The School of Natural Resources and the Department of Geography and Regional Development at The University of Arizona are proposing an academic Post-Baccalaureate Certificate in Geographical Information Science (GIS). To obtain the Certificate, students must complete a 17-unit program of study that includes core and elective courses. Core courses focus on analytic cartography and GIS technology, as well as a 2-unit practicum/internship in GIS. Electives allow students to focus on natural resource or social science applications. The structure provides students with depth and breadth of education in GIS and its application across disciplines. The program is designed for students to begin in the fall and complete in one academic year (summer work may be required depending on courses selected by student). Students may complete the Certificate in conjunction with a graduate degree program or as a stand-alone certificate.

Administration
The Program will be administered by an Executive Committee consisting of C. P. Patrick Reid, D. Phillip Guertin, Craig Wissler (of the School of Natural Resources) and J. P. Jones, Stephen Yool, and Gary Christopherson (of the Department of Geography and Regional Development). Primary administrative responsibility will be by the School of Natural Resources. The Committee will make admission recommendations and establish policy. Cheryl Craddock (SNR Academic Coordinator) will coordinate recruiting efforts, the selection process, and paperwork leading to certification.

Curriculum Overview
Students will be required to take 17 units of course work, consisting of 8 units of core curriculum and guided practicum, and 9 units of elective credit. All courses in the curriculum are taught at the University of Arizona; none are offered through distance learning. Proposed courses are associated with new faculty hires, and are in the process of being approved through University channels. Students must take all course work for a letter grade.

Core Curriculum
The core curriculum consists of 8-credit hour regular classroom instruction and guided practicum/internship experience in GIS. The core curriculum is designed to provide students with a solid background in GIS database structures and spatial analysis. The classes provide a foundation in the design and development of GIS databases and familiarity with spatial analysis techniques for a variety of applications. The practicum/internship is included in the core curriculum to ensure that each participant has the opportunity to apply the theories and methods presented in the core courses.

GEOG 516a: Computer Cartography (3 units) Fall
Note: A new description is being written for this course.
Introduces the principles of map design, production and analysis. Graduate-level requirements include an instructor approved 5-8 page paper on a related topic and analytical cartography demonstrating scholarly analysis in contemporary analytical cartography. GEOG is home department.

And
RNR 517: Geographic Information Systems for Natural Resources (3 units) Fall

*Proposed new title: Geographic Information Systems for Natural and Social Sciences*

Introduction to the application of GIS and related technologies for both the natural and social sciences. Conceptual issues in GIS database design and development, analysis, and display. Graduate-level requirements include a thorough bibliographic review and a scholarly paper on a current application of geographic information systems in the student's major field.

**Plus**

RNR 594: Practicum in geographic information processing (2 units) Fall/Spring/Summer

Supervised instruction in the processing of geographic data for applications in natural resources. The student will be responsible for the supervised processing of research data sets. Emphasis will be placed on methodological practice and documentation of procedures.

**Or**

GEOG593: Internship (2 units) Fall/Spring/Summer

Specialized work on an individual basis, consisting of training and practice in actual service in a technical, business, or governmental establishment.

**Electives**

Students must take 9 additional units; at least one course must be from the Electives. The electives represent coursework from which a student can customize a curriculum to meet their interests.

GEOG 516C: Urban Geographic Information Systems (3 units) Fall

*Proposed*

Introduces concepts and application skills for use of geographic information systems to investigate a range of urban spatial issues and decision-making processes. Emphasis on complete process of GIS-based problem solving, including project planning, spatial data sources/acquisition, preparation/coding, analysis, representation, and communication.

GEOG 516D: PPGIS: Participatory Approaches in Geographic Information Science (3 units) Spring

*Proposed*

A project-based course focusing on applications and impacts of GIS and other spatial analysis technologies in grassroots community development, participatory decision making, and community-engaged social science. Class format includes discussion seminar, GIS workshop, collaboration, and out-of-classroom community involvement.

GEOG 516E: Geovisualization (GIS) (3 units) Spring

*Proposed*

Introduces principles and practices of Geovisualization (Geoviz) and softwares (Community Viz and ERDAS Image).

GEOG 524: Integrated Geographic Information Systems (3 units) Spring

*Proposed*

Integration of airborne and spaceborne remote sensor image data with non-image geographic information system (GIS) data.
GEOG 583: Geographic Applications of Remote Sensing (3 units) Spring
Use of aircraft and satellite imagery for monitoring landforms, soils, vegetation and land use, with the focus on problems of land-use planning, resource management and related topics. Graduate-level requirements include the completion of a project report.

REM 590: Remote Sensing for the Study of Planet Earth (3 units) Spring
A multidisciplinary course delineating the physical basis of electromagnetic remote sensing, the concepts of information extraction, and applications pertinent to earth systems science. Graduate-level requirements include an additional term paper.

RNR 503: Introduction to Geographic Information Science (3 units) Fall
Proposed title: Applications of Geographic Information Science
General survey of principles of geographic information systems (GIS); applications of GIS to issues such as land assessment and evaluation of wildlife habitat; problem-solving with GIS. Graduate-level requirements include completion of a project on the use of GIS in their discipline or an original GIS analysis (100 points) in coordination with the instructor.

RNR 519: Cartographic Modeling for Natural Resources (3 units) Spring
Computer techniques for analyzing, modeling, and displaying geographic information. Development of spatially oriented problem design and the use of logic are applied to the use of GIS programs. Emphasis on applications in land resources management and planning. Graduate-level requirements include a research paper.

RNR 520: Advanced Geographic Information Systems (3 units) Spring
Examines various areas of advanced GIS applications such as dynamic segmentation, surface modeling, spatial statistics, and network modeling. The use of high performance workstations will be emphasized. Graduate-level requirements include the development of a GIS study plan.

RNR 522: Resource Mapping (3 units) Summer
Use of computer technologies to map and inventory natural environments; integration of global positioning systems, remote sensing, and geographic information systems. Graduate-level requirements include a detailed report on the application of resource mapping to a specific problem in natural resource management.

RNR 527: Artificial Intelligence in Resource Management (3 units) Fall
Use of artificial intelligence as it applies to natural resources, including knowledge representation, problem solving, expert systems, feature recognition, neural networks, and genetic algorithms. Examples will be derived from current applications using various techniques to address management problems.

RNR 573: Spatial Analysis and Modeling (3 units) Fall
Examination of spatial analysis and statistical techniques for investigating natural phenomena. Topics include point pattern analysis; spatial autocorrelation; point to surface transformation; geostatistical techniques; and landscape analysis and modeling.

SWES 553: Remote Sensing of the Environment (3 units) Spring
Remote sensing techniques and applications for improved natural resource utilization of soils, water, grasslands, and forest. Fundamental energy-matter interactions that influence the spectral characteristics of vegetation, soil, and water. Graduate-level requirements include an in-depth research paper on a single aspect of a current topic.

Sample Schedules
The scheduling of classes suggests a year-long program that begins in the fall term. Because of prerequisites, the certification program will likely be course-heavy in the spring, though students may take an elective during the fall subject to their advisors' approval. See sample schedules below.

Sample 1

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<tr>
<th>Fall</th>
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Sample 2

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Sample 3

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Sample 4

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Student Learning Objectives

Upon completion of the GIS Certification program, the student shall be able to:

- Select appropriate models of spatial information to represent features and processes in an application domain.
- Identify data processing algorithms that are suited to analyzing spatially distributed phenomena.
- Demonstrate comprehensive knowledge of the functionality and applications of GIS technology.
- Apply high level skills in spatial problem solving and spatial analysis.
- Effectively organize, communicate, and present the results of spatial analysis.
- Employ practical information technology skills in the processing of spatial data.
Recruitment
We will advertise this program through appropriate UA web pages, contact with current graduate students, and contact with graduating seniors. Many students apply to our MS programs who have an interest in acquiring this sort of background. While they are inadmissible to a M.S. program, this Certification Program may well suit their needs. Finally, we will distribute promotional materials to our contacts with local government and non-government agencies and organizations, and across campus. We will recruit participants from three distinct populations.

- Graduate students wishing to complete the program alongside their regular MA/MS or PhD programs
- Professionals desiring training/re-training in GIS (these individuals must have at least a baccalaureate)
- Recently graduated seniors for whom this training would provide greater employment opportunities.

Application and Selection Process
Students must formally apply to the GIS Certification Program. Admission materials must include a Program application, transcripts of relevant coursework, one paragraph detailing the applicant’s experience with computers (technical proficiency is a prerequisite), and a one page biographical sketch outlining the applicant’s background and interest in pursuing GIS certification as it pertains to his/her professional goals. Students will enroll through the University of Arizona’s Office of Continuing Education and Academic Outreach.

Selection of participants will be based on relevant background and submitted interest in the program. The Executive Committee will be responsible for admitting students to the program. Students are admitted to the GIS Certification Program only. While we expect most of our students will be local residents, we will not preclude non-residents from participating.

Advising
An advising team formed by D. Phillip Guertin, Craig Wissler, Sarah Ellwood, Kieron Bailey, Stephen Yool, and Gary Christopherson will take responsibility for advising students in this Program. Admitted students will be made aware of this advising team, and be assigned an initial advisor to consult regarding their interests and to review the course work requirements. Because the course work is defined, most advising will be related to the student’s capstone experience in the practicum. The Advising Team shall assist students in identifying projects and assigning a mentor to oversee the project.

*Note: Students concurrently enrolled in the Certificate Program and a University of Arizona graduate program may be advised on their certification course work by their advisory committee (if the course work is related to their thesis or dissertation work), or by a member of the advising team.

Policies

*Completion of certification requirements at the undergraduate level:*
Students may not earn certification as undergraduates. The GIS certification program is designed to be a post-baccalaureate experience. Graduate level courses require greater depth of understanding and more sophisticated application of the principles covered. We will allow students to use up to 6 units of course work earned as an undergraduate towards their certification, provided this course work was not applied toward an undergraduate degree.

*Completion of certification requirements while in a graduate degree program:*


Students who complete the Program requirements while a graduate student in a formal degree program may be awarded certification as part of their degree program. They will not be afforded the same benefits as program participants (see below).

**Transfer Course Work**
Students may transfer, from another accredited academic institution, up to 6 units of course work to be applied to this Certification program. Course work must be approved by the Executive Committee.

**Application of Certification to a Graduate Degree**
Students in the Program interested in pursuing a graduate degree are permitted to do so through the regular admissions process. Students will be allowed to use up to 12 units of the course work earned in the Certification Program towards their advanced degrees.

**Minimum GPA required:** Students must pass each class in the curriculum, including transfer or undergraduate course work, with a B or better to receive certification.

**Student Benefits**
Students receive University of Arizona Certification in Geographic Information Technology, and a document from the School of Renewable Natural Resources and the Department of Geography and Regional Development that outlines the participant’s curriculum and the objectives achieved by that curriculum. Program participants may receive Graduate Tuition Scholarships (GTSSs) if they are out-of-state.

**Assessment**
We will take a multi-faceted approach to assessment, including informal feedback and formal assessment instruments. First, the Executive Committee shall meet annually to review

- recruitment strategies
- program curriculum and its relevance to professional needs
- review assessment tools

Assessment tools will include the final document produced for the practicum, a written assessment of the students’ knowledge and ability provided by the supervisor for the practicum, and an exit survey.

The final paper from the practicum will address all the learning objectives identified above by giving the student the opportunity to synthesize information from the course work, apply it to a problem, and present the results. The letter from the supervisor will illustrate the ability of the student to handle the practicum independently. The exit survey will allow students to self-identify strengths and weaknesses of the program and their performance in the program. These instruments will attempt to distinguish between individual performance and the program’s contribution to the quality of the performance.

**Demand for the Post-Baccalaureate GIS Certification Program**
The University of Arizona is positioned uniquely to offer the proposed GIS Certification Program. First, it has the faculty resources to allow students to complete the Program alone or in combination with a graduate degree program. This dual function serves both the professional community and current and future students. Second, as a land grant university with a significant extension component, we have in-roads with numerous agencies and organizations who have a demonstrated interest in providing their employees with educational opportunities to promote career growth. Third, we already attract a great many students who recognize the importance of spatial analysis techniques in addressing scholarly or applied problems. Our current students,
aware of the growing market for people with GIS training, have expressed interest in earning a formal certificate for work in this area. In combination with interest from professionals outside the university, we expect 15 students (conservatively) to enroll in the Program in the first year. There are currently 198 graduate students enrolled in the two academic units (67 in GRD and 131 in SNR). Though each academic unit is working on new graduate student recruitment strategies, we expect graduate student enrollment to remain relatively steady over the next three years. We also have 35.27 FTE faculty between the two academic units (12.9 currently in GRD, with 1.5-3.5 expected in the next three years, and 22.37 in SNR, with 3.0 expected in the next three years). Projected GIS Certification Program participants would represent an 8% increase in graduate enrollment; the faculty in this particular program can certainly absorb this workload.

Particularly compelling to the development of this Certificate Program is the partnership between the School of Natural Resources (College of Agriculture and Life Sciences) and Geography and Regional Development (College of Social and Behavioral Sciences). The two academic units have built the curriculum cooperatively, collaborated in instruction, and have worked together to coordinate computing resources. This cooperation facilitates curriculum development in both colleges, and paves the way for research collaboration among faculty, staff, and students.

**Expected Faculty and Resource Requirements**

Keiron Bailey, Ph.D., Assistant Professor, Geography and Regional Development
Dr. Bailey will teach a course associated with this program. He will also serve on the Advisory Team to assist students in finding a research project (particularly in “human GIS”) on which to focus for their practica.
He is a new hire.
kbailey@email.arizona.edu

Gary Christopherson, Ph.D., Research Social Scientist, Geography and Regional Development, Social and Behavioral Sciences Research Institute, Director, SBSRI Center for Applied Spatial Analysis (CASA).
Dr. Christopherson teaches courses associated with this program. He will also serve on the Executive Committee, overseeing Program operations and assessment. As Director of CASA, he will also serve on the Advisory Team to assist students in finding a research project (particularly in the social and behavioral sciences) on which to focus for their practica.
garych@casa.arizona.edu

Sarah Elwood, Ph.D., Assistant Professor, Geography and Regional Development
Dr. Elwood will teach a course associated with this program. She will also serve on the Advisory Team to assist students in finding a research project (particularly in “human GIS”) on which to focus for their practica.
She is a new hire.
selwood@email.arizona.edu

H. Randy Gimblett, Ph.D., Professor, School of Natural Resources
Dr. Gimblett will teach a course associated with this program.
gimblett@ag.arizona.edu

D. Phillip Guertin, Ph.D., Associate Professor, School of Natural Resources
Dr. Guertin teaches courses associated with this program. He will also serve on the Executive Committee, overseeing Program operations and assessment. As Program Chair of the Landscape
Studies Program and Leader in the Advanced Resource Technology Group in the School of Natural Resources, he will also serve on the Advisory Team to assist students in finding a research project (particularly in the life and physical sciences) on which to focus for their practica.
phil@srnr.arizona.edu

Alfredo Huete, Ph.D., Professor, Soil, Water and Environmental Science
Dr. Huete will teach a course associated with this program.
ahuete@ag.arizona.edu

John Paul Jones, III, Ph.D., Professor, Geography and Regional Development
Dr. Jones will serve on the Executive Committee charged with overseeing the Program operations and assessment.
jpjones@email.arizona.edu

Stuart Marsh, Ph.D., Professor of Arid Lands Resource Sciences and Geography
Dr. Marsh will teach a course associated with this program.
smarsh@ag.arizona.edu

C. P. Patrick Reid, Ph.D. Professor, School of Natural Resources
Dr. Reid will serve on the Executive Committee charged with overseeing the Program operations and assessment.
cppr@ag.arizona.edu

Kurtis Thome, Ph.D., Associate Professor, Optical Sciences
Dr. Thome will teach a course associated with this program.
kurt.thome@opt-sci.arizona.edu

Craig Wissler, MLA, Assistant Professor, School of Natural Resources
Mr. Wissler teaches courses associated with this program. He will also serve on the Executive Committee, overseeing Program operations and assessment. As GIS Coordinator for the Advanced Resource Technology Group in the School of Natural Resources, he will also serve on the Advisory Team to assist students in finding a research project (particularly in the life and physical sciences) on which to focus for their practica.
craig@srnr.arizona.edu

Stephen Yool, Ph.D., Associate Professor, Geography and Regional Development
Dr. Yool teaches courses associated with this program. He will also serve on the Executive Committee, overseeing Program operations and assessment. He will also serve on the Advisory Team to assist students in finding a research project on which to focus for their practica.
yools@email.arizona.edu

Non-faculty participants
Cheryl Craddock, M.S., Academic Coordinator, School of Natural Resources
Ms. Craddock will coordinate advertising, recruitment, and certification requirement paperwork of the Certification Program, and serve on the Executive Committee to oversee Program operations and assessment.
craddoc@email.arizona.edu
At this juncture, we do not anticipate requiring more faculty to effectively implement this Certificate Program.

**Fees**
At this stage, we do not assess fees for participating in this program (beyond those collected by the University of Arizona Continuing Education and Academic Outreach unit).

**Funding**
Without up-to-date computing facilities, effective instruction and scholarly endeavor in the area of Geographic Information Science is not possible. By offering this GIS Certification Program through the Office of Continuing Education and Academic Outreach (CEAO), we will generate some program-specific revenue to be applied to teaching and operating costs of this Certification Program. However, we cannot expect to see that revenue until approximately 6 months after the first student actually enrolls in the GIS Certification Program. Because it is unclear how many students will enroll through CEAO rather than through the UA proper, we may request funds to support the following:

1. **A: Lab instructors**
The core courses for this Program are already fully subscribed; the number of reliably functioning computer stations in SNR’s teaching lab limits seats. To adequately serve the additional population of students enrolling in these courses as part of the Certification Program requires additional teaching and administrative support. We request funding for lab instructors (1 FTE) to be split between the School of Natural Resources and the Department of Geography and Regional Development. Lab instructors are responsible for in-class assistance for students.

2. **B: Technology Refreshing**
The School of Natural Resources currently has agreements in place through the College of Agriculture and Life Sciences to refresh their teaching lab computers. However, the Department of Geography and Regional Development does not have such an agreement through the College of Social and Behavioral Sciences. We anticipate requesting funds to refresh computing facilities for teaching purposes, possibly through Prop 301/TRIF.

3. **C: Software**
Critical to the success of such a technologically oriented discipline is access to and experience with the most current software. We anticipate requesting funds to offset the costs of purchasing software upgrades associated with courses exploring new applications in GIS and not covered by faculty start-up packages.

Funding returned to the program from Office of Continuing Education and Academic Outreach will be allocated to GIS Certification accounts within the Department of Geography and Regional Development and the School of Natural Resources proportional to the number of students enrolling in each academic unit’s courses. Those funds derived from courses for which SNR or GRD are not the home department will be used for administrative purposes or divided equally, based on the determination of the Executive Committee.