WATER SCIENCE AND MANAGEMENT

Graduate Program Information

New Mexico faces serious challenges concerning the supply, development, quality, management and administration of water resources; responses to the challenges will have major impacts on the regional economy, environmental quality, and the quality of life of the residents of New Mexico. A major need exists to train the next generation of water resource researchers, educators, and managers to address these challenges, both inside and outside New Mexico. To help meet these needs, an interdisciplinary program in Water Science & Management (WSM) has been developed at NMSU by the departments of

- Agricultural Economics and Agricultural Business,
- Animal and Range Science,
- Civil Engineering,
- Geography, and
- Plant and Environmental Sciences.

The primary purposes of the interdisciplinary masters and doctoral degree programs in WSM are to provide graduate education for addressing state, national, and international water issues, and to train the next generation of water professionals needed to meet the challenges noted above.

Admission Requirements

Admission Requirements for the Master of Science (MS) in water science and management include all general requirements for a graduate degree as set forth in the NMSU Catalog, plus the following:

- Possession of a bachelor's degree from an accredited university grade point average of 3.5 or higher on a 4.0 scale. However, students with grade point averages between 3.0 and 3.5 will be given consideration, this degree being preparatory to the Water Science and Management degree.
- A letter of intent or statement of purpose that addresses individual professional and personal goals related to water science and management and discusses how these goals fit within the degree programs at NMSU. It is expected that the candidate will have made contact with prospective advisor(s) at NMSU and speak to how he or she would work with said advisor(s) to advance their research and study.
- Three letters of recommendation submitted directly from persons who know the applicant professionally, including a recommendation from the candidate's current employer/sponsor. These letters should provide evidence of professional ability, research experience and the potential for professional development.
- A brief resume or curriculum vitae not to exceed five pages that summarize the candidate's background and qualifications.

Admission Requirements for the Doctor of Philosophy (Ph.D.) in water science and management include all general requirements for a graduate degree as set forth in the NMSU Catalog, plus the following:

- Possession of a master's degree from an accredited university with a grade point average of 3.5 or higher on a 4.0 scale. However, students with grade point averages between 3.0 and 3.5 will be given consideration. This degree being preparatory to the Water Science and Management doctorate.
- Three letters of recommendation submitted directly from persons who know the applicant professionally, including a recommendation from the candidate's current employer/sponsor. These letters should provide evidence of professional ability, research experience, and the potential for professional development.
- In addition, applicants to the Ph.D. program should provide evidence of research experience. This could include a master's thesis, a professional paper, peer-reviewed manuscripts, consulting reports, or other evidence of experience conducting research.
- A letter of intent or statement of purpose that addresses individual professional and personal goals related to water science and management and discusses how these goals fit within the degree programs at NMSU. It is expected that the candidate will have made contact with prospective advisor(s) at NMSU and speak to how he or she would work with said advisor(s) to advance their research and study.
- A brief resume or curriculum vitae not to exceed five pages that summarize the candidate's background and qualifications.

Water Science & Management Graduate Courses

To view the list of core courses required for our Master of Science and Doctor of Philosophy degrees please see the Degrees (p. 2) tab.

Five (5) concentrations are offered in the program and are detailed on the program page:

- **Agricultural Water Resources** relates to the major use of ground and surface water in providing safe and secure food systems while ensuring ecosystem services. This field of study includes water allocation, water conservation and water management issues facing urban water supply and irrigated agriculture.
- **Watershed, Riparian and Aquatic Systems** includes the processes of organizing and guiding land and other resources used in a river basin to provide desired goods and services without adversely affecting soil and water resources. Watershed, riparian, and aquatic system management involves an array of nonstructural (vegetation management) practices, as well as an array of structural (engineering) activities, when conditions warrant.
- **Water Quality and Treatment** includes processes used to make water acceptable for desired end-uses. These can include use as drinking water, industrial processes, agricultural uses and environmental management. The goal of water treatment processes is to remove existing contaminants in the water or reduce the concentration of such contaminants so the water becomes fit for its desired end-use.
- **Water Economics and Policy** examines the demand for water by all its competing uses, including irrigated agriculture, energy, urban supply, and environmental restoration and management. Policies are examined for their influence on water supplies, water demands, and economic values of water reallocations among agricultural, environmental, energy, and urban users. It examines the role of water markets, water user decisions, institutional adjustments, and water-related policies with respect to resource costs, water quality, profitability, and environmental effects.
- **Water Informatics** is an interdisciplinary science primarily concerned with the collection, classification, manipulation, storage, retrieval and especially the dissemination of water information, including both human and machine readable documents. Examples of human readable documents include maps, field data sheets, operational schedules, and long term asset management plans with narrative

text. Machine readable documents include files for geographic information systems (GIS), Global Positioning Systems (GPS), relational database management systems and emerging applications.

Degrees for the Department

Master Degree(s)

- Chemistry (Biochemistry) - Doctor of Philosophy (https://catalogs.nmsu.edu/nmsu/graduate-school/chemistry-biochemistry-doctor-philosophy/)
- Teaching English to Speakers of Other Languages - Graduate Certificate (https://catalogs.nmsu.edu/nmsu/graduate-school/teaching-english-speakers-other-languages-graduate-certificate/)
- Teaching Spanish for Heritage Language Learners - Graduate Certificate (https://catalogs.nmsu.edu/nmsu/graduate-school/teaching-spanish-heritage-language-learners-graduate-certificate/)
- Water Science and Management (Agricultural Water Resources) - Master of Science (https://catalogs.nmsu.edu/nmsu/graduate-school/water-science-management-agricultural-water-resources-master-science/)
- Water Science and Management (International Water Resilience) - Master of Science (https://catalogs.nmsu.edu/nmsu/graduate-school/water-science-management-international-water-resilience-master-science/)
- Water Science and Management (Water Economics and Policy) - Master of Science (https://catalogs.nmsu.edu/nmsu/graduate-school/water-science-management-water-economics-policy-master-science/)
- Water Science and Management (Water Informatics) - Master of Science (https://catalogs.nmsu.edu/nmsu/graduate-school/water-science-management-water-informatics-master-science/)
- Water Science and Management (Water Quality and Treatment) - Master of Science (https://catalogs.nmsu.edu/nmsu/graduate-school/water-science-management-water-quality-treatment-master-science/)
- Water Science and Management (Watersheds and Aquatic/Riparian Wetlands) - Master of Science (https://catalogs.nmsu.edu/nmsu/graduate-school/water-science-management-watersheds-aquatic-riparian-wetlands-master-science/)
- Water Science and Management - Master of Science (https://catalogs.nmsu.edu/nmsu/graduate-school/water-science-management-master-science/)

Doctoral Degree(s)

- Water Science and Management (Agricultural Water Resources) - Doctor of Philosophy (https://catalogs.nmsu.edu/nmsu/graduate-school/water-science-management-agricultural-water-resources-doctor-philosophy/)
- Water Science and Management (International Water Resilience) - Doctor of Philosophy (https://catalogs.nmsu.edu/nmsu/graduate-school/water-science-management-international-water-resilience-doctor-philosophy/)
- Water Science and Management (Water Economics and Policy) - Doctor of Philosophy (https://catalogs.nmsu.edu/nmsu/graduate-school/water-science-management-water-economics-policy-doctor-philosophy/)
- Water Science and Management (Water Informatics) - Doctor of Philosophy (https://catalogs.nmsu.edu/nmsu/graduate-school/water-science-management-water-informatics-doctor-philosophy/)
- Water Science and Management (Water Quality Treatments) - Doctor of Philosophy (https://catalogs.nmsu.edu/nmsu/graduate-school/water-science-management-water-quality-treatments-doctor-philosophy/)
- Water Science and Management (Watershed and Aquatic/Riparian Wetlands) - Doctor of Philosophy (https://catalogs.nmsu.edu/nmsu/graduate-school/water-science-management-watershed-aquatic-riparian-wetlands-doctor-philosophy/)
- Water Science and Management - Doctor of Philosophy (https://catalogs.nmsu.edu/nmsu/graduate-school/water-science-management-doctor-philosophy/)

Affiliated Faculty – S. Angadi, Ph.D. (University of Manitoba, Canada); S. Archambault, Ph.D. (UNM); A. Salim Bawazir, Ph.D. (NMSU); M.P. Bleiweiss, M.S. (California State-Los Angeles); W.Boeing, Ph.D. (Louisiana State); K. Boykin, Ph.D. (NMSU); C. E. Brewer, Ph.D. Iowa State); C. Brown, Ph.D. (San Diego State/California-Santa Barbara); S. W. Brown, Ph.D. (NMSU); M. Buenemann, Ph.D. (Oklahoma); K. C. Carroll, Ph.D. (Arizona); D. S. Cram, Ph.D. (NMSU); C. M. Downes, Ph.D. (New Mexico); D. W. DuBois, Ph.D. (Nevada); D. P. Dugas, Ph.D. (Oregon); W. M. Fedio, Ph.D. (University of Alberta, Canada); A. G. "Sam" Fernald, Ph.D. (Colorado State); R. Flores, Ph.D. (Kansas State); R. Foudazi, Ph.D. (Cape Peninsula University of Technology, South Africa); A. Ghassemi, Ph.D. (NMSU); R. M. Goss, Ph. D. (Nebraska); S. J. Guldan, Ph.D. (Minnesota); P. Gutierrez, Ph.D. (Oklahoma State University); J. Herrick, Ph.D. (Ohio State); B. H. Hurd, Ph.D. (California-Davis); M. D. Johnson, Ph.D. (NMSU); N. Khandan, Ph.D. (Drexel University); J. P. King, Ph.D. (Colorado State); S. Langarudi, Ph.D. (Worcester Polytechnic); A. S. Lara, Ph.D. (NMSU); B. Leinauer, Ph.D. (Hohenheim University, Germany); H. Luo, Ph.D. (Tulane); L. Papelis, Ph.D. (Stanford); G. A. Picchioni, Ph.D. (Texas A&M); R. C. Pratt, Ph.D. (Purdue); D. A. Rockstraw, Ph.D. (Oklahoma); R. Sallenave, Ph.D. (University of Guelph, Canada); Z. A. Samani, Ph.D. (Utah State); M. K. Shukla, Ph.D. (University of Agricultural Sciences-Vienna, Austria); G. Sims, Ph.D. (Purdue); G. B. Smith, Ph.D. (North Carolina State); R. G. Smits, Ph.D. (Purdue); S. N. Smirnov, Ph.D. (Novosibirsk University, Russia): R. St. Hilaire, Ph.D. (Iowa State); C. M. Steele, Ph.D. (King's College, University of London, UK); K. Stevens, M.S. (NMSU); B. L. Stringam, Ph.D. (Utah State); A. L. Ulery, Ph.D. (California-Riverside); J. Urquidi, Ph.D. (Texas Tech); F. A. Ward, Ph.D. (Colorado State); N. Webb, Ph.D. (University of Queensland, Australia); B. Widner, Ph.D. (Colorado State); P. Xu, Ph.D. (Ecole Nationale de Gunie Rural, France)

Water Science and Management Courses

WSAM 470. Environmental Impacts of Land Use and Contaminant Remediation
3 Credits (3)
The course will cover the integrated assessment of soil erosion, contaminant transport in soil and water, and contaminant remediation from site scale to watershed scales. Understanding of the controlling factors for each type land use impact will be gained through the use of risk assessment, case studies, and computer modeling. Case studies will illustrate the processes under various environmental applications. This course will also cover the application of solute transport principles and methods for the remediation of contaminated soil and groundwater. It will also discuss the contaminated site characterization, monitoring, and remediation design. Discussions of innovative methodologies will be supported with case studies.

WSAM 550. Special Topics
1-4 Credits (1-4)
Specific subjects to be announced in the Schedule of Classes. May be repeated up to 9 credits.

Learning Outcomes

1. Readings, discussions, and/or field and laboratory investigation of selected problems.

WSAM 551. Earth Data Retrieval
3 Credits (3)
This course covers topics related to identifying sources, preprocessing, utilizing earth data that can be used to monitor some hydrological and water related variables, vegetation growth and related biophysical properties. The course focuses on developing students' skills on how to handle and analyze high-level large amounts of research data in different formats (i.e. .hdf). The course highlights the use of remote sensing and land surface models-based (NLDAS) earth observation datasets (e.g. NDVI, LST, Ta, and ET). The course uses some open-source tools including Python, API as well as MATLAB. Crosslisted with: RGSC 551.

WSAM 575. Climate Studies, Water and Society
3 Credits (3)
The course provides a brief description of the Earth's climate system, an in-depth review and methodologies used to investigate climate change and variability, evidence of climate change on natural systems (water availability) vulnerability of human systems (e.g. agriculture) to climate change, and mitigation and adaptation strategies. Crosslisted with: RGSC 575.

WSAM 585. Land Cover Analysis for Natural Resources
3 Credits (3)
This course is designed to help students understand, manipulate and extract Earth Observation (EO) data and to conduct land cover analysis related to natural resources including water and vegetation. The course provides and highlights means to identify and access EO data in different formats, extract meaningful information, and to help students developing critical thinking skills. The course introduces tools such as python and ArcGIS Pro to handle different data formats (e.g. hdf) efficiently; develop and present creative maps. The course provides basic information about how to conduct land use, land cover change analysis, mapping vegetation, water related variables and plant and animal distribution analysis. Crosslisted with: RGSC 585.

WSAM 589. Landscape Hydrology Modeling
3 Credits (3)
Understand the landscape scale of hydrologic cycle and related hydrological processes. Quantitatively evaluate hydrological system components. Retrieve, visualize and model some of the physical processes using some of the available tools. Consent of Instructor required.

WSAM 590. System Dynamics
3 Credits (3)
This course takes a system dynamics approach to the study of economics and natural resources management. We will examine some of the example theories such as Solow-Swan model and endogenous growth theories as well as the tragedy of the commons, using system dynamics tools to uncover the feedback and explicitly examine its impact on the dynamic behavior of the system. Through these examples, we will learn how to develop, validate, and use system dynamics models for policy design and analysis.
Learning Outcomes

1. Identify common generic structures and behavioral modes in socioeconomic and ecological systems.
2. Define important feedback theories that explain the behavioral modes in socioeconomic and ecological systems.
3. Implement the system dynamics method to translate the feedback theories into dynamic simulation models.

WSAM 595. Hands-On Transboundary Aquifer and Community System Convergence Seminar
1 Credit (1)
An opportunity for graduate researchers to build partnerships with their colleagues in the IWR cohort and with our expert collaborators. Graduate researchers present their research methods, share lessons from their research activities, and report on experiences in the field and in the IWR program. An opportunity for academic, industry, and stakeholder project partners to share career development and research convergence insight with the cohort. May be repeated up to 18 credits.
Learning Outcomes

1. Students will learn about natural and social science convergence.
2. Convergence tool skill-building.
3. Students will learn how to lead the coordination of international, multidisciplinary research collaboration.

WSAM 598. Internship
1-9 Credits (1-9)
Out-of-classroom learning experiences to gain relevant education, experience, and expertise. Field-based learning providing transformative education and hands-on training. May be repeated up to 18 credits.
Learning Outcomes

1. Gain the experience necessary to engage confidently in community-centered hydrologic and social science approaches to water research.
2. Students will learn how to lead the coordination of international, cross-disciplinary research collaboration.
3. Gain experience applying academic and research knowledge in professional capacities.
4. Develop cross-sector communication skillsets.

WSAM 599. Masters Thesis
1-15 Credits (1-15)
Thesis. May be repeated up to 88 credits. Consent of Instructor required. Restricted to: Water and Science Management majors. Thesis/Dissertation Grading.

WSAM 600. Doctoral Research
1-15 Credits (1-15)
Assigned credit for research preformed. May be repeated up to 15 credits. Consent of Instructor required.
Learning Outcomes

1. Identify appropriate research methodologies.
2. Reflect on their own research, identifying lessons learned, strengths, and ways to improve.
3. Communicate confidently and constructively with faculty advisors.

WSAM 605. Arid Land Water Resources
3 Credits (2+2P)
The course will cover various issues of relevance to water resources and water supply management within the Southwest US and other semiarid and arid regions. Discussions may include development and sustainability, climate change and drought, socioeconomic and cultural, and transboundary issues. May be repeated up to 3 credits. Crosslisted with: ENVS 605.

WSAM 610. Water and Sustainable Economic Development
3 Credits (3)

For graduate students in the Water Science and Management or other research degree programs, use the water economics literature as a model for student research leading to an M.S. thesis or Ph.D. dissertation.

WSAM 700. Doctoral Dissertation
1-15 Credits (1-15)
Dissertation for Water Sciences and Management Majors May be repeated up to 88 credits. Restricted to: Water Sciences and Management majors. Thesis/Dissertation Grading.

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Coordinating Institute

- New Mexico Water Resources Research Institute, (575) 646-4337

Sponsoring Departments

- *Agricultural Economics and Agricultural Business*, (575) 646-3215, https://aeab.nmsu.edu/
- *Animal and Range Sciences*, (575) 646-2514, https://anrs.nmsu.edu
- *Civil Engineering,* (575) 646-3801, http://ce.nmsu.edu
- *Geography,* (575) 646-3509, http://geography.nmsu.edu
- *Plant and Environmental Sciences*, (575) 646-3405, http://aces.nmsu.edu/academics/pes (http://aces.nmsu.edu/academics/pes/)