GEORGE MASON UNIVERSITY
Graduate Council NEW Certificate, Concentration, Track or Degree Program
Coordination/Approval Form

(Please complete this form and attach any related materials. Forward it as an email attachment to the Secretary of the Graduate Council. A printed copy of the form with signatures should be brought to the Graduate Council Meeting. If no coordination with other units is required, simply indicate “None” on the form.

Title of Program/Certificate, etc: Geographic Information Science

Level (Masters/Ph.D.): Graduate Certificate

Please Indicate: _____ Program _____ X _____ Certificate _____ Concentration _____ Track

Description of certificate, concentration or degree program:
Please attach a description of the new certificate or concentration. Attach Course Inventory Forms for each new or modified course included in the program. For new degree programs, please attach the SCHEV Program Proposal submission.

Please list the contact person for this new certificate, concentration, track or program for incoming students:

Dr. Sergei Andronikov, Associate Professor, Geography Department, College of Arts and Sciences

Approval from other units:
Please list those units outside of your own who may be affected by this new program. Each of these units must approve this change prior to its being submitted to the Graduate Council for approval.

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Submitted by: Dr. Sergei Andronikov_________________________ Email: sandroni@gmu.edu

Graduate Council approval: _______________________________ Date: _____________

Graduate Council representative: ___________________________ Date: _____________

Provost Office representative: _____________________________ Date: _____________
## Graduate Certificate in Geographic Information Sciences

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1. Executive Summary

Because of the current National and Global trend in the usage of Geospatial technology and information, enormous demand for GIS professionals all over the World, and increase in the availability and utilization of Geospatial data related to the Earth, the department of Geography and the College of Arts and Science (CAS) propose this Graduate Certificate in Geographic Information Sciences (GIS) to meet the needs of prospective students, area employers, and community at large. The GIS Graduate Certificate requires students to complete a set of 18-credit hours of graduate courses. Admission to this Certificate will be opened to students from almost any discipline at Mason. Ideal candidates are those who have a background in Earth, Environmental, Geographical and Cartographical sciences, and are either currently working in or intend to enter into the field of GIS and/or Geospatial Technology. We believe that the Graduate Certificate in GIS will prove very attractive to students who are interested in advancing their career goals, but who may not have adequate time available to undertake a graduate degree program. The 18-credit certificate is based upon the set of core courses currently supporting the Master Degree program in Geographic and Cartographic Sciences at CAS. Students completing the GIS Graduate Certificate program will receive the most up-to-date advanced GIS education available in the region. Completion of the Certificate will enhance the careers of those students who are already working in this area, and can also serve as a useful intermediate step towards later enrollment in the Geographic and Cartographic Sciences M.S. degree program, and/or the further doctoral program.

2. Description of Proposed Graduate Certificate

2.1 Mission and Objectives

Geographic Information Science has been born by merging skills and theory across many disciplines. In recent years it has become a central element of modern spatial information and analysis systems. GIS is used in many different fields from geography, geology, agriculture, and biology to history, social studies, economics and engineering; from emergency services to tourism, road planning and rail management; from criminal justice to telecommunication, business and management. In the new era of the Information Age GIS is a tool for a sustainable human future offering the promise of managing natural resources, improving living standards, eliminating diseases, helping manage environmental risk and disasters, understanding global change, and planning economic and business growth.

One of the examples of the use of multidisciplinary Geotechnology is the combination of GIS and environmental issues. Today it represents a national and global trend. The study of the impact of human-environment interactions, expanding results of industrial and commercial growth on the environment, and overall environmental capacity analysis are all areas requiring substantial data gathering, information analysis, and spatial analytical modeling. GIS and Geotechnology are capable to producing all these activities.

The primary mission of the proposed Graduate Certificate in Geographic Information Science is to equip students to meet the needs of society by working in the rapidly developing GIS-related industry. The Graduate Certificate in GIS will be opened to anyone at Mason who meets the general GMU graduate requirements. GMU students graduating from the schools/departments/programs with added skills in Geographic Information Systems and Science are becoming more marketable, moving into higher paying professional position, in many instances several thousand dollars a year higher than they would otherwise be able to obtain. The enhancement of GIS technology at George Mason will provide increased educational and training opportunities, significant research growth, and public service for and within the DC region, its governments and business communities.

With this certificate, we intend to provide advanced and up-to-date training for students currently working in this field who would like to enhance their skills in this area and acquire the latest knowledge in GIS technology. Some of the potential students may be those who would like to enter this field of work, and may have some prior training, but do not yet have an in-depth educational background, training and skills. In other words, this certificate will help to “re-train” the workforce to meet the new challenges in the area of GIS, and to prepare the
population for the job market in this area. One more potential student flow would be from those who have already taken some GIS-related classes at undergraduate level through the Geography program.

2.2 Administrative Structure

The Graduate Certificate in GIS will be administered by the Geography department within CAS. The cooperation and support of other Schools and Departments at Mason will be actively sought. Currently, faculty members in Geography oversee the Geographic and Cartographic Sciences M.S. program and jointly with School of Computational Science (Earth Systems and Geoinformation Sciences Program) and Environmental Science and Policy Department in CAS, the Earth Systems Sciences M.S. program. For this particular certificate, the Certificate Coordinator, who will be a Geography faculty member designated by the Department Chair, will direct the administration of the proposed certificate. The Coordinator will supervise the admission of students into the program, monitor student progress, advise the students, promote the certificate, and coordinate course offerings. The mechanics of the admission process (i.e. application processing, student record control, etc.) will be handled centrally by CAS. Thus, the Certificate Coordinator will work closely with CAS admissions staff and also with the Associate Dean for Graduate Studies on admission issues and processes.

2.3 Admission Requirements

Applicants to this graduate certificate program should hold a B.A. or B.S. degree with a minimum GPA of 3.00. Applications will be processed by the CAS administrative office. Applicants must submit a completed GMU graduate application, along with official transcripts, resume, VA domicile classification form, and TOEFL scores if they are foreign nationals. GRE scores and letters of recommendation are not required. Applicants should have a working knowledge of, or prior education/training in, computing technology; and knowledge of GIS, Remote Sensing technology and cartography is preferable. Students with a background in one of the physical science areas (atmospheric science, hydrology, or geology), geography, or environmental science will be particularly well suited to undertake this certificate program. However, the students from any disciplines (business and management, social sciences, telecommunications, etc.) are welcome to apply. Depending on the background of the individual student, the Coordinator may recommend remedial or preparatory courses tailored to student’s needs. Students may transfer no more than 3 credit hours into the certificate program with the approval of the Certificate Coordinator or Departmental Chair.

2.4 Curriculum Requirements

The Graduate Certificate in GIS requires a total of 18 credit hours, or 6 courses. Students are required to take five core courses. The sixth one can be selected from the set of electives indicated below according to the student interest. Catalog descriptions of the existing courses are provided in Appendix.

Required Core Courses:

- GEOG 550 Geospatial Science Fundamentals
- GEOG 553 Geographic Information Science
- GEOG 563 Advanced Geographic Information Science
- GEOG 653 Geographic Information Analysis
- GEOG 590/EOS 772 Distributed GIS

Elective Course (one of the following, or another course approved by Coordinator):

- GEOG 590 Natural Resources and GIS
- GEOG 590* GIS in Health
- GEOG 590* GIS in Public Policy
- GEOG 590/EOS 771 Algorithms and Modeling in GIS
Upon completion of the GIS Graduate Certificate, students will be encouraged to continue their education by applying for admission into the “Geographic and Cartographic Sciences”, “Earth Systems Sciences” M.S. programs, or newly proposed by the School of Computational Science PhD in “Earth Systems and Geoinformation Sciences”.

2.5 Relationship to other GMU Programs

No comparable certificate program is currently being offered at GMU. The proposed certificate is unique; it focuses on Geographic Information Science and the use of innovative GIS technology in different disciplines to enhance our understanding of the Earth.

At GMU, several programs provide some formal training and course work related to GIS, but no certificate program is designed specifically to meet the mission and objectives of the proposed certificate. The Geography Department in CAS offers an Undergraduate Minor in Geographic Information Systems within a Major in Geography. Some GIS classes are required in the “Geographic and Cartographic Sciences” M.S. program in Geography, CAS. These courses form the bases of the proposed Graduate Certificate in GIS.

In the School of Computational Science, the GIS area of concentration within the newly proposed PhD in “Earth Systems and Geoinformation Sciences” will offer together with Geography Department in CAS several GIS-related courses. Students pursuing this new Ph.D. in this track are required to take additional courses in Earth sciences, Geography, and computational sciences.

There is also a non-academic professional Certificate in GIS offered through the Office of Continuing and Professional Education. But it is a non-credit Certificate that offers an opportunity for working professionals to increase their technical knowledge of GIS.

Students finishing the academic graduate certificate in GIS may choose to pursue one of the graduate degrees mentioned above. Courses completed for the certificate will be completely counted toward the M.S. in “Geographic and Cartographic Sciences” and the Ph.D. degree in “Earth Systems and Geoinformation Sciences” (concentration in GIS), and most of these courses will also be counted toward the M.S. in ESS.

3. Justification for Proposed Graduate Certificate

3.1 Student Demand

Our research on student demand for this certificate is based upon our first-hand knowledge of the GIS industry and the related workforce in the Washington, D.C. metropolitan area, and also on the nation-wide development trend in GIS technology training, which will be addressed in more detail in section 3.3. The Washington, D.C. region (including counties in Maryland and Virginia) probably has the highest concentration in the GIS professionals and the highest demand in the nation for such professionals in both the government and private sectors. The large number of employees in these organizations will provide a steady supply of students for enrollment in the proposed certificate program.

NASA (headquarter in DC) and its Goddard Space Flight Center (in Greenbelt)
NOAA (headquarter in Silver Spring)
These agencies currently employ a large number of GIS professionals and scientists. Some of these employees have been in the workforce for a significant period of time and may greatly benefit from the re-training possibility offered by the proposed certificate. A big source of such professionals lies in the field of land surveying, planning and mapping. As the use of GIS in military and civilian applications will continue to grow, students who are not currently working in this field may wish to increase their chances of being hired by these agencies by completing our proposed certificate.

There is a big demand for GIS professionals in local, regional and state government. Governmental agencies require lots of GIS-experienced staff in the IT sector as well as in a stand-alone GIS-related departments and agencies.

In the private sector, several companies that are major players in the GIS industry are located in this region. These include many large defense, IT, development/construction or environmental consulting companies. Below is a partial listing of these companies:

EarthSat (Rockville)
Northrop Grumman
Raytheon
SAIC
Boeing
Dewberry & Davis
Michael Baker Corporation
GeoDigital
EarthData
VARGIS
ESRI (Vienna)

The companies listed above, and many others, will likely send their employees to GMU to pursue advanced training in the science and technology/applications of GIS in order to support the growth of their businesses. The existence of this certificate will allow them to hire graduates with environmental or Earth science backgrounds, and then send them to GMU for advanced GIS training.

We have personal contacts with some of these companies via our faculty and alumni, and it is quite clear that these companies are eager to take advantage of such a locally provided certificate program to enhance the skills of their current employees, and to equip qualified GIS professionals and scientists to be employed by their companies.

3.2 Employer Demand for Graduates

GIS technology is increasingly in demand within almost ANY discipline. Hence, the students interested in the Graduate Certificate in GIS can come from any college/school/department on campus. The first student flow will likely have backgrounds in Earth science, such as geology, geography, environmental science, atmospheric science, oceanography, and hydrology. It is likely that a number of them may already have some formal training in Geospatial Technology, Remote Sensing, and cartography.
We expect that our graduates from this certificate will be classified as GIS scientists or professionals in the GIS areas, as there is no formal category for GIS scientist in the labor market. URISA is trying to create a system for certification of professionals in the GIS area. Our graduates with a Certificate in GIS will fit nicely into the category of GIS professionals.

Growth in employment related to Geospatial Technology and GIS in particular is also expected. According to the Bureau of Labor Statistics, “…increasing demand for geographic data, as opposed to traditional surveying services, will mean better opportunities for cartographers and photogrammetrists involved in the development and use of geographic and land information systems,” and “nontraditional areas such as urban planning and natural resource exploration and mapping also should provide areas of employment growth, particularly with regard to producing maps for management of natural emergencies and updating maps with the newly available technology.” Major federal government employers in this category of jobs include NOAA, NGM, BLM, FEMA, and USGS.

In short, we are very optimistic about the job prospect of graduates from the proposed certificate program given the development trends in the labor market for scientists and professionals with GIS education and GIS-related expertise.

### 3.3 Comparison with Other Programs in the Region and the Commonwealth

While the demand for GIS professionals in this region, nationwide, and internationally is very high and on the rise today, most professionals receive education and training through formal degree programs, which require significant commitment of one’s time and resources. Little is available in post-graduate training beyond the traditional degree programs with a set of GIS-related classes. The proposed graduate certificate therefore serves a special niche in meeting the needs of GIS professionals in this geographic area, and potentially for the nation.

We performed a survey on the Internet to identify programs in Virginia, Maryland, and the Washington D.C. area similar to the one we propose here.

In Radford University there are several GIS classes at the undergraduate level. At University of Virginia there are no special GIS programs. There are several schools that incorporated GIS classes into their curriculum. The heaviest users of GIS come from the School of Architecture, the School of Engineering and Applied Science, and the College of Arts and Science. Old Dominion University is teaching several GIS classes in the Department of Civil and Environmental Engineering. Virginia Tech provides an opportunity for obtaining either a Master of Science degree or a PhD in Civil and Environmental Engineering using GIS. In the VT Northern Virginia campus, the Civil and Environmental Engineering Department offers a set of certificates (http://www.nvge.vt.edu/engineering/CEECertificate1.htm) some of which include remote sensing and GIS courses. But all of them focus on specific civil and structural engineering issues. We found no existing programs in Georgetown University similar to that proposed.

In George Washington University, the Department of Geography has launched a new Minor in GIS (http://home.gwu.edu/~icheung/gis/).

The only Program that offers a similar type of Certificate is a Certificate in GIS Program at Penn State University (http://www.worldcampus.psu.edu/pub/gis/index.shtml). However, the Certificate in GIS at Penn State is a noncredit certificate targeting experienced professionals similar to the one offered by OCPE at GMU.

GMU will target the D.C. regional group of students and offer a unique academic Graduate Certificate in GIS. Similar types of Certificates exist in some other universities within the U.S. but not in the Northern Virginia and the Washington D.C. area.
3.4 Projected Enrollment

With the expectation that the certificate will be approved and in place for Fall 2004, the enrollment in the initial year will likely be low, but the number will increase quickly when the news about the availability of the certificate spreads throughout the local GIS community. Below are some projected figures for the number of students enrolling in the certificate program in GIS:

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<th>Year</th>
<th>Fall 2004</th>
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In the long run we would like to keep the enrollment of the certificate between 15 and 20, approximately one-third the size of our M.S. in Geographic and Cartographic Sciences student body. We expect that students enrolling in the certificate will be primarily part time students, and therefore they will take only one to two courses per semester. Consequently, on average, a student will complete the certificate program in about one-and-a-half to two years.

4. Resource Needs

4.1 Faculty

The Department of Geography at College of Arts and Science has successfully offered several GIS courses within the M.S. in Geographic and Cartographic Sciences. We are anticipating using the same courses as a base for the Certificate in GIS while only adding a couple of electives courses in the future. The primary faculty members supporting the certificate and their respective courses are:

- Sergei Andronikov (GEOG 553, GEOG 563, GEOG 653)
- Paul Young (GEOG 590)
- Doug Wheeler (GEOG 550)
- Lee DeCola (GEOG 590*)
- Barry Kronenfeld (GEOG 590*)
- David Wong (GEOG 590/EOS 772)
- Phil (Chaowei) Yang (GEOG 590/EOS 771)
- Liping Di (EOS 773)

In addition, we have several other faculty members on campus to serve potentially as an instructor of the certificate program. We expect that no more than one additional faculty position will be necessary in the future to support the instructional and administration functions of this proposed certificate.

4.2. Equipment and Computing Environment

Currently in addition to the general computing facilities provided by College of Arts and Sciences and GMU, graduate students in the M.S. in Geographic and Cartographic Sciences and M.S. in Earth Systems Sciences Programs also have access to Remote Sensing/GIS computational facilities located in Robinson-A 113.

There is also dedicated to GIS-related programs a brand new state-of-the-art Geospatial Classroom in Innovation Hall. The purpose of this room is to provide educational opportunities for GMU students in learning, understanding and getting hands-on experience in application of various aspects of Geographic Information Sciences.
In summary, there are over 38 desktops and three PC-based servers running either the Unix or Windows operating systems. On the software side, George Mason has site licenses for the whole suite of the widely used GIS software: ArcView 3.x, ArcGIS 8.x with ArcView/ArcEditor/ArcINFO licenses, several important extensions to ArcGIS such as: Spatial Analyst, Geostatistical Analyst, 3-D Analyst, SDE, ArcIMS; several licenses on ERDAS IMAGINE software, and Manifold.

In addition, the Geography department holds a license on R2V32: Raster-to-Vector conversion package, and other data analysis software such as Matlab, Splus, and the Oracle DBMS. “Earth Systems and Geoinformation Sciences” Program at SCS has the Intergraph suite of GIS software.

On March 1 the Provost chartered a new GIS Center of Excellence at GMU that will serve as an important educational/research/training entity at George Mason University. The Center’s facilities as well as data derived will be available to students for instructional use. The students within the “Graduate Certificate in GIS” program will do their practical projects with real data provided by the Center. They may also provide innovative research and public service (helping to generate even more useful data and solve practical problems) to our region, its governments and business communities.

Through educational classes in the Graduate Certificate in GIS, the George Mason students will gain the knowledge and experience of using innovative technological tools and programs for further professional application in GIS. It will also foster the unique multidisciplinary research opportunities at GMU, joining the efforts of various schools and departments on campus.
Appendix: Catalog Descriptions of Existing Courses

GEOG 550 Geospatial Science Fundamentals (3:3:0). Prerequisite: Graduate standing. Introduces students to the geospatial sciences, emphasizing the concepts and theories of cartography, remote sensing especially air photo interpretation, and geographic information systems. Lectures accompanied by hands-on exercises to familiarize students with current technology.

GEOG 553 Geographic Information Science (3:3:0). Prerequisite: GEOG 550 or a course in geographic information systems. Introduces students to topics in geographic information science, emphasizing the concepts and theories of cartography and geographic information systems. Lectures accompanied by hands-on lab exercises to familiarize students with current technology.

GEOG 563 Advanced Geographic Information Science (3:3:0). Prerequisite: GEOG 553 or permission of department. Discussion of advanced geographic information science concepts in great detail, including spatial data structure, spatial analysis, and programming. Hands-on exercises demonstrate these concepts. Address selected issues related to data fusion, geographic information systems on the Internet, and database management.

GEOG 590 Selected Topics in Geography and Cartography (3:3:0). Prerequisite: Permission of department. Students analyze topics of immediate interest. Content varies.

GEOG 653 Geographic Information Analysis (3:3:0). Prerequisite: GEOG 553 and 585. Exploration of existing and potential capabilities of geographic information systems in conducting spatial analysis and spatial modeling.

GEOG 590/EOS 771 Algorithms and Modeling in GIS (3:3:0). Prerequisite: Prior course or experience in GIS and computer programming. This course examines several fundamental GIS algorithms based upon computational geometry and computer graphics. It will also discuss issues in modeling features of different dimensions and surfaces in GIS. Significant programming is expected.

GEOG 590/EOS 772 Distributed Geographic Information Science (3:3:0). Prerequisite: an introductory course in GIS and some programming experience, or Permission of Instructor. This course examines different aspects of science and technology in the context of distributed GIS. Issues included are general concepts, architecture, component design, component development, and system integration as well as other advanced topics, such interoperability and agent-based GIS.

EOS 759 Interoperability of GIS (3:3:0). Prerequisite: EOS 754 and GEOG 553 or a course in GIS. This advanced course addresses theories, standards, and implementations of Web-based interoperable geographic information systems for on-line data and information services. International standards, including OGC, and associated tools for interoperability will be reviewed in detailed.