UNIVERSITY OF
MARYLAND
OFFICE OF THE PRESIDENT

Main Administration Building
College Park, Maryland 20742
301.405.5803 TEL 301.314.9560 FAX

February 4, 2019

James D. Fielder, Jr.
Secretary of Higher Education
Maryland Higher Education Commission
6 N. Liberty Street
Baltimore, MD 21201

Dear Secretary Fielder:

I am writing to request approval for a new Master of Science program in Geospatial Intelligence. The proposal for the new program is attached. I am also submitting this proposal to the University System of Maryland for approval.

The proposal was endorsed by the appropriate faculty and administrative committees. I also endorse this proposal and am pleased to submit it for your approval.

Sincerely,

Wallace D. Loh
President

MDC
cc: Antoinette Coleman, Associate Vice Chancellor for Academic Affairs
Mary Ann Rankin, Senior Vice President and Provost
Gregory Ball, Dean, College of Behavioral and Social Sciences

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# Cover Sheet for In-State Institutions
# New Program or Substantial Modification to Existing Program

| Institution Submitting Proposal | University of Maryland, College Park |
|---|---|

***Each action below requires a separate proposal and cover sheet.***

- (●) New Academic Program
- ( ) New Area of Concentration
- ( ) New Degree Level Approval
- ( ) New Stand-Alone Certificate
- ( ) Off Campus Program
- ( ) Substantial Change to a Degree Program
- ( ) Substantial Change to an Area of Concentration
- ( ) Substantial Change to a Certificate Program
- ( ) Cooperative Degree Program
- ( ) Offer Program at Regional Higher Education Center

Payment Submitted: ( ) Yes (●) No
Payment Type: ( ) R*STARS (●) Check
Payment Amount: 850
Date Submitted:

| | | |
|---|---|---|
| Department Proposing Program | Geographical Sciences | |
| Degree Level and Degree Type | Master of Science | |
| Title of Proposed Program | Geospatial Intelligence | |
| Total Number of Credits | 30 | |
| Suggested Codes | HEGIS: 220602.00 | CIP: 29.0203 |
| Program Modality | ( ) On-campus ( ) Distance Education (*fully online*) (●) Both | |
| Program Resources | (●) Using Existing Resources ( ) Requiring New Resources | |
| Projected Implementation Date | (●) Fall ( ) Spring ( ) Summer | Year: 2019 |
| Provide Link to Most Recent Academic Catalog | URL: https://academiccatalog.umd.edu/ | |
| Preferred Contact for this Proposal | Name: Michael Colson | |
| | Title: Senior Coordinator for Academic Programs | |
| | Phone: (301) 405-5626 | |
| | Email: mcolson@umd.edu | |
| President/Chief Executive | Type Name: Wallace D. Loh | |
| | Signature: [signature] | Date: 02/04/2019 |
| | Date of Approval/Endorsement by Governing Board: | |

Revised 12/2018

**A. Centrality to the University's Mission and Planning Priorities**

*Description.* The Master of Science (MS) in Geospatial Intelligence at the University of Maryland, College Park (UMD) will provide workforce-focused training in cutting-edge topics in geospatial intelligence, geographic information science, remote sensing, and data science in the big data era. The program will provide skills and expertise to graduates to lead new initiatives in the rapidly shifting landscape of defense and security applications. The field of geospatial intelligence was initially associated with national security, but now there is a need in a variety of areas, including machine intelligence, business intelligence, criminology, government, and emergency management. The 30-credit master's program consists of 15 credits of core courses and 15 credits from a list of elective courses.

The program exists already as an iteration of UMD's Master of Professional Studies program. The Master of Professional Studies is an approved "umbrella" degree program created in 2005 to allow for nimble changes in graduate level training for working professionals. The proposed stand-alone MS program will succeed the current Professional Studies program iteration. A limitation of offering the program as a Professional Studies iteration is that all Professional Studies programs must use the same generic federal Classification of Instructional Programs (CIP) code rather than a CIP code that accurately describes the program content. Searches that use CIP codes to find program offerings do not result in the discipline-specific iteration, which reduces market visibility. Moreover, some CIP codes are designated as "STEM" eligible by the Department of Homeland Security, and international students with F1 visas who graduate from STEM designated programs may continue to work in the United States for two years longer than students in non-STEM designated programs. The generic CIP code for Professional Studies programs does not qualify as STEM-designated, even though the academic content of the Geospatial Intelligence program is STEM-related. The proposed MS program will have a STEM CIP code. Based on the number of inquiries from international students, the program expects to attract a significant number of international students, and a 24-month post-completion optional practical training (OPT) term will make the program more competitive for international applicants.

*Relation to Strategic Goals.* As the flagship campus of the University System of Maryland, and the original 1862 land-grant institution in the State, UMD has a mission to provide excellent teaching, research, and service to nourish a climate of intellectual growth and provide outstanding instruction in a broad range of academic disciplines and interdisciplinary fields. UMD has as a primary goal to provide knowledge-based programs and services that are responsive to the needs of the citizens across the state and throughout the nation. UMD states the following graduate education objective in its *Strategic Plan*: "The University will maintain excellent professional graduate programs that are nationally recognized for their contributions to the practice of the professions, for their forward-looking curricula, and for their spirit of innovation and creativity."[1] UMD established the Geospatial Intelligence program as an iteration of the Master of Professional Studies in 2016 in order to expand professional graduate opportunities in emerging fields. The Geospatial Intelligence program addresses

[1] University of Maryland, College Park. (May 21, 2008). *Transforming Maryland: Higher Expectations. The Strategic Plan for the University of Maryland.* (p. 15). Retrieved January 18, 2019 from: http://www.provost.umd.edu/SP07/StrategicPlanFinal.pdf.

the immediate and growing need to train a workforce for the rapidly expanding local geospatial intelligence industry in Maryland and in particular the greater Washington, D.C. metropolitan area.

*Funding.* The program currently exists as a Master of Professional Studies iteration and no changes are being made to the program other than the conversion to a stand-alone MS program. Consequently, the resources that currently exist for the program are sufficient. The program derives its funding through tuition revenue.

*Institutional Commitment.* The program will be administered (as it currently is now) by the Department of Geographical Sciences within the College of Behavioral and Social Sciences. Since the program already exists as Professional Studies iteration, the department has the administrative, instructional, advising, and facilities infrastructure in place to operate the program. In the event that the program is discontinued, the courses will be offered for a reasonable time period so that enrolled students can finish the program. The faculty and administrative infrastructure will still be in place to work with students who have not finished the program.

**B. Critical and Compelling Regional or Statewide Need as Identified in the State Plan**

*Need.* The growing field of geospatial intelligence was originally associated with national security—the National Geospatial-Intelligence Agency (NGA) is tasked with visualizing, analyzing, and assessing national security through collection and interpretation of geospatial data. These data now come from an ever-growing array of sources, including other intelligence agencies; grounded, airborne, and orbital sensor platforms; evolving silos of big data generated by Internet and Communications Technologies (ICTs); and actively and passively volunteered geographic information that populations and devices cast during their everyday actions and interactions. Geospatial intelligence has, however, begun to grow beyond its original security focus, and the field now encompasses a variety of arenas in which geospatial intelligence plays a role. In machine intelligence, geospatial intelligence is a core component of navigation systems for vehicles and robots, as well as computer vision schemes. In business intelligence, it forms the basis for geodemographics, customer management systems, marketing analytics, location-allocation and site selection support systems, and logistics. In criminology, geospatial intelligence is widely employed in managing public security and investigating crime. In government and public policy, geospatial intelligence is significant in resource allocation and assessment of service delivery. In natural hazards and emergency response, it provides key data management and analysis tools for monitoring, assessing, and mitigating capabilities in decision making, method preparedness, and early warning system. In engineering and computing industries, it forms an important component of systems engineering, particularly in the emerging area of cyber-physical systems and cyberspace systems using commercial and open-source platforms. In the earth sciences, geospatial intelligence is used to provide base mapping, geo-referencing, and data fusion for a variety of data products and sensor systems.

Our local surroundings play host to the center of influence for the geospatial intelligence industry in the United States. The National Geospatial-Intelligence Agency employs 8,500 people at the third largest federal building in the D.C. region at nearby Springfield, VA. The NASA Goddard Space Flight Center in nearby Greenbelt, and the United State Geological Survey in nearby Reston, VA serve as the

nexus for the nation's earth science geospatial intelligence. The U.S. Census Bureau in nearby Suitland, MD is tasked with a decennial nationwide data collection exercise that mobilizes a huge workforce to perform geospatial intelligence gathering year-round.

*State Plan.* The proposed program in Geospatial Intelligence aligns with the *Maryland State Plan for Postsecondary Education's* emphasis on success and innovation by connecting students with the innovative technologies needed for careers in geospatial intelligence. Students have access to two 25-seat GIS labs equipped with dual-monitor high-end workstations and connected to remote storage facilities. Students are also able to work from virtual desktops and servers supported by a VMware environment. The labs run a wide variety of commercial and open source software for GIS, remote sensing, statistical analysis, data access, image processing, mathematical analyses, graphics and 3D modeling, and software development. The department's Center for Geospatial Information Science maintains a set of location-aware devices for teaching mobile GIS. These include (1) tablets equipped with positioning and motion sensors that students can learn how to program and extract data from, (2) virtual reality media for immersive exploration of models and data, and (3) sensing devices for desktop and console computing that can generate real-time positioning, motion, and gesture captures.

**C. Quantifiable and Reliable Evidence and Documentation of Market Supply and Demand in the Region and State**

The field of geospatial intelligence has recently and suddenly ballooned and major technology companies (Google, Apple, Facebook, Über, for example) have been scrambling to put together teams to get up to speed. These technology-based companies join already well-established geospatial intelligence divisions in major government contract companies in and around the Washington metropolitan area, such as BAE Systems, Lockheed Martin, Northrup-Grumman, IDS, and Leidos, as well as most banks and insurance companies, all of which have geospatial intelligence divisions. Entirely new companies are beginning to form around the topic of geospatial intelligence (see Palantir, which has offices locally in Tyson's Corner, VA). In early August 2015, Audi, BMW, and Daimler purchased the geospatial intelligence division of Nokia (known as "Here") for $3.1 billion.

The need for a well-trained and nimble workforce in geospatial intelligence is growing, markedly. The US Bureau of Labor Statistics *Occupational Outlook Handbook* does not list geospatial intelligence analysts as an occupation, but does project that jobs in a related category, cartographers and photogrammetrists, is growing "much faster than average" between 2016-2026.[2] The Bureau lists the state of Maryland as one of the strongest states in the nation for jobs in the geographical sciences, mainly because of the prevalence of federal agencies.[3] As noted above, however, geospatial intelligence is spreading beyond the traditional role of geography in governmental operations.

[2] US Bureau of Labor Statistics. (September 6, 2018). Occupational Outlook Handbook: Cartographers and Photogrammetrists. Retrieved from: https://www.bls.gov/ooh/architecture-and-engineering/cartographers-and-photogrammetrists.htm.
[3] US Bureau of Labor Statistics. (March 30, 2018). Occupational Employment and Wages, May 2017 - 19-3092 Geographers. Retrieved from: https://www.bls.gov/oes/current/oes193092.htm#nat.

**D. Reasonableness of Program Duplication**

As an iteration of the Professional Studies program in only its second year of operation, the program has proven student interest by enrolling 13 students. The program differs from research-oriented graduate programs in Geographical Sciences, such as UMD's Master of Science in Geographical Sciences program, because the proposed program is not designed to prepare students for doctoral study. The program also differs from geospatial information science (GIS) programs, which focus on methods of handling spatial data. GIS programs do not offer significant coursework in the specific area of geospatial intelligence. Geospatial intelligence coursework focuses on the cutting-edge technologies and platforms used in the geospatial intelligence industry, including open source tools and methods and big data computing.

The only existing Master of Science program in Geospatial Intelligence in the state is Johns Hopkins University's Master of Science in Geospatial Intelligence. The Johns Hopkins program is online, whereas the proposed program will be offered on campus as well as in a distance-learning (online) format. Maryland citizens who live in Montgomery and Prince George's counties and who wish to take advantage of on-site training and lab facilities will likely participate on-site. As geospatial intelligence continues to grow in a variety of industries, the demand for graduate-level training is likely to expand.

**E . Relevance to Historically Black Institutions (HBIs)**

No such program currently exists at any of Maryland's Historically Black Institutions (HBIs).

**F. Relevance to the identity of Historically Black Institutions (HBIs)**

UMD has already established itself in the field of Geographical Sciences with its established undergraduate and graduate programs in geographical sciences. Accordingly, the proposed program would not have an impact on the uniqueness or institutional identity of any Maryland HBI.

**G. Adequacy of Curriculum Design, Program Modality, and Related Learning Outcomes**

*Curricular Development.* The program was developed to expose students to geospatial information sciences in the context of geospatial intelligence. Students are taught the fundamentals of geospatial intelligence science and technology, including geospatial data handling processes that require advanced algorithms, models, and commercial and open source platforms. Applications of these skills are explored in a variety of geospatial intelligence contexts, including public administration and policy analysis, public safety, military intelligence, emergency response and preparedness, project and workflow management, environmental applications, urban studies and regional sciences, and transportation geography.

*Faculty Oversight.* The program will be housed in the Department of Geographical Sciences. The Program Oversight Committee is responsible for directing the program, while the program will be administrated and managed by the Department's Center for Geospatial Information Science (CGIS).

The program will also form a program advisory committee that will include the CGIS director, Professor Kathleen Stewart, and Geographical Sciences Graduate Director, Professor Laixiang Sun.

*Educational Objectives and Learning Outcomes.* Students are expected to complete the program with the following learning outcomes:

- A well-rounded understanding of the fundamental nature of geospatial intelligence and analysis, including the core theory, methods, and protocols for gathering and management of geospatial intelligence data, analyses and visualization of those data, use of the resulting products in operational settings for applied geospatial intelligence, and the ethical treatment of data and analysis throughout those procedures.
- Advanced expertise in either or both of the challenges and opportunities for geospatial intelligence in human, security, and engineering domains; and technologies for future geospatial intelligence and analysis in computing, machinery, and software.
- Practical, hands-on project and lab-style training with data collection procedures, data analysis, algorithm development, using commercial and open source modeling and analysis software and platforms.
- The ability to design and implement strategies to solve real-world intelligence problems as they present across a variety of domains, including intelligence activities, security and defense, hazards and emergency response and management, and transportation and urban applications.
- Training in analytic thinking and real-world problem solving for future success in the workforce. Skills include but are not limited to interpersonal communications and teamwork, creative and critical thinking, occupational planning and organizing, problem-solving and decision making.

The learning outcomes are the same for the distance-education and on-site students.

*See Appendix A for more information on learning outcomes assessment.*

*Institutional assessment and documentation of learning outcomes.* Student learning outcomes assessment in graduate programs is directed by the Graduate Outcomes Assessment Committee. Established in 2011, this committee is comprised of representatives from each college and school. Graduate Outcomes Assessment reports for doctoral and master's programs are due every other year, with approximately half of the campus graduate programs reporting each year.

*Course requirements.* The curriculum will consist of 30 credits organized into the following categories:

- 15 credits of core courses
- 15 credits of elective courses

| Geospatial Intelligence Core Courses (15 credits) | | |
|---|---|---|
| Course | Title | Credits |
| GEOG661 | Fundamentals of Geospatial Intelligence | 3 |
| GEOG662 | Advances in Geographic Information Science and Remote Sensing | 3 |
| GEOG664 | Geospatial Intelligence Systems and Platforms | 3 |
| GEOG665 | Algorithms for Geospatial Intelligence Analysis | 3 |
| GEOG697* | Capstone Project | 3 |

| Geospatial Intelligence Elective Courses (15 credits) | | |
|---|---|---|
| Course | Title | Credits |
| GEOG651 | Spatial Statistics | 3 |
| GEOG656 | Programming and Scripting for GIS | 3 |
| GEOG657 | Web Programing | 3 |
| GEOG660 | Advanced Remote Sensing Using Lidar | 3 |
| GEOG663 | Big Data Analytics | 3 |
| GEOG680 | Geospatial Intelligence Networks | 3 |
| GEOG682 | Open Source Intelligence | 3 |
| GEOG683 | Hazards and Emergency Management | 3 |
| GEOG686 | Mobile Computing and Geospatial Information Management | 3 |
| GEOG684* | Image Analysis and Geovisualization | 3 |
| GEOG685* | Machine Learning and Data Mining | 3 |
| GEOG687* | Geospatial Intelligence for Security | 3 |
| GEOG688* | Human and Activity-Based Intelligence | 3 |
| GEOG690* | Data Visualization | 3 |
| GEOG691* | Food Security | 3 |

*Courses that are planned for the program but have not yet completed the UMD course approval process.

*See Appendix B for course descriptions.*

*General Education.* Not applicable as this is as a master's program.

*Accreditation or Certification Requirements.* The program plans to seek the accreditation from the United States Geospatial Intelligence Foundation (USGIF). The USGIF is the only organization dedicated to promoting the geospatial intelligence tradecraft in the USA. Students do not need certification and do not need to graduate from an accredited program in order to work in this field, but accredited programs benefit the students, college, university, industry, government, and geospatial intelligence community at large by ensuring current hiring needs are reflected in cross-disciplinary coursework.

*Other Institutions or Organizations.* The department will not contract with another institution or non-collegiate organization for this program.

*Student Support.* As the program already exists as an iteration of the professional studies program, student support mechanisms are already in place. The Center for Geospatial Information Science provides a comprehensive and detailed webpage of resources for understanding curriculum, advising, technological needs (including the learning management system), relevant Graduate School policies, financial aid and cost and payment information. See https://geospatial.umd.edu/education/resources for more details.

*Marketing and Admissions Information.* The professional studies program iteration is clearly and accurately described in the university website: https://geospatial.umd.edu/education/master-

professional-studies-geospatial-intelligence. This website will be updated for the Master of Science program upon approval.

## H. Adequacy of Articulation

As a graduate program, articulation is not applicable.

## I. Adequacy of Faculty Resources

*Program faculty.* As the program is already offered as an iteration of the professional studies program, faculty resources are already in place. The Center for Geospatial Information Science has two full-time Lecturers for the program. These two dedicated lecturers will serve as instructors for most of the courses in the program, and some of the elective courses will be taught by other lecturers from the Geographical Sciences department. Initially, lecturers also provide lab instruction, but these responsibilities will be shifted to graduate teaching assistants as the program grows large enough to warrant the support of graduate teaching assistants (TA's) for supporting lab assignments.

In the following years, should enrollments grow as anticipated, we expect to hire one new lecturer and establishing two to three TA lines. In each case, resources for these hires will come from program revenues.

*See faculty listing in Appendix C for those currently expected to teach in the program.*

*Faculty training.* Courses are subject to constant updates with the development of the technologies in the geospatial intelligence industry. The Teaching and Learning Transformation Center at the University of Maryland inspires and supports effective, engaging, efficient, and equitable teaching innovations among the university's instructors and assistants. This team provides faculty with training, resources, professional development activities, and individualized consultation to transform their classrooms and careers.

For the learning management system, faculty teaching in this program will have access to teacher development opportunities available across campus, including those offered as part of the Teaching and Learning Transformation Center. For online elements of the coursework, instructors will work with the learning design specialists on campus to incorporate best practices when teaching in the online environment.

## J. Adequacy of Library Resources

The University of Maryland Libraries has conducted an assessment of library resources required for this program. The assessment concluded that the University Libraries are able to meet, with its current resources, the curricular and research needs of the program.

## K. Adequacy of Physical Facilities, Infrastructure, and Instructional Resources

The program exists already as an iteration of the professional studies program, and currently has facilities, infrastructure, and instructional resources in place. The Center for Geospatial Information Science has access to two 25-seat GIS labs with specialized software and hardware that allows students to engage in GIS training. The labs run a wide variety of commercial and open source software for GIS, remote sensing, statistical analysis, data access, image processing, mathematical analyses, graphics and 3D modeling, and software development. The Center maintains a set of location-aware devices for teaching mobile GIS. These include (1) tablets equipped with positioning and motion sensors that students can learn how to program and extract data from, (2) virtual reality media for immersive exploration of models and data, and (3) sensing devices for desktop and console computing that can generate real-time positioning, motion, and gesture captures. The Center also has high-performance computational capabilities.

For online components of the program, UMD maintains an Enterprise Learning Management System (ELMS) for coursework. ELMS is a Web-based platform for sharing course content, tracking assignments and grades, and enabling virtual collaboration and interaction. The Geospatial Intelligence program will use ELMS for all its courses. The Department of Geographical Sciences also maintains a Cisco WebEx Online course delivery platform, by which lectures and discussions can be streamed virtually. Faculty, staff, and students can communicate in real-time using chat, voice (microphone and speakers), and video (webcam) with WebEx. WebEx allows for the ability to display presentations, annotate overtop slides, perform live editing of documents and even conduct a poll within the software. The Department maintains two dedicated servers and shared storage for server-side delivery of GIS software. All students, regardless of program modality, have access to the UMD email system.

**L. Adequacy of Financial Resources**

Tables 1 and 2 contain the details of resources and expenditures. This program is relatively new and enrollments do not yet cover the full cost of the program. Startup support is being provided by the Center for Geographical Information Science. As the program matures, it is anticipated that tuition revenue will cover the cost of delivery.

**M. Adequacy of Program Evaluation**

Formal program review is carried out according to the University of Maryland's policy for Periodic Review of Academic Units, which includes a review of the academic programs offered by, and the research and administration of, the academic unit (http://www.president.umd.edu/policies/2014-i-600a.html). Program Review is also monitored following the guidelines of the campus-wide cycle of Learning Outcomes Assessment (https://www.irpa.umd.edu/Assessment/LOA.html). Faculty within the department are reviewed according to the University's Policy on Periodic Evaluation of Faculty Performance (http://www.president.umd.edu/policies/2014-ii-120a.html). Since 2005, the University has used an online course evaluation instrument that standardizes course evaluations across campus. The course evaluation has standard, university-wide questions and also allows for supplemental, specialized questions from the academic unit offering the course.

**N. Consistency with Minority Student Achievement goals**

The proposed program provides workforce-focused technical training that gives graduates the technical skills and domain expertise to qualify for mid-level career opportunities in industry and government. Most of the current students in the program are working professionals from the Washington Metropolitan Area. The program uses a recruiting model that contributes to the diversity of the university by marketing and attracting applicants from various backgrounds and regions of the world. The program markets in person at professional conferences and has on-line question and answer sessions to reach the widest possible range of potential students. UMD has stated goals for recruiting and graduating a diverse population of graduate students in its strategic plan for diversity. The Graduate School works with programs on recruiting and graduating diverse populations. Furthermore, "the provost and Graduate School will consider the success of its programs in recruiting and graduating a diverse population of graduate students when allocating institutional financial support to programs, departments, and colleges and schools."[4]

**O. Relationship to Low Productivity Programs Identified by the Commission**

N/A

**P. Adequacy of Distance Education Programs**

Should the program be approved, the goal is to offer a distance-education version of the program in order to reach a broader student population. UMD has received approval to offer programs through distance education and is a member institution of the National Council for State Authorization Reciprocity Agreements and therefore complies with C-RAC guidelines. See Appendix D for the UMD's notice to add distance education as a modality for this program.

[4] University of Maryland, College Park. (September 16, 2010). *Transforming Maryland: Expectations for Diversity and Inclusion.* (p. 20). Retrieved January 28, 2019 from: http://www.provost.umd.edu/Documents/Strategic_Plan_for_Diversity.pdf.

**Table 1: Resources**

| Resources Categories | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 |
|---|---|---|---|---|---|
| 1.Reallocated Funds | $0 | $0 | $0 | $0 | $0 |
| 2. Tuition/Fee Revenue (c+g below) | $288,036 | $415,348 | $600,969 | $734,404 | $756,436 |
| a. #FT Students | 10 | 16 | 22 | 25 | 25 |
| b. Annual Tuition/Fee Rate | $19,202 | $19,778 | $20,372 | $20,983 | $21,612 |
| c. Annual FT Revenue (a x b) | $192,024 | $316,456 | $448,180 | $524,575 | $540,312 |
| d. # PT Students | 10 | 10 | 15 | 20 | 20 |
| e. Credit Hour Rate | $800 | $824 | $849 | $874 | $901 |
| f. Annual Credit Hours | 12 | 12 | 12 | 12 | 12 |
| g. Total Part Time Revenue (d x e x f) | $96,012 | $98,892 | $152,789 | $209,830 | $216,125 |
| 3. Grants, Contracts, & Other External Sources | $0 | $0 | $0 | $0 | $0 |
| 4. Other Sources | $0 | $0 | $0 | $0 | $0 |
| **TOTAL (Add 1 - 4)** | **$288,036** | **$415,348** | **$600,969** | **$734,404** | **$756,436** |

**Table 2: Estimated expenditures**

| Expenditure Categories | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 |
|---|---|---|---|---|---|
| 1. Faculty (b+c below) | $212,800 | $232,883 | $299,837 | $308,832 | $318,097 |
| a. #FTE | 2.0 | 2.0 | 2.5 | 2.5 | 2.5 |
| b. Total Salary | $160,000 | $175,100 | $225,441 | $232,204 | $239,171 |
| c. Total Benefits | $52,800 | $57,783 | $74,396 | $76,627 | $78,926 |
| 2. Admin. Staff (b+c below) | $0 | $0 | $49,385 | $50,866 | $52,392 |
| a. #FTE | 0.0 | 0.0 | 0.5 | 0.5 | 0.5 |
| b. Total Salary | $0 | $0 | $37,132 | $38,245 | $39,393 |
| c. Total Benefits | $0 | $0 | $12,253 | $12,621 | $13,000 |
| 3. Total Support Staff (b+c below) | $0 | $0 | $84,660 | $87,200 | $89,816 |
| a. #FTE | 0.0 | 0.0 | 1.0 | 1.0 | 1.0 |
| b. Total Salary | $0 | $0 | $63,654 | $65,564 | $67,531 |
| c. Total Benefits | $0 | $0 | $21,006 | $21,636 | $22,285 |
| 4. Graduate Assistants (b+c) | $0 | $76,648 | $78,948 | $81,316 | $83,756 |
| a. #FTE | 0.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| b. Stipend | $0 | $41,200 | $42,436 | $43,709 | $45,020 |
| c. Tuition Remission | $0 | $35,448 | $36,512 | $37,607 | $38,736 |
| 5. Equipment | $0 | $0 | $0 | $0 | $0 |
| 6. Library | $0 | $0 | $0 | $0 | $0 |
| 7. New or Renovated Space | $0 | $0 | $0 | $0 | $0 |
| 8. Other Expenses: Operational Expenses | $97,693 | $118,773 | $149,508 | $171,602 | $175,250 |
| **TOTAL (Add 1 - 8)** | **$310,493** | **$428,304** | **$662,338** | **$699,817** | **$719,311** |

**Appendix A: Learning Outcomes Assessment for the Master of Science in Geospatial Intelligence**

To ensure that these outcomes are met, the MS in Geospatial Intelligence (MS GEOINT) program will focus on coursework and course modules that emphasize:

1. Well-rounded understanding—Impose a core set of coursework to ensure that students develop a well-rounded education in the fundamentals of geospatial intelligence and analysis, with courses that cover basics of the profession and science, technical offerings, and ethics.
2. Advanced expertise—Offer a series of balanced electives that build on that core with advanced coverage of topics of a substantive nature and/or a technical nature.
3. Practical training—A capstone project will be required of all students, affording them the opportunity to develop hands-on problem-solving skills on operational intelligence tasks.
4. Lab skills—In each course, a set of projects or lab exercises will ensure that students apply their theoretical knowledge to actionable topics in geospatial intelligence and analysis.
5. Workforce success—A dedicated course will be offered to train students in the art and practice of thinking and acting entrepreneurially, so that they are well-prepared for success in the workplace.

Our success in guiding students through the outcomes will be evaluated using a set of varied metrics and instruments:

1. In-class observation–Assessments will be carried out throughout the program to gauge (1) student involvement, (2) student interest and engagement, (3) student performance, (4) faculty performance, and (5) the nature of the learning environment. This assessment will be carried out by informal observation by other faculties in the MS GEOINT program, as well as by faculty in the Department of Geographical Sciences. Unstructured (quick chats and check-ins) and structured (survey questions) data will be collected to support these observations.
2. Student participation—Will be gauged through checks on attendance and progression through course milestones (submitting assignments and projects in a timely manner). Where content is provided digitally (through Adobe Connect or via ELMS, for example), empirical metrics for students' access to course resources can also be evaluated.
3. Student feedback—Will be collected through open sessions (office hours or question-and-answer sessions) and formal evaluation events (end-of-course evaluation). Upon graduating from the course, we will also hold student exit interviews to gather feedback on their success in the course and in meeting our learning outcomes objectives.
4. Capstone project—The capstone project is one of the main culminating course experiences for the MS GEOINT program. Each capstone project will be evaluated in a dedicated review session and evidence of learning outcomes as they present in the projects will be assessed.

**Appendix B: Course Descriptions**

**Core Courses**

*GEOG 661: Fundamentals of GEOINT (3 Credits)*
*Geospatial Intelligence (GEOINT) is the collection, analysis, visualization and dissemination of geospatial information to support decision-making. This course introduces the fundamental knowledge required to become a successful GEOINT practitioner, including the history of the GEOINT discipline, the intelligence applications of remote sensing and Geographic Information Systems (GIS) technologies, and how GEOINT products are used to support national security and humanitarian missions. Upon completion of this course you will understand the roles that technology, policy, doctrine, government, and industry play in shaping the Geospatial Intelligence discipline, and develop the technical knowledge and domain expertise to create basic GEOINT products that provide context for decision makers.*

*GEOG 662: Advances in GIS and Remote Sensing (3 Credits)*
*Focuses on state-of-the-art advances in geographic information science and remote sensing as they support geospatial intelligence. Focus on synergies between GIS and remote sensing in informatics, computer science, and spatial engineering, and their application to problem domains in human systems, physical systems, and cyberspace. Advances in GIS presents recent advances regarding fundamental issues of geo-spatial information science (space and time, spatial analysis, uncertainty modeling and geo-visualization), and new scientific and technological research initiatives for geo-spatial information science (such as spatial data mining, mobile data modeling, and location-based services). Advances in remote sensing will provide opportunity to understand and work with latest developments in the Remote Sensing datasets. The curriculum covers wide range of remote sensing data interpretation and their processing techniques.*

*GEOG 664: GEOINT Systems and Platforms (3 Credits)*
*There are numerous systems and platforms that support the collection, visualization and dissemination of Geospatial Intelligence (GEOINT). Platforms such as satellites and aircraft carry sensors systems that can detect both physical and man-made objects on the earth. Ground-based processing systems are used to analyze and visualize sensor data, and also to create and disseminate GEOINT products that guide decision-making. In this course you will learn how to develop and implement source-to-screen GEOINT workflows, and will understand how to use a system of systems approach to describe the programmatic and technical strengths and weaknesses of many different GEOINT systems and platforms.*

*GEOG 665: Algorithms for GEOINT Analysis (3 Credits)*
*Exposes students to fundamental algorithms in geospatial intelligence and their application in methodological and substantive domains, and their implementation in computer programs and software systems. Current topics include spatial and space-time analysis, cartographic transformations, data compression and reduction, MapReduce and distributed data access, genetic algorithms, clustering and indexing algorithms, filtering algorithms, geometry and tessellation algorithms, routing*

*algorithms, localization algorithms, and complexity and scaling. Implementation of algorithms will be explored through pseudo-code and a variety of scripting, data access, and programming languages.*

**GEOG 697: Capstone Project (3 Credits)*
*The Capstone is an independent research project that demonstrates competence in geospatial intelligence technologies. This project can originate from an internship, from relevant work at a current or past employer, or can be developed in conjunction with CGIS faculty. The student will prepare a project report and presentation which shall contain an executive summary, background information including a literature review and establishment of requirements, a detailed technical description of the project data and methods, a discussion of results obtained, and final conclusions and recommendations. The final project submission will include all data, computer code and/or workflow documentation required to replicate the project results. In completing this project, students develop a concrete example of how GEOINT technologies can be applied to solve real-world problems, and begin developing a portfolio that can be presented to potential employers.*

**Elective Courses**

*GEOG651: Spatial Statistics (3 Credits)*
*This course is about quantitative analysis of spatial data. It is intended to provide a broad survey of various spatial statistic methods. The course is geared towards helping students: (1) develop an understanding of the important theoretical concepts in spatial data analysis; and (2) gain practical experience in the application of spatial statistics to a variety of social and environmental problems using the advanced statistical software. This course covers five broad topical areas: (1) point pattern analysis; (2) area data analysis; (3) continuous data analysis; (4) spatial sampling; and (5) multivariate spatial and temporal analysis.*

*GEOG656: Programming and Scripting for GIS (3 Credits)*
*An introduction to programming and scripting for intermediate GIS users. The fundamental concepts of computer programming will be introduced within the Geoprocessing framework in ArcGIS primarily using Python. Basic concepts of object-oriented programming and scripting will be presented. Students will develop skills in programming techniques to explore, manipulate and model spatial data using the Geoprocessor methods.*

*GEOG657: Web Programming (3 Credits)*
*Intermediate course designed to teach students the techniques for Web development, particularly creating dynamic and data-driven Web applications. Introduces a high-level, object-oriented programming language such as VB.Net and the designing, coding, debugging, testing, and documenting for the development of Web-based applications. Other popular Web development tools such as DHTML, CSS and PHP are also covered.*

*GEOG660: Advanced Remote Sensing using Lidar (3 Credits)*
*Lidar, also known as laser scanning, is an active remote sensing tool that can produce high-resolution point clouds. Lidar is being applied to problems such as terrain modeling, biomass estimation, change detection, feature extraction, and measuring tree canopy. Topics covered are fundamentals of lidar,*

*current developments in lidar technology, and different applications where lidar is being used. Students will get hands-on learning about lidar data management, processing, and analysis.*

*GEOG 663: Big Data Analytics (3 Credits)*
*Designed to introduce statistical analysis over big data sets (and tackling big data problems), primarily in geography and spatial sciences, but with broader appeal throughout the socio-behavioral sciences. Students will be introduced to a range of methods that can be applied to the exploration, modeling, and visualization of big quantitative data. This course explores data fusion, statistical analysis, and data-mining for geospatial and non-geospatial data in structured and unstructured form, with an emphasis on large silos of data across diverse sources and assumptions. Topics will include open sourcing, metadata schemes, data standards and models, data-access, data-mining, clustering methods, classifiers, data reduction, machine learning, filtering schemes, real-time and streaming data, archiving and preservation, and handling uncertainty.*

**GEOG 680: Geospatial Intelligence Networks (3 Credits)*
*Networks are an important part of the Geospatial Intelligence (GEOINT) cycle, from the sensor networks that are used to collect raw geospatial information to the telecommunication networks that are used to disseminate finished GEOINT products. Transportation networks, computer networks, social networks, and many other man-made and natural features can also be characterized by a link-node network topology, and can be studied using network science methods. Upon completion of this course you will be able characterize and classify real-world GEOINT networks and their components, understand network dynamics including routing, scalability, and robustness, and be able to apply engineering methods for network design and network analysis.*

*GEOG 682: Open Source Intelligence (3 Credits)*
*Open Source Intelligence (OSINT) is information that is publicly available which is collected and analyzed to support decision-making. The collection and analysis of OSINT is often considered to be the first step in developing an "all-source" intelligence product, where OSINT is fused with Geospatial Intelligence (GEOINT), Signals Intelligence (SIGINT), and Measurement and Signature Intelligence (MASINT), and Human Intelligence (HUMINT). In this course you will learn about the sources, ethics, and methods that are associated with OSINT, and will also develop knowledge and skills related to open-source geospatial technologies and organizations such as the Open Geospatial Consortium (OGC).*

**GEOG 683: Hazards and Emergency Management (3 Credits)*
*Timely and accurate Geospatial Intelligence (GEOINT) is essential for protecting people from hazardous events such as floods, wildfires, tsunamis, hurricanes, industrial accidents, and terrorist attacks. GEOINT plays a critical role in all four stages of emergency management: preparedness, mitigation, response, and recovery. The use of remote sensing and Geographic Information Systems (GIS) before, during, and after Hurricane Katrina and the 9/11 terror attacks are two of the case studies that are discussed during this course. You will develop a deeper understanding of the emergency management successes and failures that occurred during these historic and deadly events, and learn the technical skills to develop and disseminate GEOINT products that support decision-making at all four stages of emergency management.*

**GEOG684: Image Analysis and Geovisualization (3 Credits)*
*This course explores image processing routines atop remotely-sensed data from a variety of multispectral, hyperspectral, radar, and microwave platforms, including data preparation and enhancement, feature transformation, classification, pattern detection, and feature extraction. It explore next-generation platforms for machine vision, including commercial sensors in location-aware devices and gaming devices, car sensor systems, and security cameras, and methods for object detection and tracking, structure from motion, and gait and expression analysis. It will also cover computer cartography, scientific visualization, handling high-dimensional data, and animation.*

**GEOG685: Machine Learning and Data Mining (3 Credits)*
*This course provides a basic introduction to Machine learning and Data mining, a dynamic and fast evolving subfield of artificial intelligence that learn from past experience and find useful patterns in data. Topics include the three basic branches in this field: (1) Supervised learning to predict problems; (2) Unsupervised learning for clustering data and discovering patterns from data; and (3) Reinforcement learning for decision making. The course will not only learn various machine learning and data mining techniques, but also learn how to apply them to real problems in practice including character recognition, speech recognition, text mining, document classification, pattern recognition, social media analysis, and information extraction from web pages.*

*GEOG 686: Mobile Computing and Geospatial Information Management (3 Credits)*
*An introduction to mobile GIS, to the programming concepts underlying mobile GIS development, and more importantly, to the design and implementation of a mobile GIS application. The course covers how to develop, test, and publish mobile GIS native apps working across two mobile platforms: Android and iOS. It also leverages the capabilities of JavaScript, Swift, Google maps, ArcGIS Server and runtime SDK to developing and publishing mobile GIS apps.*

**GEOG687: Geospatial Intelligence for Security (3 Credits)*
*This course focuses on security problem-sets, opportunities, methods, and applications of geospatial intelligence in security four main domains. First, in defense and homeland security, the course will examine how geospatial intelligence supports military operations (including operations other than war) and national security initiatives. Second, in the domain of crime, the course will explore how geospatial intelligence is used in law enforcement, crime prevention, and forensic analysis. Third, the course examines the role of geospatial intelligence in cyber-security, including topics such as cyber-crime, location spoofing, and space-time dynamics of computer virus and service attacks, fraud, and SPAM. Fourth, the course treats geospatial intelligence as it relates to the identification, analysis, evaluation, management, and response to hazards, crises, and critical scenarios. Here, we focus on both natural and on man-made phenomena and systems, as well as interactions between them.*

**GEOG688: Human and Activity-Based Intelligence (3 Credits)*
*This course focuses on the applied human domain of geospatial intelligence and its relationship to social and behavioral science. It begins with a review of human geography, behavioral geography, political geography, and cultural geography and their relationships to human intelligence gathering. It then focuses on fundamental and emerging techniques for activity-based intelligence. Current topics*

*include migration and flow, movement analytics, transportation analytics, time geography and event conceptualization, transactions and interactions, and social and cyber-physical networks.*

**GEOG690: Data Visualization (3 Credits)*
*Data visualization techniques provide people with enhanced perceptual and cognitive abilities to understand and extract information from increasing amounts of data. This course will introduce a number of common data domains and corresponding analysis tasks, including multivariate data, networks, text, and spatial data. Students will learn offline data visualization tools as well as interactive web techniques to create visualizations that allow viewers from all backgrounds to interact with data, and gain insight into data through the data's presentation. This course will also cover computer cartography, handling high-dimensional data, and dynamic visualization.*

** GEOG691: Food Security (3 Credits)*
*Measuring human food security is an important application of geospatial intelligence. Remote sensing resources can be used to identify regions where food insecurity may occur, and geospatial data fusion can help analysts understand and predict broader national security implications. Course topics include monitoring crop conditions using multispectral imagery, developing products to manage agricultural areas, analyzing the complexity and diversity of food production systems, and integrating socioeconomic and demographic data into geospatial analysis processes and decision support products.*

**Courses are being developed or moving through the UMD course approval process.*

**Appendix C: Faculty**

**Dr. Micah Brachman, Full-time, Professional Track Faculty.**
Micah Brachman is a Lecturer in the Center for Geospatial Information Science at UMD. He holds a Ph.D. (2012) and M.A. (2009) in Geography from the University of California, Santa Barbara and a B.S. (2000) in Geography from the University of Minnesota. Micah has extensive professional experience in GIS and Remote Sensing in the commercial, government, and non-profit sectors, and recently transitioned from a Geospatial Scientist position supporting the Army Geospatial Center to teach in the new Geospatial Intelligence (GEOINT) program. In addition to GEOINT, Micah is also actively engaged in teaching and scholarship in Hazards and Emergency Management, Network Science, and Active Transportation.
Courses to teach in program:
GEOG661, GEOG664, GEOG680, GEOG682, GEOG683

**Dr. Junchuan Fan, Full-time, Professional Track Faculty.**
Dr. Junchuan Fan is a postdoctoral research associate with the Center for Geospatial Information Science at UMD. His research is focused on spatiotemporal modeling and analysis of naturalistic driving behaviors, big geospatial data mining on human activity and movement dynamics, geospatial semantics, and smart cities. Dr. Fan has been involved in research projects funded by FDOT, MSHA, National Advanced Driving Simulator (NADS), and IARPA. He teaches courses on open source GIS, spatial databases, web mapping, and geospatial semantic data handling.
Courses to teach in program:
GEOG684, GEOG687, GEOG688

**Dr. Ruibo Han, Full-time, Professional Track Faculty.**
Dr. Ruibo Han is the Director and Senior Lecturer of the Master and Graduate Certificate programs of Professional Studies in Geospatial Intelligence in the Center for Geospatial Information Science at the UMD. He also teaches courses in both of the program, as well as the graduate and undergraduate programs in the Department of Geographical Sciences. Ruibo earned his Ph.D. in Geography from the University of Ottawa and formerly worked at the University of Ottawa and the University of Toronto teaching courses in GIS and Statistics. Ruibo's research and teaching interests include urban dynamics, web and mobile GIS, big data analytics, and public participatory geospatial systems, and he has received research funded and produced publications in these fields.
Courses to teach in program:
GEOG662, GEOG663, GEOG665, GEOG685, GEOG686, GEOG697

**Dr. Eunjung Elle Lim, Full-time, Professional Track Faculty.**
Dr. Lim earned a Ph.D. degree in Geography (GIS specialty) from the State University of New York at Buffalo. Her dissertation is about methodology detecting a sequence of changes in dynamic spatiotemporal data and investigating patterns of detected changes. In her dissertation she dealt emergency vehicle location and allocation strategies coping with time-varying emergency 911 calls. Her specialty is geographic information sciences. In the realm of GIS, she has developed special interest and knowledge in GIS modeling, programming, network analysis, and spatial statistics. She has about 12

years of experience developing software using Java, C, C++, Visual Basic and relational databases. She is very interested in designing and developing new functionalities in GIS that provide abilities to make users perform tasks that they even haven't thought they can do with geographical knowledge.
Courses to teach in program:
GEOG651, GEOG657

**Dr. Jonathan Resop, Full-time, Professional Track Faculty.**
Dr. Jonathan Resop earned his Ph.D. at Virginia Tech in Biological Systems Engineering. During his time at Virginia Tech, he worked on multiple projects related to spatial modeling and remote sensing, in particular problems that involve agricultural and environmental systems. His dissertation involved applying ground-based lidar to various ecological applications. After completing his Ph.D. he worked as a post-doc for the USDA-ARS in Beltsville in the Crop Systems and Global Change Lab, doing research related to simulating the potential production capacity of crops within regional food systems using a geospatial crop model. Jonathan received his undergraduate degrees at the University of Maryland, College Park in Biological Resources Engineering and Computer Science.
Courses to teach in program:
GEOG656, GEOG660

**Dr. Kathleen Stewart, Full-time, Tenure-Track Faculty**
Kathleen Stewart is Director of the Center for Geospatial Information Science and works in the area of geographic information science with a particular focus on geospatial dynamics. This includes topics such as moving objects research (e.g., space-time trajectories, space-time scheduling) and event modeling for dynamic GIS. She is interested in mobility, spatial accessibility, big geospatial data, and currently investigates movement and mobility for a number of different application domains, for example, health and transportation. She is also interested in modeling geospatial semantics including geospatial ontologies and their role for geographic information system design, and spatiotemporal information retrieval. At the University of Maryland, Dr. Stewart is a member of the Program in Oncology at the University of Maryland Marlene and Stewart Greenebaum Comprehensive Cancer Center and also collaborates with researchers at the Institute for Global Health, the Center for Substance Abuse Research, the National Transportation Center, the School of Public Health, and among others. Her research is currently supported in part by grants from the National Institutes of Health, NASA, and the Federal Highway Administration, among other organizations, and she has also received support from IARPA, NGA and NSA. Dr. Stewart serves as a member of the Mapping Science Committee of the National Academies of Sciences, Engineering and Medicine and the Board of Directors for the University Consortium of Geographic Information Science. She is a member of the steering committee for the Maryland Transportation Institute. She also serves as a member of the editorial boards for The International Journal of Geographical Information Science (IJGIS), Computers, Environment, and Urban Systems, Transactions in GIS, Geographical Analysis, and the open-access Journal of Spatial Information Science (JOSIS).

**Appendix D** Distance-Education Offering of Program

## Change in Program Modality Request Form

*Institutions may change an approved program's modality.*

An institution of higher education that has received approval to operate a program in the state of Maryland may add, change, suspend, or discontinue a program modality if the institution provides advance notice to the Commission in accordance with COMAR 13B.02.03.29 and COMAR 13B.02.03.22

**An institution's notice to the Commission shall include**:

Provide the program's title and degree level:

Master of Science in Geospatial Intelligence

Provide the program's HEGIS and CIP code:

HEGIS: 220602
CIP: 29.0203

Provide a description of, and rationale for, the addition, change, suspensions, or discontinuation of program modality:

In order to reach a broader range of students, courses will be delivered in a hybrid format. Instructors will present lectures and lead discussions in a regular classroom setting, while also streaming the lectures online. Students that can attend in person may do so, while those that require or prefer remote access can also participate (via WebEx technology). Similarly, laboratory sessions may be attended tangibly, or students may access instruction remotely using video conferencing and virtual machine access to our software and data in the Department of Geographical Sciences.

Provide an affirmation that the program's most recently approved curriculum and objective are coherent, cohesive, and comparable, regardless of program modality:

Students in the distance-education format are taking the same courses as the students who are on campus. The program objectives and outcomes are therefore the same as they are for the on-campus modality.

Provide the planned implementation date of the addition, change, suspension, or discontinuation of program modality:

August 1, 2019

For any suspension or discontinuation of a program modality;

Provide the number of students enrolled in the program who are using that program modality and their expected graduation dates:

N/A

Provide a plan that covers each of the students using the program's modality to ensure that:

The student's time to completion of the program is not increased;
Students and faculty continue to have access to course material, student services, and academic support for the duration of the program.

The proposed program will be delivered in a hybrid format, thus all students will be taking the same courses. Some students will be in the classroom and some will be attending remotely. Those who attend remotely have access to on-campus resources equal to on-site students. The distance-education students follow the same course plan as the on-site students. All available resources for our current MPS GEOINT program are listed on our program website (https://geospatial.umd.edu/education/resources).

Please submit the coversheet and Program Modality Request form to the Secretary via postal mail or electionally to acadprog.mhec@maryland.gov