University of Washington
Department of Geography together with Professional and Continuing Education

Professional Masters Program in Geographic Information Systems
Program Description

The Professional Masters Program in Geographic Information Systems (PMP-GIS) prepares graduates to understand and apply GIS technology to complex problems about sustainability management. Sustainability management is a workflow process that involves balancing economic, social, and environmental considerations when addressing complex problems like land use, water resource, and transportation management, among other topics.

The program primarily serves working professionals who have had exposure to GIS and seek further expertise or a career change. The program is offered as a hybrid of online learning and on-site learning. The hybrid courses contain both online and on-site learning sessions. The online courses contain a distance learning component only.

Core courses (See Appendix A for course descriptions and Table A-1 for learning objectives):
Early Autumn (late summer) 1: Geog 514 GIS Problem Solving (hybrid)
Fall 1: Geog 560: Principles of GIS Mapping (online)
Winter 1: Geog 582: GIS Data Management (online)
Spring 1: Geog 517 Geospatial Data Analysis (online)
Summer 1: Geog 565: GIS Programming (hybrid)

GIS for sustainability concentration courses (See Appendix A for course descriptions):
Fall 2: Geog 562: Coastal GIS (online)
Winter 2: Geog 564: GIS and Decision Support (online)
Spring 2: Geog 568: International Case Studies of GIS for Sustainability (online)
Summer 2: Geog 569: GIS Workshop (hybrid)

The program commenced in early autumn 2010. It is being offered principally part-time (full-time as space available starting in summer of 2011) via a hybrid on-site and online delivery.[1]

To be admitted, students must have a B.A. or B.S. degree, competitive GRE scores, a minimum TOEFL score determined by the Graduate School, and at least a year of work experience. Students would be admitted annually in a cohort, and most would attend part-time.

Once admitted, students would take nine 5-credit courses, for a total of 45 credits. The program would consist of a 25-credit GIS core and a 20-credit concentration in a specific subject area. Initially, the concentration would focus on sustainability, but other concentrations may be

[1] Instruction would be delivered using a mix of online delivery and on-site delivery using U of Washington facilities in the Puget Sound region. Six out of nine required courses would be offered entirely online, and three summer classes would include online elements, plus a week-long face-to-face session. Online learning would be structured asynchronously most of the time, but at times synchronous interaction would be set up for student groups that want to share insights using chat-based software. Chat sessions would be moderated with the faculty instructor and/or the teaching assistant. A high level of interactive engagement is sought whereby students build upon the contributions of each other through discussion and problem solving processes to increase engagement in the learning process. Director Nyerges will draw from his online tool set that enables structured participation in online activities.

offered as the program matures. Courses would address the relationships among social/cultural, environmental, and economic issues, fostering insights about the balance and tradeoffs among processes and outcomes at local, regional, national, and global scales.[2] Students take a final capstone course that immerses student teams in the full range of tasks associated with a GIS project, culminating in the presentation of a final report.

Students would normally complete the proposed program in two years and one summer (part-time) and be prepared to:

- Ask and follow through on appropriately scaled and applied research questions;
- Find, code, and manage data of multiple kinds;
- Tackle complex problems by managing, analyzing, and displaying geospatial data;
- Negotiate and participate in group deliberations around mapping and analysis;
- Produce original and creative work related to sustainability problems around the world.

These student learning objectives would be measured through quizzes, lab assignments, and short-answer essay questions tied to the objectives and topics of each course and to overall program outcomes. Student progress would be monitored through online meetings with academic advisors using the latest in online technologies for collaboration. The capstone course would offer students a culminating opportunity to demonstrate their skills and knowledge in a group project. Capstone work products would be evaluated by community partners, first based on group product materials made available online and later on presentations in an end of session symposium on the last day of the final week-long face-to-face session. Peer assessments would also occur as students comment on each others' group work.

Program assessment approaches would involve a mixture of external professional guidance and internal assessment strategies and tools to ensure that the program's goals, objectives, and outcomes would align with current employer needs and meet the academic rigor of a master's level program. Program assessment approaches would include:

- Peer review of teaching materials by faculty to ensure high quality courses;
- Advisory board[3] evaluation of course materials, with each member evaluating a course he or she is interested in;
- Assessment of enrollment and attrition rates to determine connections with various possible causes;
- Regular surveys of current students to assess and update the program, including standard university course evaluations plus targeted detailed course evaluations;

[2] These relationships commonly have a geospatial and temporal character. For example, locations of alternative fuel production often influence where that fuel is consumed, and the ability of water-oriented ecosystems to naturally cleanse themselves depends on the proximity and magnitude of pollution sources, which change over time.
[3] The program would maintain an ongoing advisory board consisting of GIS-savvy professionals from public, private, and non-for-profit organizations.

- Exit interviews of all graduating students with a follow-up evaluation one year after program completion;
- Regular alumni surveys;
- Annual benchmarking study of peer programs to identify current best practices and areas for program growth and refinement.

Data from all of the above approaches would be used to assess and improve the content and curriculum of the program.

More complete information is available at the Professional and Continuing Education PMPGIS web page.

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Appendix A.
PMP-GIS Curriculum Course Descriptions

The courses below constitute the PMP-GIS curriculum.

Core Courses

Geog 514 GIS Problem Solving (New) (5)
Geography 514 introduces students to several geospatial information technologies including geographic information systems, global positioning systems, remote sensing, and spatial decision support systems for addressing complex geospatial problems. Students work together in teams to gain an understanding of the intellectual benefits and costs of integrated data processing strategies with geospatial information technologies. Strategies include problem definition, database design, data collection, data structuring, data analysis, and information presentation in light of the geospatial information technologies. Workstation, local area network, and wide-area network data communications are introduced, particularly Internet GIS and Web-based GIS applications, e.g., ArcGIS Server, Google Earth, Microsoft Bing Maps, and NASA World Wind. Course topics are presented as an overview of material in the masters program, giving students exposure to the array of learning expectations.

Geog 560: Principles of GIS Mapping (5)
Geography 560 provides students with an opportunity to learn and use concepts, techniques, and software tools that are part of geographic information systems (GIS). GIS brings together geovisualization technology, data management technology, and geospatial analysis technology to enable people to develop geospatial databases, analyze those databases and depict them in the form of 2D and 3D map displays. Students apply principles of map design for different types of maps depicting sustainability – social, economic, and environmental - topics at geographic scales from global to local. Students practice critical thinking skills during geographic information representation and use of GIS mapping software. Web mapping applications are introduced to demonstrate Internet GIS technologies.

Geog 582: GIS Data Management (5)
Geography 582 exposes students to geospatial database management software, particularly solutions provided by Environmental Systems Research Institute, including personal geodatabase and enterprise geodatabase management solutions. Case studies in database management provide students with hands-on experience with a variety of data types and sizes of databases. Issues addressing data sources and data quality inform students about the benefits and drawbacks of transforming data into information. Implications of managing small, medium, and large database are explored. Students are exposed to enterprise architectures for GIS in light of varying size units within organizations. The role of Internet, Intranet and Extranet architectures for intra and inter-organizational collaboration are addressed due to popularity of such technologies for accessing data.

Geog 517: Geospatial Data Analysis (New) (5)
Geography 517 exposes students to statistical analyses of diverse datasets. Several types of distributions are examined, including Poissan, Chi-square, and Gaussian. Descriptive and inferential statistics are the foundation of the course. Introduction to geostatistics, including interpolation and Kriging are among the techniques examined. Spatial statistics include pattern analysis, spatial autocorrelation, and cluster and outlier detection (hot spots). GIS maps provide the display companion to the statistical approaches.

Geog 562: Coastal GIS (5)
Geography 562 provides students with a learning experience that links the theory underlying GIS with its application to modeling land-water geographic dynamics. The course combines an overview of general principles of GIScience focusing on vector and raster data structures with the practical experience of using those data structures to create geospatial information. The lectures introduce students to the analytical treatment of geographic information using several frameworks for understanding data, software operations, and systems. The course adopts a thematic focus about coastal concerns, particularly coastal vulnerability using an environment-society perspective. Coastal is defined as the watershed basins that drain into coastal waters, as influenced by social and natural features in those areas; thus material is relevant to all watershed, river, and lake features. Student lab assignments using GIS software make use of coastal data sets from Puget Sound and other areas around the world depending on student interest to address feature measurement, characterization, and movement related to the land-water interface.

Sustainability Management Concentration Courses

Geog 564: GIS and Decision Support (5)
Geography 564 provides students with a learning experience about "GIS methods" in the context of several pervasive decision support contexts involving urban-regional sustainability management settings. Two significant categories characterize the decision support contexts – topics and decision situations. Three inter-related topics – land use, transportation, and water resources – are fundamental to how people upgrade and/or degrade the quality of life in communities, each having a significant influence on the natural environment. Three pervasive decision situations – planning, improvement programming, and project implementation – are ways that communities attempt to address quality of life changes in the long, medium and short terms. Students work with GIS methods in both commercial-off-the-shelf and customized software to address various decision support scenarios that characterize those nine contexts (of 3 topics by 3 decision situations). Students gain exposure to group-based decision support methods to address those nine contexts; those contexts being among the most complex and important topics in the 21st century. The role of Internet, Intranet and Extranet architectures for intra and inter-organizational collaboration support are addressed.

Geog 568: International Case Studies of GIS for Sustainability (NEW) (5)
Geography 568 provides an overview about perspectives on sustainability around the world. Various international, national, and regional perspectives are used as a lens to understand how different organizations view sustainability. Students explore case studies that provide insight about the practice of using GIS for sustainable development decision problems around the world. Case studies range in themes – social, economic, and environmental - and scales – local, regional, and global. Diverse datasets and task emphasize a range of sustainability problems.

Geog 565: GIS Programming (New) (5)
In Geography 565 students receive hands-on experience with the Python programming language applicable to GIS database work, particularly related to extending current commercial GIS such as ArcGIS. Students learn the basics of geoprocessing using command line, dialog box, ModelBuilder, and Python Scripting interfaces to interact with geospatial databases. Students develop Python programming/scripting skills fundamental to advanced GIS data manipulation based on previous work with data management course work. Assignments are conducted as team work, with students playing analysis and programmer roles to develop programming projects.

Geog 569: GIS Workshop (5)
Geography 569 is designed as a capstone experience in the curriculum. Students become independent and effective GIS team analysts who can develop and use GIS databases for geospatial analysis to support problem solving, meeting the needs of project partners. The course is an intensive workshop that involves hands-on experience in which student teams develop GIS data analysis as part of applications working in collaboration with local partners (University units, community agencies, or local government etc.). The course immerses students in the full range of tasks associated with a GIS application. Working in teams, students communicate with project partners to identify project goals, acquire and prepare spatial data for GIS data analysis, communicate with project partners to assess progress, manage spatial data, and produce necessary maps for presentation as part of a final report. In lecture and readings, students examine GIS project management strategies (in a variety of organizational and application contexts), and concepts and skills for data acquisition, data preparation, database design, data analysis, and reporting skills.

Table A-1. Learning Objectives and Expected Outcomes of PMP-GIS Curriculum

Lrn Obj Num	***Learning Objective Topic***[3]	**PMP-GIS Courses**[1] (cell entry[2] - expected level of student learning outcome)								
		514	**560**	**582**	**517**	**565**	**562**	**564**	**568**	**569**
1	Geospatial information technologies	2	2	3	2	3	2	2	2	3
2	Representation - data, information, evidence, knowledge; reality, data measurement, and output	2	3	4	3	3	3	3	3	4
3	Analytical and communication perspectives on representation	1	2	2	4	2	3	3	4	3
4	Geospatial concept abstraction as relationship among geographic phenomena, object types, and data measurements	2	3	4	3	4	3	3	3	4
5	Data distributions	-	2	2	3	-	1	1	-	2
6	Data source materials Primary and Secondary	 2 2	 2 3	 2 3	 2 4	 3 4	 3 3	 3 3	 4 2	 3 4
7	Data collection/acquisition/entry approaches, formats	2	2	3	1	-	2	2	2	3
8	Data search, compilation, and integration	2	1	3	2	4	2	3	2	4
9	Coordinate systems for spatial referencing	2	3	3	2	3	3	3	2	4
10	Map projections	1	2	3	2	3	3	3	2	3
11	Map type displays	2	3	-	2	2	2	3	3	4
12	Map layout design	1	3	-	1	1	1	2	3	3
13	Visual variables and color use	1	3	-	3	-	3	3	2	4
14	GIS information visualization	2	3	1	2	1	3	3	3	4
15	Problem solving as critical thinking	3	2	2	3	3	3	3	3	4
16	GIS data structures; object types: point, line, polygon, and surface	1	3	4	2	4	3	3	2	4
17	GIS database strategies; small and large enterprise architectures	1	1	4	2	2	2	2	2	3
18	GIS operations / transformations	1	1	2	2	2	3	3	2	3
19	Data quality and consequences of use	1	1	3	2	2	2	2	2	3
20	Application case studies	1	2	3	-	2	3	3	4	4
21	Project/product presentation	2	2	1	-	2	3	3	-	4
22	Data models and database structures	1	2	3	-	3	3	3	2	3
23	Database design process - Conceptual, Logical, and Physical design	-	1	3	-	2	2	3	4	3
24	Vulnerability and risk assessment	2	1	1	1	1	3	3	3	2
25	Descriptive statistics	1	2	1	3	3	2	2	2	3
26	Spatial statistics	-	-	-	3	1	2	2	1	2
27	Decision support strategies	2	2	-	2	-	3	4	3	2
28	Multicriteria evaluation	1	1	-	3	1	3	3	1	2

29	GIS project management - Gaining organizational support through cost and benefit study - Workgroup management - Project workflow steps - Milestones and budgeting	1	1	1	-	-	2	2	1	3
30	GIS use in society; community participation, value conflicts	1	1	2	4	-	2	2	4	3
31	Institutional and organizational mandates	3	1	2	1	-	2	3	3	4
32	Algorithms and programming - software programming language - GIS components	-	-	3	-	4	2	2	2	2
33	Modeling geographic dynamics	2	-	2	1	2	3	2	3	3
34	Environment-society relationships	2	3	2	1	1	3	3	3	2
35	Systems design and architecture	-	-	3	2	4	1	2	2	3

[1]**Course number and name:**
EAu1: Geog 514: GIS Problem Solving (Nyerges or Elwood)
Au1: Geog 560: Principles of GIS Mapping (Lecturer)
Wi1: Geog 576: GIS Data Management (Nyerges)
Sp1: Geog 517 Geospatial Data Analysis (Withers)
Su2: Geog 565: GIS Programming (Lecturer)
Au2 Geog 562: Coastal GIS (Nyerges or Lecturer)
Wi2: Geog 564: GIS-Based Decision Support (Nyerges)
Sp2: Geog 568: International Case Studies of GIS for Sustainability (Lecturer)
Su3: Geog 569: GIS Workshop (Nyerges or Elwood)

[2]**Expected level of student outcome:**
- : not introduced, hence outcome not expected in course
1 : "knowledge" of the topic involves awareness of its significance
2 : "comprehension" involves "understanding the principles" associated with topic
3 : "application and analysis" involves the demonstrated use of the topic
4 : "synthesis and evaluation" involves a base level of "mastery" to address the topic

[3]**Learning Objective Topic –** and description

1. Geospatial information technologies – geographic information systems, global positioning systems, remote sensing, mobile location services, field collection systems

2. Representation – representations of data, information, evidence, and knowledge from multiple perspectives. The interplay among a multi-valued reality and intentions for database and map display representations can change interpretations of data, information, and knowledge.

3. Analytical and communication perspectives – two approaches to working with representations of geographic data have predominated the study of mapped information over the past 40 years - maps as an analytical tool and maps as a communication device.

4. Geospatial concept abstraction - relationship among geospatial phenomena, object types, and data measurements as related to forms of data representation

5. Data distributions - Poissan, Chi-square, Gaussian, and others.

6. Data source materials -- the materials used in compiling and updating maps through manual means and digital data sets; review relationship to topics in measurement sciences such as surveying and photogrammetry; advanced topics include analysis and appraisal of materials, geographic coverage, and aspects of data quality.

7. Data collection -- the digitizing process, including both manual and semi-automated techniques.

8. Data search, compilation and integration -- the process of compiling digital data sources, including both digital and analog (hard copy map) data sources; emphasis is placed on resolving divergent and potentially incompatible sources in overlay analysis.

9. Surveys and coordinate systems – surveys and coordinate systems as related to spatial referencing systems, geographical (latitude and longitude) and planar (state plane and universal transverse Mercator) coordinate systems used to express locational information with reference to a datum. Datum reference includes discussion of the geoid and ellipsoids with particular discussion of coverage and use of coordinate systems in spatial reference frameworks.

10. Map projections – classification and selection of map projections and map transformations for small scale and large scale maps, including projections used by the U S Geological Survey, and coordinate data transformations for computer graphics.

11. Map type displays – general reference and thematic maps; basic types of point, line, area, and volume maps depicting spatial patterns; map types: choropleth, dot, flow, proportional symbol, 2D surface and isarithms, 3D surface and solids

12. Map layout design -- fundamental issues in designing maps, including visual hierarchy, intellectual hierarchy, audience objectives, and components of balance and contrast in promoting hierarchy, and basic elements that determine effective symbolization.

13. Visual variables and color use -- different types of point, line area and volume symbols generated from the use of graphic design principles.

14. GIS information visualization -- the process of interpreting graphic information on a map, including the processes of perception and recall from short term and long term memory; cognitive visualization principles. Use of analysis and display capabilities together to enhance insight into interpretation of geographic information.

15. Geospatial problem solving as critical thinking -- fundamentals of spatial logic underlying the use of spatial operators; problem solving strategies with spatial information; operational and cognitive aspects of information use; includes analysis of problem domains and work tasks to determine how information is used in particular contexts; advanced topics include the foundations of reasoning, problem solving and decision making from mathematics, philosophy, management /decision science, and cognitive science.

16. GIS data structures -- fundamentals of organizing data for storage, management, analysis and display using programming languages, including locational, temporal and thematic characteristics of data.

17. GIS database strategies – concept, techniques, and tools for managing spatial and attribute data in support of analysis and display. Databases oriented to small and large enterprise architectures are addressed.

18. GIS operations / transformations -- manipulating point, line, area and volume data to derive other point, line, area, and volume data, including conversions of one to another; used for investigating spatial pattern as a data distribution across a surface and spatial process as the change in patterns over time.

19. Data quality and consequence -- Types of errors that exist in spatial data and their influence on spatial models and the decisions derived from such models. It includes all testable components of data quality: positional and attribute accuracy, logical consistency, and completeness.

20. Application case studies -- case studies for particular topics of interest to students in class; appropriate application processing strategies for particular problems of interest including but not limited to sustainable development issues about natural resources, transportation, land use, ecosystems and environmental hazards.

21. Project/product presentations -- strategies for making presentations in line with standard professional practice.

22. GIS data models and database structures – frameworks for spatial database management systems including storage constructs, operations and integrity rules; compares database management approaches to file management approaches, and uses spatial database management software.

23. Database design -- the process of designing conceptual, logical and physical data descriptions for implementing single and multipurpose geographic databases.

24. Vulnerability and risk assessment – examine how phenomena when exposed to hazards and stressors are impacted. Probability is used to compute risk.

25. Descriptive statistics – computing mean, median, mode, frequencies on various distributions.

26. Spatial statistics – using coordinate dimensionality to influence the computation of statistics.

27. Decision support strategies – multiple stages of modeling in GIS workflow.

28. Multicriteria evaluation – consider a collection of attributes to influence the scoring of options to select an outcome.

29. GIS Project management – needs analysis, requirements definition, gaining organizational support through cost-benefit studies, workgroup management, project workflow, milestones and budgeting.

30. GIS use and society -- cartography and geographic information systems in their cultural and institutional settings in society including private and public organizations, communities, private-public partnerships.

31. Institutional and organizational mandates – motivations for GIS applications commonly come from institutional and organizational missions and goals, which in turn are translated into need-to-know questions, focusing database development, operations on those databases, and output of information products.

32. Algorithms and programming -- specification, design, and implementation of software for geographic data processing.

33. Model geographic dynamics – new developments in GIS that focus on spatial-temporal modeling of phenomena that change and move.

34. Environment-society relationships – environmental resources are influenced by social and economic activity. Data analysis focuses on those influences.

35. Systems design & integration -- different types of information systems architectures, how they interface to one another, including the interfacing of spatial modeling, GIS, remote sensing, and management information systems.