes with a particular focus on technical subjects and the problem of communicating technical subjects in an understandable manner (to a non-expert audience). Special attention will also be given to issues of clarity, logic and coherence. Finally, the course will cover citation techniques, references and the issue of plagiarism. Students will have to produce a series of short sample texts over the course of the semester which will be peer reviewed according to the standards introduced in class by their fellow students.

Evaluation mode: Written Assignments

References *(books, papers, reviews,….).*

- Bailey, Stephen 2001: Academic Writing. A Handbook for International Students, Taylor & Francis.
- Glasman-Deal, Hilary 2009: Science Research Writing For Non-Native Speakers Of English: A Guide for Non-Native Speakers of English, ICP.
- O'Keefe, Sarah S./Pringle, Alan S. 2011: Technical Writing 101: A Real-World Guide to Planning and Writing Technical Content, Scriptorium Publishing Services.
- Tim Skern 2011: Writing Scientific English, UTB.
- Turabian, Kate L. 2007: A Manual for Writers of Research Papers, Theses, and Dissertations: Chicago Style for Students and Researchers, University of Chicago Press.

Title of Master: Master in Water, Engineering Track

Semester 2: Hydraulics

Teacher Responsible of TU: A3

Teacher responsible of module: A3

Objective of the course (teaching)

The course is designed to give the engineering student a solid understanding of hydraulics (open channel hydraulics and flows under pressure), particularly in steady, gradually varied flow, and a basis for the design of free surface systems. After attending this course, a student will be able to describe the various types of flows in open channels, the velocity distribution across and along the channel and hydraulic jumps. Technical lecture (Flows Under Pressure) uses modelling: concepts and methods of computational assisted design are widely used in the projects. Teaching is focused on acquiring or updating knowledge of basic hydraulics lectures include, tutorials, visits and especially technical projects (case studies based on solving real and complex problems).

Recommended background knowledge

Basics of calculus, mechanics.

Module Content:

Part 1: Open Channel Hydraulics

1. Introduction to Open Channel Flow
2. Uniform flow
3. Energy and Momentum Principle
4. Non-Uniform Flow
5. Canal Design
6. Unsteady Flow:

Part 2: Flows under Pressure

1. Review: Fluid characteristics, fluid properties, ideal gas law, classification of fluids, vapor pressure, surface tension, capillarity.
2. The steady flows in pipes (Flow of a real fluid , Unidirectional flow, Instruments for measuring)
3. Non-permanent flows in pipes (Quasi-permanent Flow , Oscillatory movements of liquid , Transient flow, Water Hammer, Protection against water hammer)

Evaluation mode: homework assignments, field report, final exam

References *(books, papers, reviews,….).*

• V.T. Chow: Open-channel hydraulics. McGraw Hill Publications (1959,1973)
• Rajesh Srivastava: Flow through open channels. Oxford University Press (2008)
• H. Chaudhury: Open channel flow. Second Edition. Springer (2008)
• A. Osman Akan: Open Channel Hydraulics Butterworth-Heinemann (imprint of Elsevier) (2006)

- AWWA. 2003. Water Transmission and Distribution, 3rd edition. American Water Works Association.
- Bhave, P.R. 1991. Analysis of Flow in Water Distribution Networks. Technomic Publishing Co., Inc.
- Larock, B.E., Jepson, R.W., Watters, G.Z. 2000. Hydraulics of Pipeline Systems. CRC Press, Boca Raton
- Mays, L.W. 2000. Water Distribution Systems Handbook. McGraw-Hill, New York.
- Roberson, J.A., Crowe, C.T. 1995. Engineering Fluid Mechanics. John Wiley & Sons, Inc., New York.
- Streeter, W.L., Wylie, E.B. 1985. Fluid Mechanics. 8th edition. McGraw-Hill, Inc., New York.
- Todini, E., Pilati, S. 1987. A Gradient Method for the Analysis of Pipe Networks. International Conference on Computer Applications for Water Supply and Distribution, Leicester Polytechnic, UK

Title of Master: Master in Water, Engineering Track

Semester 2: Hydrogeology

Teacher Responsible of TU: A7

Teacher responsible of module: A7

Objective of the course (teaching)

This course is aimed at providing the student with a comprehensive introduction to the most important topics in groundwater hydrology/hydrogeology. The teaching format consists of the presentation of key concepts followed by problem-solving and laboratory practice. This course will prepare students to analyze ground-water flow processes taking into account aquifer properties, basic hydraulic factors, geologic controls, and their temporal and spatial interactions. Mastery of concepts relies on quantitative analysis. Upon completion of the course the student should be able to:

- *Explain basic water chemical & physical parameters;*
- *Distinguish between confined & unconfined aquifers from data;*
- *Draw groundwater flow nets to scale from provided data;*
- *Apply Darcy's Law to groundwater flow and geological material interpretation;*
- *Use & interpret pumping data for groundwater flow applications;*
- *Distinguish between continuous and discontinuous media*
- *Plot & interpret Ternary & Piper Diagrams for water quality analysis.*
- *Use proper sampling & water analytical techniques for water quality analysis*

Recommended background knowledge

Module Content:

I. Water Physics & Chemistry
II. Soil & Rock Science of Porosity, Permeability, Density (Aquifer Parameters)
III. Groundwater Flow, Darcy' Law
IV. Pumping Aquifers
V. Karst Hydrogeology
VI. Modeling in Hydrogeology
V. Introduction to Hydrochemistry
VII. Groundwater Water Quality

Evaluation mode: homework assignments, quizzes, mid-term exam, final exam

References *(books, papers, reviews,….).*

- Hydraulics of Groundwater. Jacob Bear. McGraw-Hill.
- Groundwater Dynamics, Steady flow. Milan Vukovic and AnjelcoSoro. Water Ressources Publication 1997.
- Fetter, C.W., 2001, Applied Hydrogeology; 4th edition, Pearson.

Title of Master: Master in Water, Engineering Track

Semester 2: Sanitation and Water Treatment

Teacher Responsible of TU: A4

Teacher responsible of module: A4

Objective of the course (teaching)

Drinking Water Treatment

• To understand global and African situation in regard to the issues of water resources and drinking water and its relation to health, resource conservation and environmental protection

• To know scientific, technical and engineering principles of drinking water abstraction, distribution and use and factors affecting their efficiency, costs, sustainability and acceptability

• To understand centralized, decentralized and household water treatment systems including desalinisation and being able to plan simple reliable concepts considering local socio-cultural conditions and local availability of human and material resources

• To be able to critically evaluate alternative solutions considering multiple criteria

• To be able to critically evaluate sustainability of existing projects and apply sustainability principles to planning of the new projects

• To understand the sector development policy and the role of African states and multilateral organizations

Sanitation

• To understand global and African situation in regard to the issues of excreta, wastewater and solid waste disposal and comprehend the connection between these processes and health, resource conservation and environmental protection

• To know technical fundamentals and principles of operation of major technologies and processes of liquid and solid waste disposal relevant to rural and urban areas in Africa and being able to critically evaluate them considering multiple criteria

• To get insight in new developments of sanitation technologies and concepts that aim at protecting and conserving resources.

• To learn the concept of community participation and its role in enabling successful implementation of a project and its sustainability on a long term.

• To understand social and cultural aspects as well as equity principles and their implications to environmental sanitation planning.

• To understand the sector development policy and the role of African states and multilateral organizations.

Recommended background knowledge

Module Content:

Drinking Water Treatment

This part of the course covers scientific, technical and engineering aspects of drinking water from the resource to the tap including desalinization. Natural processes, anthropogenic pollution, legislation of water resources and drinking water as well as drinking water treatment by unit processes on centralized, decentralized and household scale and drinking water distribution are considered with the special focus on needs of

rural, urban areas and informal settlements of Africa. Availability, accessibility, affordability, acceptability, quality and sustainability of drinking water supply and treatment are addressed with regard to socio-cultural differences in African states. Hygiene promotion principles and behaviour change concepts are discussed. The course consists of a series of lectures and series of practice-oriented exercises. Two laboratory based classes are meant to get students to learn basic drinking water treatment methods in “hands-on” exercises. Significant in-class time will be spent in discussions, solving of problems and activities conducted by students, such as presentations and demonstrations. A visit to a drinking water treatment plant is planned. During the course, the students will be encouraged to focus on a topic within their area of interest and report on it with either a presentation, new laboratory experiment, written report or prepare and guide a tour through a part of the drinking water treatment plant.

Sanitation
This part of the course introduces students to the technical and scientific fundament of wastewater, excreta and solid waste disposal in rural, urban areas and informal settlements of Africa. Connections between these processes and health, resource conservation as well as environmental protection are considered. The course will give an overview of tested and proven technologies that provide appropriate and cost-effective sanitation solutions. Students will get familiar with the sanitation system concept and learn how to work with pre-defined system templates by iteratively choosing and linking appropriate technologies. Particular emphasis is placed on the role of households and communities as partners during planning and implementation of projects. The course will discuss contemporary approaches and methods for sanitation planning at city level (Sanitation 21), in urban communities and neighbourhoods (CLUES) as well as in rural areas (CLTS).The socio-cultural aspects and principles of non-discrimination are specifically addressed. The course is organized as a combination of lectures, exercises, discussions, in-class problem solving, in-class quizzes, 1 excursion and problem-oriented project work. Students have to conduct a project work in small groups (3-4 people) and present it during the course. For the project work, the students will be grouped in such a way that students of both Science and Engineering and Governance branches are present in each group. During the project work, the students will have to find possible sanitation solutions to a given situation, design specific technologies for both water scarce and water abundant environment and focus on approaches that are compatible to local environmental conditions, culture, available material and human resources and legal framework.

Evaluation mode: participation, quizzes, field report, presentation and final paper

References *(books, papers, reviews,….).*

• E. Tilley, C. Lüthi, A. Morel, C. Zurbrügg, R. Schertenleib, Compendium of Sanitation Systems and Technologies, Eawag, Dübendorf, Switzerland, 2008.
• John C. Crittenden, R. Rhodes Trussell, David W. Hand, Kerry J. Howe, George Tchobanoglous, MWH`s Water Treatment: Principles and Design, Wiley, 3rd edition, 2012
• Thomas Clasen, Scaling up household water treatment among low-income populations, WHO/HSE/WSH/09.02, 2009

Title of Master: Master in Water, Engineering Track

Semester 2: Soil Conservation

Teacher Responsible of TU: A5

Teacher responsible of module: A5

Objective of the course (teaching)

The course confers knowledge about

- *the issues facing soil erosion and sedimentation, their determinants and modelling,*
- *the land use and technical options to control and the socio-economic factors influencing soil erosion and sedimentation and*
- *their implications for water storage, for the nutrient and carbon processes in soil and water so that students will understand them.*

The students will be qualified

- *to analyse the individual and collective decision-making processes on the farm and watershed level influencing soil and water conservation in the African context,*
- *to derive policy proposals to solve problems related to soil and water conservation reform and to assess existing policy and*
- *to assess the quality of related scientific research and assess research gaps.*

Furthermore the students will be qualified

- *to judge the problems and the perspectives for the improvement of the status of national policies and projects related to soil and water conservation in African countries,*
- *to perform well as a water professional on a national level, in international organizations and as consultants.*

Recommended background knowledge

Module Content:

The course focuses on the land–water-interface and takes a watershed perspective. It includes the relationship between the natural processes, management options and policies influencing user's management choices. Starting with the determinants and modelling of soil erosion and sedimentation, it covers the land use and technical options to reduce soil erosion including their economics. It deals with the role of soil management in the storage of water in the watershed under extreme conditions. Parallel to the sedimentation and water quality impacts, the course broadens to cover the nutrients cycle in the watershed and the carbon cycle and their changes by land use practices as well. The final topic covers the analysis of policies influencing water and soil conservation.

Evaluation mode: final exam, term paper and problem sets

References *(books, papers, reviews,….).*

- Blanco-Canqui, H. , Lal R. 2008, Principles of soil conservation and management, Dordrecht,
- Biot, Y. et al, 1995. Rethinking research on land degradation in developing countries, World Bank discussion paper No 289, Washington, D.C.,

• Pagiola, S. 1999.The global environmental benefits of land degradation control on agricultural lands, World Bank environmental paper, No 16, Washington, D.C.,
• Shiferaw, B., Holden, S.T., 2000, Policy instruments for sustainable land management: the case of highland smallholders in Ethiopia. Agricultural Economics, 22(3), 217-232.

Title of Master: Master in Water, Engineering Track

Semester 2: Research Methods for Water Engineering

Teacher Responsible of TU: A6

Teacher responsible of module: A6

Objective of the course (teaching)

The student will gain an appreciation of philosophical objectives of research in engineering. However, the course initially provides an overview of the intellectual terrain covered by science and technology policy studies, with particular illustrations of: How to choose your research question, Project management and study skills, Doing an effective literature review, Methodology, theory and research design, Design frames, Ethics and access, Tools for data collection, Effective data analysis, Discussing findings, concluding and writing up, developing personal strategy in research, how to valorize results and marketing.

Recommended background knowledge

Module Content:

- Introduction to research methods: Acquiring knowledge, Scientific methods and research process
- Designing Idea in Research (Questions and Hypothesis, Qualitative and quantitative methods): Finding an Idea for research, Review of literature, finding and using literature, observations and measurement, Sampling, Survey research, Scales and indexing
- Data collection and Analysis : Analysis, qualitative and mixed methods Analysis, Analysis for research design, Write-up, Research Synthesis, Meta-Analysis, Statistical Process Control
- Design and Structures of experiments: Qualitative and mixed methods design, quasi-experimental approach, advanced design topics, modelling and numerical simulation, prediction of risk in energy.
- Research and Strategies: National, continental and International policy context and priorities in research, identification and selection of participants, introduction to the assessment of cost and benefice, publication of results
- New generation of instruments and tools: Presentation of most popular Software, databases, others
- Writing Strategies and Ethical Considerations

Validation of results and marketing strategy: publication, visibility, patenting, innovation and technological transfer

Evaluation mode: presentation, final paper, final exam

References *(books, papers, reviews,….).*

- Research Design: Qualitative, Quantitative, and Mixed Methods Approaches by John W. Creswell (Sage publications, 2009)ISBN: 9781452226095

- Research Methods for Business Students
  By Mark Saunders, Philip Lewis, Adrian Thornhill (Financial Times/Prentice Hall, 2009) ISBN 0273716867, 9780273716860
- The Research Methods Knowledge Base, 3e
  By William Trochim, Ph.D., Cornell University and James P. Donnelly, Ph.D., SUNY-Buffalo
  (2007)ISBN-10: 1592602916 ISBN-13: 9781592602919
- Research Methods for the Behavioral Sciences
  By Frederick J Gravetter, Lori-Ann B. Forzano
  (2012) Wadesworth, Cengage Learning ISBN-10: 1111342253 - ISBN-13: 978-1111342258

How to Do Your Research Project : A Guide for Students in Education and Applied Social Sciences By Gary Thomas - Sage Publications (2013) ISBN: 9781446258866

Title of Master: Master in Water, Engineering Track

Semester 2: Human Rights and Gender

Teacher Responsible of TU: A7

Teacher responsible of module: A7

Objective of the course (teaching)

Student will be able:

- *to identify human rights issues*
- *to address human rights issues*
- *Assess the effectiveness of various forms of addressing human right issues*
- *By the end of the course the learner will:*
- *be able to appreciate fundamental and contemporary theories of gender*
- *be able to relate development scholarship to contemporary gender realities and issues*
- *be well acquainted with the various skills for critical analyses of the role of gender in development*

Recommended background knowledge

Module Content:

1. Introduction to Human Rights: Concepts & Origin
2. Basic Definition of Human Rights Approach in African Systems
3. Relating the Study of Human Right to Society :Rights of Refugees; Children's Rights; Women's Rights; Rights of indigenous peoples;
4. Reflections of Human Rights in Legal Systems: Torture and ill-treatment in detention; Criminal Justice System; Human Rights in Emergencies; Government & Human rights: Human Rights and Development; Human Rights and Democracy.
5. Overseeing Human Rights: United Nations Treaty; Regional Human Rights Systems; National Human Rights Commissions
6. Human Right Groups and Activists

Gender & Development

Gender Theorisation

1. Overview of Gender Theorisation
2. Depining Gender
3. Sex and Gender
4. Conception of Power

5. Gender and Power Relations
6. Gender Identity Construction
7. Universal Ontological Specificity for Women
8. Judith Butler's Performativity Gender Theory

Gender Representation in the different approaches to development

1. The Women in Development(WID) approach
2. The Gender and Development(GAD) approach
3. The Gender Mainstreaming approach
4. Representation of Masculinity and Femininity in development
5. Power Conception and Gender Relations
6. Dominance, Subordination, Subjectivity and Inter-Subjectivity
7. Language and gender and implications for development
8. Changing pattern of gender representation in development
9. Gender Identity Re-Signification and development indicators
10. The role of agency and Activism in development

Evaluation mode: Written Exam and Continuous assessment

References *(books, papers, reviews,….).*

Donnelly, Jack. Universal Human Rights in Theory and Practice. Ithaca and London; Corneil University Press 2003.

Smith, R., International Human Rights, Oxford University Press, Oxford, 2003.

Shaw, M., International Law, Cambridge, 1998

Shivji, I., The Concept of Human Rights in Africa, Codestria Book Series, Dakar, 1989.

Bammeke, F. "Understanding the Gender Question" in Olurode and Soyombo (eds) *Sociology for Beginners*, Lagos: NDD, 1999.

Barky, Sandra Lee (1990): Femininity and Domination: Studies in the Phenomenology of oppression. New York: Routledge.

Mackinnom, C.(1987) : Feminism Unmodified. Cambridge, MA:Havard University Press

Nneameka, Obima (ed)(1998)Sisterhood, Feminism and Power: From Africa to the Diaspora. Trenton, Njand Asmara: Africa World Press.

Rhode, Deborah L.(ed) (1990) Theoretical Perspectives on sexual Difference. New Haven and London: Yade University Press

The World Bank (1995): Development in Practice: Toward Gender Equality: The Role of Public Policy. Washington, Dc: The World BANK

Title of Master: Master in Water, Engineering Track

Semester 2: Communication, Marketing, and Networking

Teacher Responsible of TU: A7

Teacher responsible of module: A7

Objective of the course (teaching)

Recommended background knowledge

Module Content:
Introduction to networking. Why network. Types of networks: social, professional and business networks, use of social media and ICT. Sources of contacts for networking. Face-to-face and electronic networking, donor supported and self-sustaining networks, voluntary, membership and profit-making networks. Typical weaknesses and strengths, dos and don'ts, managing expectations, sustainability, institutional issues in networking.

Evaluation mode: Written reports, oral presentations, written examination

References *(books, papers, reviews,….).*

Title of Master: Master in Water, Engineering Track

Semester 3: Water Economics

Teacher Responsible of TU: A7

Teacher responsible of module: A7

Objective of the course (teaching)

The course confers knowledge about

• the economic principles and economic tools applicable to water policy issues pertaining to water resources issues prevalent in African countries and

• the determinants of water demands and water supply projects for storage and bulk conveyance.

The students will be qualified

• to apply the economic tools to specific problems in the African context,

• to derive policy proposals to solve water resource related problems and to assess existing policy proposals and

• to assess the quality of related scientific research and assess research gaps.

Furthermore the students will be qualified

• To judge the problems and the perspectives for the improvement of the status of national water policies and projects in African countries,

• To perform well as a water professional on a national level, in international organizations and as consultants.

Recommended background knowledge

Module Content:

The course covers the economics of water resources, with special emphasis on African conditions where water is a scarce resource and on those African regions with ample water supply. The aim is to teach both about economic tools – how economists go about analyzing key aspects of water policy – and also about the specifics of water in semi-arid and arid conditions and in those areas where water resources are not the major scarcity– what has been learned by applying these tools to water issues in the regions. The topics include agricultural and industrial demand for water, environmental demands for water, economics of water supply, storage projects, economic implications of surface and groundwater law, economics of drainage and salinity, economics of transboundary waters. The course assumes a knowledge of microeconomics, and some familiarity with linear regression.

Evaluation mode: final exam, final paper and problem sets

References *(books, papers, reviews,….).*

• R. C. Griffin, 2006, Water Resource Economics, The Analysis of Scarcity, Policies and Projects, MIT Press, Cambridge, Mass.,

• R.A. Young 2005, Determining the Economic Value of Water, Concepts and Methods, RfF Press, Washington, D.C.,

• A. Dinar, S. Dinar, S. McCaffrey, D. McKinney, 2007, Bridges over Water, Understanding Transboundary Water Conflicts, Negotiation and Cooperation, World Scientific Series on Energy and Resource Economics, Singapore.

Title of Master: Master in Water, Engineering Track

Semester 3: Water for Agriculture 1: Irrigation Techniques and Drainage

Teacher Responsible of TU: A5

Teacher responsible of module: A5

Objective of the course (teaching)

The goal of the drainage course is to provide learners with the knowledge and skills required to assess, plan and design agricultural surface and sub-surface drainage works. At the completion of the course the students should be able to:

- *Understand crop water needs;*
- *Manage soil moisture to promote desired crop response;*
- *Evaluate irrigation;*
- *Optimize the use of available water supplies;*
- *Minimize irrigation induced erosion;*
- *Decrease non-point source pollution of surface and groundwater resources;*
- *Manage salts in the crop root zone;*
- *Choose the appropriate and effective techniques of irrigation to the crop.*
- *understand tile drainage design.*
- *Design, test, and analyze agricultural irrigation systems and their components (gravity irrigation, sprinkler irrigation, trickle irrigation).*

Recommended background knowledge

Module Content:

Part 1: Irrigation management: Basic concepts of water irrigation (factors affecting crop growth and yield, soil-plant-atmosphere system and relationships between crop yield and water); Crop response to water and water use efficiency; Crop water requirements and practical irrigation scheduling (Crop Consumptive Use; Net Irrigation Water Requirements; Auxiliary Water Needs for Salinity Management; Available Water Capacity of Soils; Management Allowed Depletion; Net Irrigation Application; Irrigation System Capacity Requirements; Gross Irrigation Application Requirements; Irrigation Frequency; Irrigation System Capacity Requirements; Irrigation Scheduling),

Part 2: Irrigation techniques: Surface irrigation (spate of flood and runoff water; irrigation by basins; irrigation by boards; irrigation by lines); modernization of surface irrigation; Diagnostic and maintenance of surface irrigation systems; The sprinkle irrigation (main equipments, Description of the different installations); Spatial Distribution of rain by sprinkler gauge (spacing, uniformity); design of sprinkler irrigation systems at farm level; Diagnostic and maintenance of sprinkler irrigation systems; The trickle irrigation (benefits and difficulties of trickle irrigation); The components of a trickle irrigation system (The head station; The distributors; the distribution network); Distributors selection criteria; Crop water requirement in trickle irrigation; design of trickle irrigation systems at farm level; Diagnostic and maintenance of trickle irrigation systems.

Part 3: Drainage. Training on surface and sub-surface drainage according to the following program.

Drainage requirements of crops. Surface drainage system, Subsurface drainage: theory types, drainage materials; Depth and spacing of drains; Interceptor drains; Sizes of tile drains accessories; Drain tile quality; Design and layout of drainage systems; Installation of tile drains; Installation loads on conduits; cost of drainage system; Drainage by pumping; Drainage envelope materials and envelope design: Diagnostic and maintenance of existing drainage systems.

Evaluation mode: quizzes, field report, final exam

References *(books, papers, reviews,….).*

• Ali M. H., 2010, Fundamentals of Irrigation and On-farm Water Management: Volume 1, Springer
• David Alan Goldhamer, Richard L., 1989, Snyder, Irrigation scheduling: a guide for efficient on-farm water management, University of California (System), Division of Agriculture and Natural Resources, Volume 21454, 67 pages.
• Design and operating of farm irrigation systems -edited by M.E. JENSEN, American Society of Agricultural Engineers
• Jack Keller & Ron D. Bliesner, 1990, Sprinkle and trickle irrigation, Van Nostrand Rinhold, New York.
• Walker W.R., Skogerboe G.V. 1987, Surface irrigation, theory and practice, Prentice-Hall, Englewood Cliffs.
• Basak, 1999, Irrigation Engineering, Tata McGraw-Hill Education.
• A M Michael, 2009, Irrigation: Theory and Practice, Vikas Publishing House Pvt Ltd.
• Lambert K. Smedema, Willem F. Vlotman & David Rycroft, (2004), Modern Land Drainage: Planning, Design and Management of Agricultural Drainage Systems, Taylor & Francis -
• W. L. Powers, (2008), Land Drainage, Read Books.
• Henry F. French, (2009), Farm Drainage, BiblioLife.
• A K Bhattacharya & A M Michael, (2011), Land Drainage: Principles, Methods & Applications, Vikas.

Title of Master: Master in Water, Engineering Track

Semester 3: Water for Agriculture 2: Irrigation Project Design

Teacher Responsible of TU: A5

Teacher responsible of module: A5

Objective of the course (teaching)

At the end of this course, the student should be able to study a full irrigation project namely collecting the data and information necessary for the project, design and sizing of all components of the irrigation system, the estimate of the cost, the benefits and environmental impact assessment of the project.

Recommended background knowledge

Module Content:

Collection and analysis of climatic, soil and crop data. Determination of crop water requirements and gross irrigation requirements; Choice of the optimal cropping pattern based on different simulation scenarios (limited water availability, use of saline water, etc.) and economic criteria. Determination of specific continuous discharge; Hydraulic design of a large scale distribution network; Cost/Benefit analysis. Environmental Impact Assessment Applications; Synthesis, conclusions and reporting

Evaluation mode: quizzes, final paper (based on project)

References *(books, papers, reviews,….).*

• Jack Keller & Ron D. Bliesner, 1990, Sprinkle and trickle irrigation, Van Nostrand Rinhold, New York, 652 pages

• Walker W.R., Skogerboe G.V. 1987, Surface irrigation, theory and practice, Prentice-Hall, Englewood Cliffs. 386 pages

• Basak, 1999, Irrigation Engineering, Tata McGraw-Hill Education, 329 pages

• A M Michael, 2009, Irrigation: Theory and Practice, Vikas Publishing House Pvt Ltd, 768 pages.

Title of Master: Master in Water, Engineering Track

Semester 3: Water Quality and Sanitation 1: Water Quality and Environmental Health

Teacher Responsible of TU: A4

Teacher responsible of module: A4

Objective of the course (teaching)

The course objective is to understand the emissions and transport pathways of point and diffuse pollution from urban areas, agriculture and geogenic sources into the aquatic environment. Furthermore, transport, retention and degradation processes within the receiving water bodies will be introduced. Students will learn to view water bodies (for example:river basins) as integrated systems and how to analyse, quantify and evaluate the sources of pollution as a basis for the planning of mitigation measures. Students will be able to choose the right treatment technology for a given sanitation problem.

Recommended background knowledge

Module Content:

Part 1: Emission sources and pathways of point and diffuse pollution

- Urban areas (industry, waste water treatment plants, storm water runoff, traffic emissions)
- Agriculture (erosion, surface runoff, groundwater pollution, fertilizer, organic manure, pesticide application)
- Geogenic sources
- Other sources (atmospheric deposition, shipping etc.)

Balances for various substances in river basins

- Nutrients (P, N)
- Contaminants (heavy metals, PAH, pesticides, other)
- Water quality requirements and assessment
- Water quality assessment techniques and monitoring programs
- Quantification methods and modelling approaches
- Examples of mitigation measures
- Biotic and abiotic processes for self purification in water bodies. Simple kinetics for the simulation of water quality in surface waters.

Part 2: Fundamental processes in water and wastewater treatment.

- Sources for drinking water (surface water and groundwater) will be discussed and necessary treatment steps introduced.
- An important issue will be disinfection techniques and strategies. The negative part of chlorine as disinfection agent will be discussed (disinfection byproducts).
- Beside zero and first order kinetics, the Monod equation and its impact on biomass dynamics and substrate limitation will be discussed and used for calculation.
- Waste water treatment with activated sludge. Biomass growth both autotrophic and heterotrophic will be addressed together with decay and endogenous respiration.
- The advantage and disadvantage of fully mixed reactors compared to fixed bed reactors (plug flow) will be discussed.

• Aeration systems will be introduced with the fundamental equations and design parameters.Basic equations of mass transfer between phases (gas / water) will be introduced.

• Anaerobic treatment of sludge and waste water for both municipalities and industry will be introduced. On the one hand the benefits in terms of biogas productions will be shown. On the other hand the limitations in terms of removal efficiency will also be addressed.

• Furthermore, this course will provide the newest information about membrane technology in water and waste water treatment.

• Fundamentals of microfiltration, ultrafiltration, nano filtration and reverse osmosis will be introduced. A general overview on membrane technology in water management. Surface filtration and depth filtration.

• Fundamentals of biofouling and biofilm training. Removal of fouling layers. Types of membranes, polymeric and inorganic membrane materials.

Evaluation mode: final exam

References *(books, papers, reviews,….).*

• Chapra, S. C. (1997): Surface Water-Quality Modelling, University of Colorado, McGraw-Hill

• T.H. Y. Tebbutt (1998):Principles of Water Quality control, Butterworth-Heinemann

• Wastewater Engineering Treatment and Reuse Fourth Edition by Metcalf & Eddy, Inc. McGraw-Hill; 4th edition, 2003

• Biological Wastewater Treatment in Warm Climate Regions by M. Von Sperling, C.A. de Lemos Chernicharo, IWA Publishing (2006) Vol 1 and 2

• Mulder, Marcel H.: “Basic principles of membrane technology“ Kluwer Academic, Dordrecht (2000)

Title of Master: Master in Water, Engineering Track

Semester 3: Water Quality and Sanitation 2: Networks versus Decentralized Solutions

Teacher Responsible of TU: A4

Teacher responsible of module: A4

Objective of the course (teaching)

The students will learn the main principles of the design of water networks for water supply and waste respectively storm water collection. Based on water flow) they will be able to use the knowledge of design of centralized systems. Compared to the centralized solutions the students will be confronted with alternative decentralized options.

Recommended background knowledge

Module Content:

Beside water quality control, water treatment and waste water treatment the infrastructure and/or networks for water supply and waste water collection are the most expensive parts of urban and rural water management systems. The design of such networks is well known since decades. Nevertheless, the question whether such complex systems are necessary or decentralized solutions are more suitable has to be answered by the planning engineers. This course will be organized as seminar and provide a platform for discussions on how to develop/design water supply and waste water treatment under highly diverse boundary conditions, which the students face in their countries.

Decentralized Water Treatment:

- Basic technologies for water disinfection (solar disinfection, gravity driven membrane systems, slow sand filtration)
- Rainwater harvesting (RWH) and necessary storage tanks (natural storage systems).Local distribution systems like Water Kiosks, water trucks, individual household connections.

Differentiation of waste water:

- Blackwater (wastewater from the toilets, a mixture of urine and faeces).
- Greywater (wastewater without excreta respectively from kitchen, bathroom and laundry).
- Yellowwater (separately collected urine).
- Brownwater(separately collected faeces).

Based on the composition of the different waste water streams, how can the nutrient content be reused for agriculture?

Water-born sanitation:

- sewer, treatment plants (for example constructed wetland) and re-use of the outflow.
- septic tanks, cesspool emptier and central treatment plant

None water-born sanitation.

- Pit latrines (basic sanitation), Composting and dry toilets.

Evaluation mode: presentation, final paper (based on project)

References *(books, papers, reviews,….).*

• Andreas Ulrich, Stefan Reuter, Bernd Gutterer, Ludwig Sasse, Thilo Panzerbieter: Decentralised Wastewater Treatment Systems and Sanitation in Developing Countries (DEWATS): A Practical Guide, WEDC (2010)
• UNEP, 2002. Rainwater Harvesting And Utilisation: An Environmentally Sound Approach for Sustainable Urban Water Management: An Introductory Guide for Decision-Makers. United Nations.
• T.H. Y. Tebbutt (1998):Principles of Water Quality control, Butterworth-Heinemann

Title of Master: Master in Water, Engineering Track

Semester 3: River Basin Management 1: Management of Extremes (Draughts and Flooding)

Teacher Responsible of TU: A1

Teacher responsible of module: A1

Objective of the course (teaching)

The course confers knowledge that students will understand

- *The causes and occurrences of droughts and floods under the different African climate regimes and river basins*
- *The hydrology and hydraulics of extremes*
- *The role of the watershed*
- *The effect on the affected population and the resulting damages*
- *The technical and land use related options to minimize the effects .*

The students will be qualified

- *To assess the risks of extremes for a given African river basin*
- *To assess the existing approaches of dealing with the extremes by the local population*
- *To evaluate governmental options to further reduce the risks of extremes from a technical. Economic and social perspective*

Recommended background knowledge

Module Content:

The course covers the hydrological and hydraulic bases for droughts and floods as they occur in African rivers. The approaches of analysing the impact of climate change and the status of research will be applied to the African Context. The course will include the effects of draughts and floods together in one course and starting with the effects of both extremes on the local population and it will cover the approaches of the local population with dealing with the extremes (Land use uses, storage techniques, adjustment of living quarters). The classical technical options of water storage and flood protection will be analysed from a technical and economic point of view as well as non-technical approaches in land use changes and planning.

Evaluation mode: final exam, final paper and problem sets

References *(books, papers, reviews,….).*

- Wilhite, D.A. (Ed.) 2001, Drought : a global assessment, London Routledge, 2 Vols.
- Iglesias, A., A. Cancelliere, F. Cubillo, L. Garrote, and D. Wilhite, (eds.) 2009. *Coping with Drought Risk in Agriculture and Water Supply Systems: Drought Management and PolicyDevelopment in the Mediterranean*. Springer Publishers, Dordrecht, The Netherlands.

- Davis, A.P., McCuen, R.H. 2005, Stormwater management for smart growth
- Asian Development Bank, 2013, Flood Risk Management: A Strategic Approach, Manila
- Field, C.B., Barros,V., Stocker, T.F. 2012, Managing the risks of extreme events and disasters to advance climate change adaptation, Special IPCC report, Cambridge

Title of Master: Master in Water, Engineering Track

Semester 3: Water River Basin Management 2: Management of Transboundary Water Resources

Teacher Responsible of TU: A1

Teacher responsible of module: A1

Objective of the course (teaching)

This course aims to

• develop an understanding of the challenges encountered in managing transboundary water resources especially in africa,

• knowledge of legal principles upon which transboundary management of water resource is based,

• approaches and methods for managing transboundary water resources,

• to identify and evaluate twr management problems, and propose possible solutions.

Recommended background knowledge

Module Content:

1. Challenges for management of transboundary water resources.
2. Legislative Framework for Management of Transboundary Water Resources (International water law, Regional protocols, agreements and treaties for transboundary water resources management, Principles for allocating transboundary water resources)
3. Institutional Arrangements for Integrated Management of Transboudary Water Resources (Types and functions of transboundary river basin organizations, Stakeholder participation at national and transboundary levels)
4. Methods for planning integrated management of transboundary water resources (Transboundary dianostic analysis, Strategic action planning)
5. Integrated management of transboundary river basins
6. Integrated management of transboundary lakes
7. Integrated management of transboundary aquifers
8. Case Studies of approaches past and current approaches used for transboundary water resources management in Africa, e.g. Okavango, Nile, Orange River, Niger

Evaluation mode: problem sets, final paper based on group work, final exam

References *(books, papers, reviews,….).*

• International Network of Basin Organizations (INBO) and the Global Water Partnership (GWP). 2012. Handbook for integrated water resources management in transboundary basins of rivers, lakes and aquifers. www.inbo-news.org, www.gwpforum.org,

• UNEP, 2011. L. Jeftic, P. Glennie, L. Talaue-McManus, and J. A. Thornton (Eds.). Methodology for the GEF Transboundary Waters Assessment Programme. Volume 1. UNEP, x+60 pp.

• UNESCO-IHP, 2011. Methodology for the GEF Transboundary Waters Assessment Programme. Volume 2. Methodology for the Assessment of Transboundary Aquifers, UNEP, vi + 113 pp.
• ILEC, 2011. Methodology for the GEF Transboundary Waters Assessment Programme. Volume 3. Methodology for the Assessment of Transboundary Lake Basins, UNEP, viii + 69 pp.
• UNEP-DHI, 2011. Methodology for the GEF Transboundary Waters Assessment Programme. Volume 4. Methodology for the Assessment of Transboundary River Basins, UNEP, viii + 147 pp.

Title of Master: Master in Water, Engineering Track

Semester 3: Physical Instrumentation and Measurement

Teacher Responsible of TU: A6

Teacher responsible of module: A6

Objective of the course (teaching)
The goals of the course are to better make measurements, understand the physical principals of the parameters and to use those measurements in any research project to: better evaluate their use and their spatial variability, to make better use of them in the evaluation, planification or in the management of water.

Recommended background knowledge
Basics of calculus

Module Content:
1. Introduction,
2. Physical principles of measurement
3. Principal parameters (measurement of water level, flow rate, speed of water, sedimentation and conductivity of water),
4. The chains of measurement (automatic)
5. Equipment for manual measurement
6. Conclusion

Evaluation mode: lab report

References *(books, papers, reviews,….).*
See available Handbooks and Manuals of related Lab Equipment

Title of Master: Master in Water, Engineering Track

Semester 3: Applied Numerical Analysis and Modeling

Teacher Responsible of TU: A6

Teacher responsible of module: A6

Objective of the course (teaching)

• *Provide the student with an understanding of the basic concepts, computer implementation and water models;*
• *Guide the student in developing a critical eye for computational matters;*
• *Impart the basic skills needed to use finite element method to solve numerical problems*
• *Skills in applying methods to predict applied situations*

Recommended background knowledge

Basics of calculus, linear algebra, differential equations

Module Content:

A- Finite and element difference methods
I. Computer Number Representation and Round off
II. Interpolation
III. Numerical Different ion and Integration
IV. Nonlinear Equations
V. Numerical Solution of Ordinary Differential Equations
VI. Numerical Solution of Elliptic Partial- Differential Equations
VII. Parabolic Partial- Differential Equations
VIII. Hyperbolic Partial- Differential Equations

B Finite volume methods: Godunov scheme summary; Minmod limiter, flux limiting function formulation, Hartens's sufficient conditions for numerical method to be TVD, extension to systems of linear PDE's, extension to nonlinear PDE's, mat lab implementation; two dimensional advection; groundwater modelling by finite element method

Part 1: Basic Concepts
Part 2: Computer Implementation
Part 3: Modelling groundwater flow
Part 4: Modelling solute transport

- Hydrological modelling: similar to groundwater modelling all the steps sited before will be followed to give the student the basic tools how to discretize the problem domain; how to make the computer implementation and how to model flow runoff in the hydrological basin and in the river.
- Pressure network modelling: similar to what is presented in the previous, steps will be followed to solve the hardy cross problems.
- Other models

Evaluation mode: final exam (take-home)

References *(books, papers, reviews,….).*

• Introdution to Numerical Computations (Sidney Yakowitz; Ferenc Szidarovszky);
• Applied Numerical Analysis (Curts F. Gerald)
• groundwater (freeze and cerry),
• groundwater hydraulics (bear).
• introduction to finite element method (segerlind)

Title of Master: Master in Water, Engineering Track

Semester 3: Geographical Information Systems

Teacher Responsible of TU: A6

Teacher responsible of module: A6

Objective of the course (teaching)

At the end of the course, the student will be:

• able to design a GIS application,

• able to understand how are the various and multi sources data are structured in a GIS software

• to know the potential analysis that can be done in various situations to produce useful information to support decision making in planning, monitoring and management of resources (water, forests, soil, lands) and infrastructures (drinking-water systems, a network of roads and tracks, ...)

• Be able to choose the type of GIS software to operate according to its needs,

• aware of the problems associated with the information flow and the reliability of data used in a GIS for the success of its operations

Recommended background knowledge

Basics of calculus.

Module Content:

Theoretical part in the regular classroom

Chapter 1: Introduction to GIS
Chapter 2: Modelling geographical space(systemic approach)
Chapter 3: Methodology for developing a Data Conceptual Model (DCM)
Chapter 4: Numeric Modelling in GIS (Topologic and no topologic system)
Chapter 5: Acquisition Digital
Chapter 6: Digital Elevation Model (DEM)
Chapter : Quality of data (meta data)

Application part : computer room equipped with GIS software (Arc View or Map Info)

The main purpose of tutorials conducted in the computer lab is to become familiar with the main functions of a GIS application (+ GIS software application).

- Data Conceptual Modelling
- Visualization of spatial data
- Thematic Analysis/ Spatial analysis / SQL
- Digitizing / Creating new themes, up to date of data
- Georeferencing

Evaluation mode: final exam. problem sets (exercises on GIS projects)

References *(books, papers, reviews,….).*

• Springer handbook of geographic information / Kresse; Danko (ed.) Berlin [u.a.] : Springer, 2012
• The geospatial desktop: open source GIS & mapping / Gary Sherman

• Williams Lake, BC : Locate Press, 2012
• Handbook of applied spatial analysis : software tools, methods and applications / Manfred M. Fischer; Arthur Getis (eds.), Heidelberg [u.a.] : Springer, 2010
• Geographical information systems and spatial optimization / Sami Faiz; Saoussen Krichen: CRC Press, 2013

Title of Master: Master in Water, Engineering Track

Semester 3: Entrepreneurship and Intrapreneurship

Teacher Responsible of TU: A7

Teacher responsible of module: A7

Objective of the course (teaching)

Recommended background knowledge

Module Content:

I) *Introducing the Entrepreneurship/Intrapreneurship Perspective* (What is entrepreneurship/intrapreneurship? The importance of entrepreneurial dynamism for sustainable socio-economic development - contributing to the creation of social enterprise and business start-ups, fostering employability of graduates. Who is an entrepreneur/intrapreneur? How are innovation and entrepreneurship linked? Whatis an innovative company / organization? What types of innovationsand strategies do exist? – Examples from the Water and Energy Sector)

II) *Entrepreneurial/intrapreneurial mindset, motivation and behavior* (How to become an entrepreneur/intrapreneur? How to develop and identify ideas and opportunities for profitable ventures from the interplay of entrepreneurship, creativity, and innovation?What does entrepreneurship/intrapreneurship imply for an engineer, what for a policy maker?

III) *Market and Customer Understanding* (How to identify and engage relevant markets, costumers or funders? How to locate strategic positioning? How to satisfy competitive advantages and real market needs? Conducting a market and needs assessment/mapping) – How do we transfer these concepts to the public and non-profit sector?

IV) *How to manage challenges and risk taking* in entrepreneurial uncertainties? How to profit from stakeholder involvement? Mapping of the stakeholder/partner environment – Example of the Water and Energy Sector/Public and Private Sector).

V) *Business modelling and planning* (1. identifying the opportunity 2. defining the business plan, 3. authoring the business plan, 4. building financial statements,5. Sales forecasting, 6. managing the sales pipeline, 7. developing the marketing mix 8. final thoughts). Transferring the models to the public and non-profit sector.

Intrapreneurship – How can an engineer or a single actor in a public or non-profit organization foster entrepreneurship and advancement of his/her organization? How can

the developed steps and concepts of market analysis/needs assessment, risk management, business modelling and planning be applied and transferred?

Evaluation mode: Written assignment, Group project

References *(books, papers, reviews,….).*

- Eric Ries (2011): The Lean Startup. How Constant Innovation Creates Radically Successful Businesses. Portfolio Penguin, ISBN: 0670921602
- Steve Blank and Bob Dorf (2012):The Startup Owner's Manual. The Step-By-Step Guide for Building a Great Company.K & S Ranch, ISBN: 0984999302
- Alexander Osterwalderand Yves Pigneur(2010): Business Model Generation. A Handbook for Visionaries, Game Changers, and Challengers. John Wiley & Sons, ISBN: 0470876417
- Guy Kawasaki (2004): The Art of the Start. The Time-Tested, Battle-Hardened Guide
  for Anyone Starting Anything. Portfolio Hardcover, ISBN: 1591840562
- Michael H. Morris, Donald F. Kuratkoand Jeffrey G Covin(2007): Corporate Entrepreneurship & Innovation, Cengage Learning (2 edition),ISBN: 0324259166
- BarunMitra, Kendra Okonski, MohitSatyanand (2007): Keeping the Water Flowing. Understanding the Role of Institutions, Incentives, Economics and Entrepreneurship in Ensuring Access and Optimising Utilisation of Water.Academic Foundation, ISBN: 8171885837
- Guy M. Merritt, Roland Smith, Preston G. Smith (2002): Proactive Risk Management. Controlling Uncertainty in Product Development.Productivity Press, ISBN: 1563272652
- Henry William Chesbrough (2003): Open innovation. The new imperative for creating and profiting from technology. Harvard Business Review Press, ISBN: 1422102831
- Hanns C. Menzel, IirisAaltiob and Jan M. Ulijna (2007): On the way to creativity. Engineers as intrapreneurs in organizations

http://businessmodelalchemist.com/blog/2010/03/a-business-model-for-solar-energy.html

Semester 4: Thesis, Internship in enterprise and Seminars (30 credits)

Thesis (14 credits): between 4 and 6 months.

Internship in enterprise or research entity (10 credits)

Seminars (6 credits): new trends in research with several conferences.

V- Agreements /conventions

LETTRE of INTENT TYPE

(In case of master jointly sponsored by another university)

(Paper to the official letterhead of the university concerned)

Subject: Approval of the master cosponsorship entitled

For this, the university (or university center) .....states .....co-sponsor the above-mentioned master throughout the qualification period of this master.

For this purpose the university (or university center) will attend to this project:
- Giving his perspective in the development and updating of curricula,
- Participant in seminars organized for this purpose,
- By participating in panels defense,
- In working towards the mutualisation of human and material resources.

SIGNATURE of the person legally authorized:

FUNCTION:

Date:

LETTRE of INTENT TYPE

(If a master is created in collaboration with a master enterprise from the user sector)

(Official letter of the company)

SUBJECT: Approval of the launching of a Master program entitled:

Delivered to:

For this, the company .....declares its willingness to show his support for this training as a potential user of the product.

For this purpose, we confirm our commitment to this project and our role is to:
- Give our perspective in the development and updating of curricula,
- Participate in seminars organized for this purpose,
- Participate to panels defense,
- Facilitate as much as possible hosting trainees is through memories of graduation or within tutored projects.

The necessary means for the execution of our tasks for the achievement of these objectives will be implemented on the physical and human.
Mr. (or Madam) ..... is designated (e) as external coordinator of this project.

SIGNATURE of the person legally authorized:

FUNCTION:

Date:

OFFICIAL STAMP or SEAL OF THE COMPANY

VI – Curriculum Vitae of Coordinators

VII - Reviews and Visas administrative and advisory organs

Title of the Master proposed:

Scientific Committee of Department
Decision and Visa of Scientific Committee: Date :
Scientific Council of Faculty or Institute
Decision and Visa of Scientific Council Date :
Dean of faculty (or Director of Institute)
Decision and Visa of Dean or Director: Date :
Scientific Council of University
Decision and Visa of President of University : Date :

VIII - Visa of the regional Conference

(Only to fill in the final version of the Master offer)