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RESEARCH IN GEOGRAPHIC INFORMATION SCIENCE IN THE UNITED STATES: THE UNIVERSITY CONSORTIUM FOR GEOGRAPHIC INFORMATION SCIENCE

Submitted by University at Buffalo, United States [1]

INVITED PAPER

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ABSTRACT

The University Consortium for Geographic Information Science (UCGIS) was formed to serve as a voice for the geographic information science research community in the United States of America, to foster multidisciplinary research and education, and to promote the responsible use of geographic information and associated technology. The UCGIS has established and publicized national priorities for research (1996) and education (1997), and has presented its ideas to the US Congress in an effort to increase government funding for research. The paper describes the reasons that UCGIS was founded, its history, and its current structure, and plans for the future.

KEYWORDS: University Consortium for Geographic Information Science, UCGIS, geographic information science, research, science policy

I. INTRODUCTION

1. The University Consortium for Geographic Information Science was formed to serve as an effective, unified voice for the geographic information science research community, to foster multidisciplinary research and education, and to promote the informed and responsible use of geographic information science and geographic analysis for the benefit of society. Subsequently, the UCGIS has established national priorities for research and education, and has presented its ideas to the US Congress in an effort to increase government funding for research. This paper describes to UCGIS, its origins, and its structure, and then describes its major activities to date.

II. HISTORY OF THE UCGIS

2. In 1990, the advisory board of the US National Center for Geographic Information and Analysis (NCGIA) recommended that an organization be established to promote and support the field, especially the needs of researchers. This organization would be more broadly-based than NCGIA, which consists of just three Universities. After continued discussions in 1991, the NCGIA responded by establishing an ad hoc steering committee consisting of 16 individuals from as many institutions, representing about seven different academic disciplines [3]. After a series of meetings at professional conferences, sufficient momentum was gathered to establish a national conference on the issue in Boulder, Colorado. December 4-5, 1994, forty-two individuals representing thirty-three universities, other research institutions, and the Association of American Geographers (AAG), met in Boulder, Colorado and decided to establish the University Consortium for Geographic Information Science (UCGIS). Delegates were invited by the Presidents and Chancellors of seven US research universities with prominent programs in Geographic Information Systems. The initial charge for UCGIS was established at the Boulder meeting: UCGIS would be a non-profit organization of universities and other research institutions dedicated to advancing the understanding of geographic processes and spatial relationships through improved theory, methods, technology, and data [2]. During 1995, UCGIS was established in the District of Columbia as a legally-existing non-profit organization.

III. UCGIS RESEARCH PRIORITIES

3. In the summer of 1996, UCGIS held a 3-day Summer Assembly in Columbus Ohio, designed to establish a portfolio of national priorities for research. Before the Columbus workshop, UCGIS member institutions nominated up to five topics each, and about 80 such research topics were proposed, each applicable to national needs. Two-page descriptions of all topics were placed on the world-wide web for consideration by members, and a research committee grouped the topics into 17 themes. At the Columbus meeting, break-out groups refined the themes and built consensus, and a straw poll confirmed the following 10 topics as the 1996 UCGIS Research Priorities:

Spatial Data Acquisition and Integration

4. Data acquisition continues to be a major impediment to GIS development and application. Research is needed to reduce acquisition costs, to automatically integrate new data with existing data, and to facilitate analysis of data from diverse sources.

Distributed Computing

5. Processing and storage are being shared across networks involving many computer platforms. In the future, many GIS functions may become modules in distributed computing environments. Research is needed on the economic, institutional, and technical implications of this trend.

Extensions to Geographic Representation

6. Current commercial GIS products deal primarily with static, two-dimensional distributions. Many GIS applications, from local to global scale, require better representation and analysis of three-dimensional and dynamic information.

Cognition of Geographic Information

7. A better understanding of human geographic cognition will improve the utility of geographic information technologies to experienced users and will make them more accessible to inexperienced and disadvantaged users from many cultures.

Interoperability of Geographic Information

8. Interoperability refers to the integration of existing, independently developed computer applications. Research is required to improve interoperability so that each system can recognize and employ data and commands from other systems, not originally designed to work together.

Scale

9. Scale refers to the level of detail with which information is observed, represented, analyzed, and communicated. Many physical and cultural processes do not scale in a linear or uniform fashion. Research is needed to understand the sensitivity of geographic information to changes in scale.

Spatial Analysis in a GIS Environment

10. Spatial analysis allows us to go beyond maps as pictures to identify problem causes and solutions. Research is needed to extend existing approaches to larger and more complex datasets and to connect analytical techniques of other fields to the GIS environment.

The Future of the Spatial Information Infrastructure

11. The National Spatial Data Infrastructure (NSDI) is crucial to national needs economic vitality, institutional capacity, and an informed society. Research is needed on information policy, access, economics of information, and integration of local data.

Uncertainty in Spatial Data and GIS-based Analyses

12. Uncertainty in Spatial Data and GIS-based Analyses: Geographic data imperfectly represent reality, and discrepancies propagate through spatial data management and analyses in a GIS environment. Research is needed to recognize, report, reduce, and cope with uncertainty.

GIS and Society

13. Access to GIS offers great potential benefit to society. Research is needed guide the development of GIS toward maximum equity, efficiency, and effectiveness. We need to know more about the individual, societal, political, economic, legal, and institutional impacts of such technologies.

14. These ten Research Priorities have been promoted since they were established, especially to the public and private sectors, and underwent detailed re-assessment at the 1998 Summer Assembly in Park City, Utah. An article describing the process and summarizing the 10 research priorities was published in the journal, Cartography and Geographic Information Systems [4]. White Papers were prepared on each of the 10 research topics and are available on the world-wide web [6]. Each paper describes the research area, say why it is important and what benefits would result, and provide specific proposed research topics along with an estimate of how long it would take to complete work on each.

IV. UCGIS EDUCATIONAL PRIORITIES

15. The 1997 UCGIS Summer Assembly was held in Bar Harbor, Maine, and had as its main item of academic business the development of national priorities in Geographic Information Science education. The priorities identified are:

Emerging Technologies

16. Emerging technologies, such as the Internet, the Web, multimedia CD-ROMs, and distributed laboratories and seminars are rapidly changing education at all levels. UCGIS must assume an active role in testing and advancing many of these new educational technologies.

Supporting Infrastructure

17. The development or expansion of GIS courses requires supporting infrastructure of hardware, facilities, and technical support personnel. UCGIS must develop guidelines for minimum levels of infrastructure needed to maintain GIS instruction, and suggestions on how to establish such infrastructure.

Access and Equity

18. As GIS becomes a ubiquitous tool, it is important to ensure that all members of society have full access to these technologies and data. GIS may provide an excellent entry point into the world of high technology, and this potential must be explored and developed.

Curriculum Content

19. As the development and use of GIS continues to grow, it is increasingly important for educators to deliver a sound foundation in GI Science. Many different educational constituencies exist, and each has different educational needs. Work is needed to define these constituencies and identify specific skills and concepts required by each.

Professional GIS Education Programs

20. Working professionals make up an important constituency for GIS education. UCGIS encourages the documentation of national needs for formal professional GI Science programs, establishment of an appropriate core curriculum, and development of Web-based and other innovative curriculum delivery methods.

Research-based GIS Education

21. Educating the next generation of university faculty, and integrating GIS into their research, is an important GIS education topic. This topic has at least two components: educating and training the next generation of GI Science specialists at the Doctoral level; and integrating GIS and GI Science into the education of environmental and social scientists who will use the tools and concepts in their own research.

Learning with GIS

22. Educational paradigms such as active learning fits GIS very well, and efforts should be made to develop programs that use GIS as a vehicle for increasing geographic and computer literacy. A pedagogically-oriented GIS software toolbox would facilitate active spatial learning.

Accreditation and Certification

23. UCGIS did not reach consensus on approaches to the issue of professional certification and possible accreditation of GIS education programs, other than to agree that it is an important and controversial topic. Further discussion will be needed to determine whether UCGIS should offer a position statement on this topic, and what the content of such a statement should be. A summary of the seven UCGIS educational priorities was published in Geo Info Systems [1], and white papers for each educational priority also are available on the web [5].

V. EFFORTS TO INFLUENCE FUNDING AND POLICY

24. From the start, one of the main goals of UCGIS was to increase the amount of funding available to support university based research, as well as research at the national laboratories and at non-profit organizations. To this end, the UCGIS conducted a "Congressional Breakfast" in January 1997, and another in April 1998. The 1998 breakfast attracted about 100 participants, including two members of the United States Senate, and about 50 members of the support staffs of members of Congress. UCGIS plans to continue working with congressional staff members as well as Federal agencies, to increase funding available for this topic in the United States.

25. UCGIS also has a "seat at the table" in the monthly meetings of the Federal Geographic Information Committee (FGDC), an inter-agency body that coordinates US government data standards and policy directed toward development of the National Spatial Data Infrastructure. UCGIS provides FGDC with a point of contact for a considerable proportion of the US basic research community in geographic information science.

VI. SUMMARY AND PROSPECTS

26. UCGIS is in its early stages of development, but is already providing an effective voice for the research and higher education communities within the United States. With the development of AGILE, a somewhat similar organization of geographic information laboratories in Europe, prospects are excellent for international collaboration on science policy and practice regarding geographic information science.

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About the Author

David M. Mark is a Professor of Geography at the University at Buffalo, State University of New York, where he also directs the Buffalo branch of the US National Center for Geographic Information and Analysis. From November 1997 to November 1998, David Mark is serving as President of the University Consortium for Geographic Information Science. David Mark has written or co-authored more than 150 publications, including more than 50 refereed journal articles, and has made over 100 presentations. He has supervised 7 Ph.D. and about 30 Masters degrees to completion, and has been awarded 17 external research grants. Mark's main research interests are in spatial cognition and language, spatial reasoning, and algorithms for geographic problem solving. He also has worked extensively on digital elevation models and on quadtree-based algorithms and data structures. He also has strong interests in the two-way relationship between GIS and society, and in the history of GIS. David Mark joined the University at Buffalo in 1981 after teaching at the University of Western Ontario. He received his BA and Ph.D. in Geography from Simon Fraser University in 1970 and 1977, respectively, and an MA from the University of British Columbia in 1974.