POSTGRADUATE INSTITUTE OF SCIENCE

UNIVERSITY OF PERADENIYA

M.Sc. in Water Resources Management
(Course work – SLQF Level 9)

M.Sc. in Water Resources Management
(Course work and Research – SLQF Level 10)

1. INTRODUCTION

Water management traditionally has focused on manipulating the world's vast freshwater resources to meet the needs of humans. Constraints such as increased development costs and increasing concern for the environment have forced water managers to consider alternative approaches. Although water is a renewable resource, worldwide demand for water increases exponentially while quality and quantity of fresh water in many regions is deteriorating fast. Water engineers, managers and sector relevant professionals therefore, require a much broader understanding of water issues than previously. The purpose of this postgraduate program in water resources assessment evaluation, development and management is to provide engineers and scientists with expert, up-to-date knowledge in the fields of:

- Water Resources
- Hydraulics and
- Water Resources Assessment ,Evaluation, Development and Management

The Board of Study in Earth Sciences has regularly updated the M.Sc. program in Water Resources Management introducing new courses and modifying existing ones to suit national needs. This proposal introduces a five-credit independent study module to improve writing/oral communication skills as applied to Water Resources Management.

2. OBJECTIVES OF THE PROGRAMME

The program is designed to provide the students with a sound theoretical and practical knowledge of the principles of water resources assessment, evaluation development and management. The program is also intended to enable students to update their hydraulics and computational expertise, to appreciate the environmental implications of water resources, and to develop management skills.

3. PROGRAMME ELIGIBILITY

Candidates possessing the following educational and Professional qualifications are eligible to apply for the program

(i) Bachelors degree in Science, Engineering, Agriculture or Natural science from a recognized university
(ii) Any other equivalent qualifications acceptable to PGIS

Candidates who meet the eligibility requirements will be called for an aptitude test and interview and selected candidates will be admitted to the program. Employed candidates should show evidence of

leave granted to follow the program and a letter of release from the head of the department /institution.

4. PROGRAMME FEE

Category	Programme Fee	
	M.Sc. by Course work	M.Sc. by Research
Local candidates	Rs 175,000/-	Rs 275,000/-
Foreign candidates	Rs 350,000/-	Rs 550,000/-

Students registered for the M.Sc. degree by course work shall pay the Programme fee in full or in two (1/2 at the registration and the balance at the end of the first semester) or three ($1/3^{rd}$ at the registration, another $1/3^{rd}$ after 4 months from the date of registration and the balance after 8 months from the date of registration) installments. An additional payment of Rs. 100,000/- (or Rs. 200,000/- from foreign students) should be made at the end of the first year to continue for the M.Sc. degree by course work & research. Other payments including registration fee, medical fee, library subscription, examination fee and deposits (science and library) should be paid according to the procedure stipulated by the PGIS. (N.B. The Programme fees given above may be revised as per recommendation of the Board of Management of the PGIS.)

5. THE PROGRAMME STRUCTURE AND DURATION

5.1 Masters Degree with Course Work

The M.Sc. degree (Course work) can be obtained by completing course work only (without conducting any research project).

Course work, comprising of theory courses, and laboratory and/or fieldwork, shall be conducted over a period of two semesters of 15 weeks each. The total duration of the degree, including examinations, shall be about 12 months. Satisfactory completion of a minimum of 30 credits of course work with a GPA of not less than 3.00 is required for the successful completion of the degree - SLQF Level 9 (Students who do not satisfy the above criteria but obtain a GPA in the range 2.75 to 2.99 for course work of 25 credits are eligible for the Postgraduate Diploma in Water Resources Management - SLQF Level 8, and those who obtain a GPA in the range 2.75 to 2.99 for course work of 20 credits are eligible for Postgraduate Certificate - SLQF Level 7).

5.2 Masters Degree by coursework and research.

Completion of 30 credits of Course work as stated in 5.1 with a GPA of not less than 3.00 is a prerequisite for the Masters Degree by Course work and Research. The research project for the degree should be conducted on full-time basis, and completed during the second year. The research component is allocated 30 credits, totaling 60 credits for the entire programme. Therefore, duration of the entire programme shall be 24 months. After successful completion of the research project, the student shall be eligible for the award of the M.Sc. Degree in Water Resources Management by Course Work and Research (Students who do not complete the research project within the stipulated time period shall be awarded the M.Sc. Degree by Course Work in Water Resources management.

5.3 Extension of the programme for M.Phil. or Ph.D.

After conducting research for a period of six months in the M.Sc. degree (research) programme, students who have demonstrated exceptional progress may apply for upgrading the degree status to M.Phil. The student should continue the research project and any additional research work/assignments recommended by the PGIS for a total of two years (60 credits of research) to qualify for the award of the M.Phil. degree

During the second year of research, students who have demonstrated exceptional and continuous progress may apply for upgrading the degree status from M.Phil. to Ph.D. The student should continue the research project and any additional research work/assignments recommended by the PGIS for another year on full-time basis (to complete 90 credits in total to qualify for the award of the Ph.D. degree.

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PROGRAMME SUMMARY

Course Code	Course	Lecture Hrs.	Practical Hrs.	No. of Credits
Semester I				
ESW 501	Introduction to Water Resources	25	10(F)	2
ESW 502	Applied Environmental Hydrology	25	10	2
ESW 503	Groundwater Hydrology	25	10	2
ESW 504	Catchment Processes and Water Shed Management	25	10	2
ESW 505	Geochemistry of Natural Water, Pollution and Water Quality Monitoring	25	10	2
ESW 506	Economics of Water	15	-	1
ESW 507	Fluid dynamics*	20	20	2
ESW 508	Water resources of Sri Lanka	15	-	1
ESW 509	Hydraulic Civilization of Sri Lanka*	15	-	1
ESW 510	Integrated Catchment Modeling*	15	30	2
ESW 511	Geo-Information Systems in Water Resources Management	15	30	2
ESW 512	Water and Irrigation*	25	10(F)	2
ESW 514	Water and Wastewater Treatment	25	10(F)	2
ESW 515	Application of Geophysics in Groundwater exploration*	15	15+15(F)	2
ESW 516	Computer Applications in Hydrology and Hydrogeology*	15	30	2
ESW 517	Water Resources Planning and Evaluation, Water Law, Policy and Legislation	30	-	2
ESW 519	Wetlands*	15	-	1
ESW 520	Floods and Flood management*	15	-	1
ESW 597	Seminar			1
ESW 599	Independent study II	500 notional hrs.		5
ESW699	Research Project**	3000 notional hrs. (one year)		30

* *Optional courses.*
** *Compulsory for M.Sc. (Research)*

6.0 PROGRAMME CONTENTS FOR ESW 599 AND ESW 699

Course code	ESW 599
Course title	Independent Study
Credits	05
Compulsory/optional	Compulsory
Prerequisites	None
Time allocation	500 notional hrs.
Aims	Aims: The overall aim is to familiarize the student with concepts and methods involved in scientific research **Specific aims:** 1. To explain the scientific process in the conduct of research. 2. To develop skills to write a review paper and a scientific research proposal. 3. To develop skills to make a presentation. 4. To master the application of statistical methods on quantitative scientific data.
Intended learning outcomes	At the end of the successful completion of the course, students will be able to, 1. Explain the scientific method. 2. Conduct an independent review of literature on a selected topic in the area of Water Resources Management. 3. Write a formal scientific report conforming to the guidelines provided. 4. Transfer the knowledge gained through (2) and (3) above in the form of a presentation. 5. Complete a research proposal conforming to the guidelines provided. 6. Perform statistical analysis of quantitative data.
Content	*Review paper*: Review of literature; Development of the review paper in concise and professional manner and logical presentation of results that have been reported, writing the abstract, compilation of the list of references. *Proposal writing*: Interpretation and critical evaluation of results of published research; Formulation of a research problem: Concise literature review, justification, time frame, identification of resources, budgeting, etc. *Project*: Collection and analysis of data on a topic associated with the review paper. *Seminar*: Presentation of literature and data collected on a given topic; Preparation of an abstract, preparation of slides.

Assessment criteria: Continuous Assessment

Component	Review paper	Proposal writing	Project	Seminar
% marks	20	10	40	30

Recommended Texts:

1. Backwell, J., Martin, J. (2011) A Scientific Approach to Scientific Writing, Springer.
2. Postgraduate Institute of Science (2016) Guidelines for Writing M.Sc. Project Report/M.Phil. Thesis/Ph.D. Thesis
3. Cambridge University Press, R. Quentin Grafton and Karen Hussey (2011). Water Resources Planning and Management. Online ISBN:9780511974304 Hardback ISBN:9780521762588

Course code	ESW 699
Course title	Research Project
Credits	30
Compulsory/optional	Compulsory
Prerequisites	GPA 3.00 at M.Sc. (Course work)
Time allocation	3000 notional hrs. (one year duration)
Aims	Aims: The overall aim is to prepare the student to conduct a research independently. **Specific aims:** 1. To train students to apply scientific method in scientific research. 2. To train students to generate researchable hypotheses. 3. To train students to plan, design and conduct scientific research. 4. To gather reliable scientific data, analyse, and interpret. 5. To develop skills in scientific writing.
Intended learning outcomes	At the end of the successful completion of the course, students will be able to, 1. Apply the scientific method. 2. Design a research project. 3. Complete a research project. 4. Describe ethical issues in scientific research 5. Explain the patenting process in research. 6. Make presentations at national/international conferences. 7. Produce a thesis conforming to the requirements of the PGIS. 8. Write manuscripts for publication in refereed journals.
Content	The students will conduct sufficient amount of laboratory/field work on a chosen research topic under the guidance provided by an assigned supervisor/s, make a presentation of research findings at a national/international conference, and produce a thesis.

Assessment criteria

Continuous assessment	End-semester examination
30%	Oral examination (20%) Thesis (40%) Conference presentation (10%)

Recommended Texts:

1. Backwell, J., Martin, J. (2011) A Scientific Approach to Scientific Writing, Springer.
2. Postgraduate Institute of Science (2016) Guidelines for Writing M.Sc. Project Report/M.Phil. Thesis/Ph.D. Thesis
3. Cambridge University Press, R. Quentin Grafton and Karen Hussey (2011). Water Resources Planning and Management. Online ISBN:9780511974304,Hardback ISBN:9780521762588

Contents of courses

ESW 501: Introduction to Water Resources (2 credits)

Distribution of water on planet Earth , Hydrologic cycle, Renewable water resources, Time and space variability, Initial data and methodological approaches Continents, Natural-economic regions and countries, River basins, Inflow to the world Oceans. River runoff and underground water. Use of water resources, Principal water users and tendencies of their development, Assessing and forecasting global water use. Water availability and water resources deficit, Historical perspective of water and development, Anthropogenic changes in global climate and water resources. Ways of eliminating fresh water deficit in the world.

ESW 502: Applied Environmental Hydrology (2 credits)

Hydrologic processes, Methods for quantifying hydrologic parameters and processes. Soil water hydrology, Precipitation, Evapotranspiration, Infiltration Groundwater flow, Surface runoff, Soil erosion, Flow in channels, Forest and wetland hydrology, Remote sensing applications in hydrology, Modeling hydrologic systems, Environmental impacts related to Hydrological systems. Environmental impacts on water resources.

ESW 503: Groundwater Hydrology (2 credits)

Subsurface environment, Role of Groundwater in the hydrologic cycle, Water bearing properties of rocks and soils, Aquifer types: Principles of groundwater movement, Recharge, Groundwater development ,Groundwater withdrawal, Well hydraulics and Determination of aquifer parameters. Groundwater quality, Groundwater in coastal zones, Saline water intrusion, Hydrogeological mapping, Groundwater development in Sri Lanka.

ESW 504: Catchment Processes and Water Shed Management (2credits)

Introduction to watersheds, watershed functions, classifying, and evaluating watersheds, Ecology, geology, soils and geomorphology of water sheds, Basic Elements of watershed management, Soil and Vegetation management. Soil erosion/sediment control, Native species and re vegetation, Data collection, Wetland monitoring, Meteorological monitoring, Hydrological monitoring, Damage assessment, Range management

ESW 505: Geochemistry of Natural Waters, Pollution and Water Quality Monitoring (2credits)

Geochemical cycle, Composition of rainwater, Surface water and groundwater, Equilibrium thermo dynamics, Activity-concentration relationships, Carbonate systems and pH control , Silicate-water reactions , Weathering and water chemistry, Clay minerals and cation exchange, Adsorption, Organic compounds in natural waters, Radox conditions in natural waters, Quality of water, Water quality standards, Causes and concepts of pollution of water, Groundwater and Base Flow contamination, Mass transport, Transformation, retardation and attenuation of solutes, Inorganic chemicals and organic compounds in water, Urban and highway diffuse pollution, Industrial water pollution, Agricultural diffuse pollution, Water quality and health, Water quality monitoring as an information system: Sample collection, laboratory analysis, data handling, data analysis, reporting, and information utilization.

ESW 506: Economics of Water (1 credit.)

Worlds water supply and demand, Surpluses and deficits, Potential functions of water, Value of water, extractive values and insitu values, Valuation methods, Contingent Valuation Method(CVM), Hedonic Price Model (HPM), Travel Cost Method (TCM) , Production costs, Conservation and Protection, Conservation by pricing, Risk costs and value of reduction of contamination. Downstream impacts from up stream decisions.

ESW 507: Fluid dynamics (2 credit)

Introduction to fluids, Physical aspects of flow, Laminar flow theory and applications,Turbulence theory and applications, Incompressible and compressible flow, Fluid flow in porous media.

ESW 508: Water resources of Sri Lanka (1 credit)

Sri Lanka and Global climatic Zones, Hydrometeorology of Sri Lanka, Climatic zones,Precipitation, Evaporation and Evapo-transpiration. Surface runoff and infiltration, Surface water resources of Sri Lanka, Major rivers and river basins, Groundwater resources of Sri Lanka, Main Hydrogeological units, Cold and thermal water springs of Sri Lanka. Water quality and environmental impacts on water resources of Sri Lanka.

ESW 509: Hydraulic Civilization of Sri Lanka (1 credit)

Hydraulic technology of Sri Lanka, Ancient reservoirs and irrigation channels Tanks and tank Builders, Tank and Village, Water ways and Folk ways , Water and water gardens, Water and its functions, Rain makers, water across religion.

ESW 510: Integrated Catchment Modeling (1 credit)

Catchment modeling techniques, Traditional and advanced approaches, Real-time flow forecasting, Mathematical modeling of integrated catchment responses in water flow, sediment and contaminant transport, Mathematical modeling for predicting impacts of future climate and land use changes. Parameterizing, Running and Validation of specific models, Limitations of catchment models.

ESW 511: Geo-information Systems in water resources Evaluation and Management (2 credits)

Introduction to remote sensing, Principles of remote sensing, Remote sensing systems, Digital image processing, Concepts of GIS, Spatial data: sources, acquisition and entry, Database, Vector and raster data, Data analysis, GIS output, Integration of remote sensing and GIS, Application of remote sensing and GIS in water resources modeling and management.

ESW 512: Water and Irrigation (2 credits)

Soil-plant-water relations, Water requirement of crops, Cropping pattern, Irrigation of lowland rice and upland crops, Irrigation management: methods, conveyance, measurement and control, efficiency and sustainability, Droughts and alleviation strategies, Crop drainage: requirements, drainage coefficient, design considerations, Fertilizers and their management, Irrigation water quality requirements, Chemical pollution, Rainwater harvesting.

ESW 514: Water and Wastewater Treatment (2 credits)

Physical, chemical and microbiological quality of water, Water quality management strategies. Fundamentals of chemical reactions. Chemical oxidation and reduction, Coagulation, Mixing, and Flocculation, Gravity Separation, Granular filtration, Membrane Filtration, Disinfection, Reverse osmosis. Ion exchange .Introduction to wastewater, Wastewater constituents, Wastewater characteristics, Wastewater treatment processes, Wastewater removal plants, Nutrient removal from

waste water .Sludge handling and disposal, Industrial wastewater source control, Urban storm water Management.

ESW 515: Application of Geophysics in Groundwater exploration (2 credits)

Subsurface geophysical parameters, Surface geo physical methods in groundwater exploration, principles and applications of Resistivity, Seismic, electromagnetic and gravity methods, Geo physical well logging techniques.

ESW 516: Computer Applications in Hydrology and Hydrogeology (2 credits)

Two available computer packages one on hydrology and the other on hydrogeology will be will be selected based on students background and will be conducted as combined theory and laboratory practical assignment.

ESW 517: Water Resources Planning and Evaluation, Water Law, Policy and Legislation (2 credits)

Planning fundamentals and processes, Water resources systems, Sustainable development, Water policy, Water sharing, Sectoral demands and resource allocation, Management of water demand and use, Water conservation and augmentation, Multi-criteria analysis, Planning under risk and uncertainty, Institutional aspects and people's participation. Water use and water market, Water and ethics, Water and poverty, Water and gender issues, Water conflicts and corporation, Water policies and procedures, Legal and Institutional requirements for water resource management, Water allocation laws, Environmental issues of water quality and quantity.

ESW 519: Wetlands (1credit)

Definitions and classification of wetlands, Wetlands of the World. Wetland Environment, Wetland Hydrology. Wetland Ecosystems, Tidal Salt marshes, Tidal fresh water marshes, Mangrove swamps, Fresh water marshes, Peat lands, Riparian Ecosystems, Wetland Management, Wetland laws and protection.

ESW 520: Floods and flood Management (1 credit)

Floods as natural hazards, Causes, dynamics and consequences of river and coastal floods, Study of floods and their effects on landforms, Sediments, human works, and populations, Impacts and interpretations of flood hazard, Spatial characteristics and form of river floods and coastal floods, Common alluvial systems leading to flood plains. Flood estimation, Flood forecasting and warning. Policies and prospects.

ESW 597: Seminar

Students will be guided to survey for the literature on current topics related to their research topics. All students pursuing a M.Sc. degree will be required to present the findings at an oral presentation which will be of 30 minutes duration followed by another 30 minutes questions/discussion session. A hard copy of the presentation must be submitted to the PGIS.

7.0 PROGRAMME EVALUATION

Evaluation of Course work

Evaluation of course work is done as per guidelines stipulated in the PGIS Handbook. Scheme of evaluation of the five-credit independent study (ESW 599) and the Research Project (ESW 699) is given in Section 6 above.

8.0 TEACHING PANEL

	Name, Affiliation, Qualifications and Expertise	Area of Specialization
1.	Prof. Christina Shanthi De Silva, *B.Sc. (Ceylon), M.Phil. (Perad.), Ph.D. (Cranefield)* Department of Agricultural Engineering, Open University, Nugegoda	Agriculture Engineering, Hydrogeology
2.	Prof. C. B. Dissanayake, *B.Sc. (Cey), Ph.D. (Oxon.), D.Sc. (Oxon.)* Professor emeritus, Department of Geology, UOP	Geochemistry
3.	Dr. J. Goonatileke, *B.Sc. (Perad.), M.Sc. (AIT), Ph.D. (Saga* Department of Geology, UOP	Engineering Geology
4.	Dr. H. A. Dharmagunawardhane, *B.Sc. (Perad.), M.Phil. (Perad.), Ph.D. (Copenhagen),*Department of Geology, UOP	Hydrogeology, Applied Geophysics
5.	Prof.Rohana Chandrajith, *B.Sc. (Perad), Ph.D. (Germany)* Department of Geology, UOP	Geochemistry
6.	Prof. H. A. H. Jayasena, *B.Sc. (Perad.), M.Sc. (Colorado)* Department of Geology, UOP	Hydrology
7.	Prof. C. M. Maddumabandara, *B.A. (Cey.), Ph.D. Cambridge*, Prof. emeritus, Department of Geography, UOP	Geography
8.	Prof. A. Senaratne, *B.Sc. (Perad.), Pg.Dip. (London), M.Sc. (London), Ph.D. (Mainz)* Department of Geology, UOP	Geochemistry
9.	Prof. P.Wikramagamage, *B.A. (Perad.), Ph.D. (London)* (Retired),Department of Geography, UOP	Geography, GIS
10.	Dr. J.J. Wijethunge, *B.Sc. Eng. (Moratuwa), Ph.D. (Cambridge)* Department of Civil Engineering, UOP	Civil Engineering, Hydraulics
11	Prof. K.D.W. Nandalal, *B.Sc. (Perad), Ph.D.* Department of Civil Engineering, Faculty of Engineering,UOP	Civil Engineering, Hydrology
12	Mr. K.A.W. Kodituwakku, *B.Sc. (Perad), M.Sc. (Nederlands)* Former Deputy General Manager, Water Resources Board.	Hydrogeology
13	Dr. Gemunu Herath, *B.Sc.(Perad), (Ph.D.,)* Department of Civil Engineering, Faculty of Engineering,UOP	Environmental Engineering
14	Mr. A.S.M. Naufal , BA *(Perad)*, Mphil (Perad) retired Senior Lecturer, Department of Geography, UOP	Geographic Information Systems
18	Muditha P. Perera, *B.A. (Cey.), M.Phil. (Perad.)* Senior Lecturer, Department of Geography, UOP	Geography
19	Dr.C.S.Kalpage, Senior Lecturer, Department of Chemical and Processing Engineering, Faculty of Engineering,UOP	Chemical Engineering, Environmental Engineering)
20	Dr N.W.B Balasooriya .Sc. (*Perad.*), Ph.D.Peradeniya Department of Geology, UOP	Geology
22	Dr. Apsara Umayangani Wijenayake, BSC *(Perad*)Geology, PhD. Geochemistry Research Officer, Gem and Jewellery Research and Training Institute, Weliwita, Kaduwela	Geology, Geochemistry
23	**Prof . Tilak Hewawasam,** BSc *(Perad),* PhD.Geology, Department of Geography, University of Peradeniya	Geology, Geochemistry
24	**Dr Nadishani Nanayakkara**, BSc Civil Eng.,PhD Civil Eng Senior Lecturer**,** Department of Civil Engineering, Faculty of Engineering, University of Peradeniya.	Water and wastewater treatment
25	**Dr Shamin Jinadasa Nanayakkara**, BSc Geology, PhD Civil Engineering Senior Lecturer**,** Department of Civil Engineering, Faculty of Engineering, University of Peradeniya.	Waste water management

9.0 PROGRAMME COORDINATOR

Prof. H. A. Dharmagunawardhane
Department of Geology
University of Peradeniya
Peradeniya Tel 081 2394212
E-mail: dharmag@pdn.ac.lk