

# Education in Environmental Remote Sensing: A Bibliography and Characterization of Doctoral Dissertations

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## INTRODUCTION

THE GROWTH AND STATUS of remote sensing education in North America have been documented most recently by Kiefer and Lillesand (1983), Lillesand (1982), Dahlberg and Jensen (1980), Estes et al (1980), Nealey (1977), and others. These reports have provided valuable assessments of the nature and extent of remote sensing education by detailing the types and number of courses offered in remote sensing and mapping sciences, and by discussing trends and issues in remote sensing education.

This paper presents yet another characterization of remote sensing education, focused specifically at the graduate level, by documenting the doctoral dissertations granted in the United States and Canada between 1965 and 1984. The purpose of this documentation is two-fold: (1) to present an account of universities and colleges granting doctoral degrees in remote sensing (by topic and by year), and (2) to provide a detailed bibliography of remote sensing dissertations published during this period. It is hoped that this document will be a useful resource for faculty, researchers, and students, particularly current or potential doctoral candidates, in the field of environmental remote sensing.

## METHODS

The doctoral dissertations presented here were found through perusal of *Dissertation Abstracts International* (DAI), a compendium of dissertation titles and abstracts from nearly 450 North American universities and colleges. DAI is published by University Microfilms International of Ann Arbor, Michigan. (All dissertations listed here are accessible either through the University Library Loan program, or through purchase from University Microfilms International.)

A search for dissertation titles was made in the

cummulative and supplemental monthly DAI indexes (through Volume 45; June 1985). The key word list used to find the titles was aerial, airphoto, digital, image, infrared, Landsat, mapping, microwave, multispectral, orthophoto, photogrammetry, photography, radar, radiance, reflectance, remote, satellite, scanner, Seasat, sensing, spectral, thematic, thermal, and the derivatives of these words (eg., imagery and imaging for image).

The selection of pertinent dissertation titles has been confined to those dealing with *environmental remote sensing*, defined here as remote sensing of the terrestrial and aquatic environment. This means that dissertations concerned with meteorological satellites used to study the atmosphere or clouds have been omitted, but those concerned with such satellites used to study snow and ice, sea or lake surface conditions, or terrestrial features have been included. Dissertations concerning the remote sensing of extraterrestrial features have been excluded, as have been those concerning medical sciences, certain types of physical or engineering applications, and electrical engineering and computer science. Also, most dissertations in the fields of geodesy, photogrammetry, surveying, cartography, and other mapping sciences have been omitted, unless the topic focused on a particular environmental monitoring application. Dissertations concerning instrumentation and methodology pertinent to environmental remote sensing, however, have been included.

While a thorough search has been made to locate pertinent dissertations, some titles may have been inadvertently omitted. In some cases, dissertation titles simply may not have been forwarded by the university or college to University Microfilms for inclusion in DAI. In addition, some titles may have been overlooked because they did not contain one of the key words listed above. (Some environmental remote sensing dissertations, whose titles did not

contain the key words, were found in fact by chance in the DAI indexes.) Thus, the following characterizations are subject to limitations.

### CHARACTERISTICS

A total of 356 doctoral dissertations in environmental remote sensing, as found in the DAI indexes, were granted by 79 universities and colleges in the United States and Canada between 1965 and 1984. The number of dissertations granted annually is depicted in Figure 1. The graph shows a steady annual increase in the number of degrees granted, with dramatic "peaks" in 1976 (32 dissertations granted) and in 1980 (35 dissertations). Each year the number of universities and colleges granting doctorates in remote sensing increased steadily, from two in 1965 to 26 in 1984. Based on an earlier account of doctoral dissertations in remote sensing and photogrammetry (Merideth, 1981), an obvious link has been suggested between these trends and research funding support from NASA's Earth Resources Program, which began in 1966 and continued through the late 1970's (Carter, 1981).

Of the 79 universities and colleges granting doctorates in environmental remote sensing during this period, a relative few granted most of the degrees. For example, 30 awarded four or more Ph.D.'s each between 1965 and 1984, accounting for 266, or 75 percent, of the total degrees awarded by all universities and colleges during this period. Ten universities and colleges were responsible for 43 percent of all dissertations awarded, and five granted 28 percent of the total.

The University of Kansas ranked first in number

of Ph.D.'s awarded, with a total of 25. Purdue University ranked second with 22 dissertations. University of Wisconsin-Madison was third with 21; Texas A & M University, fourth with 16; Colorado State University was fifth with 15; Cornell University and Oregon State University ranked sixth with 12 each; University of California-Berkeley was seventh with 11 Ph.D.'s; and University of Michigan and Stanford University were eighth with ten doctoral degrees each.

A year-by-year summary of how many degrees were awarded by the 30 institutions granting four or more degrees is presented in Table 1. In addition to these "top thirty" schools, 11 institutions granted three doctoral degrees; 19 awarded two degrees; and 19 awarded one doctorate.

To indicate the "areas of specialization" of the various universities and colleges, the dissertations have been grouped into twelve topic areas: (1) geology, (2) agriculture/soil science, (3) forestry, (4) other vegetation assessment (wetlands, rangeland, etc.), (5) land cover/land use, (6) hydrology, (7) water quality, (8) oceanography, (9) wildlife and wildlife habitat, (10) engineering and physical sciences, (11) instrumentation and methods, and (12) miscellaneous. A summary of the institutions granting at least three Ph.D.'s in a given topical area is presented in Table 2.

### BIBLIOGRAPHY FORMAT

Each entry contains the following information (although, for some entries, certain information may be unknown or unavailable):



Fig. 1. Number of remote sensing doctorates granted between 1965 and 1984.

TABLE 1. UNIVERSITIES AND COLLEGES GRANTING FOUR OR MORE REMOTE SENSING DOCTORATES BETWEEN 1965 AND 1984

University/College	School Total	YEAR-BY-YEAR TOTALS																			
		1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Kansas	25			1		1	1	2		1	2	3	3	4			1		4		2
Purdue	22			1	1	1				2	1	2	1		2	3		3	4	1	
Wisconsin-Madison	21		1				1	1	1	3	2		1		2	3	2	1	1	2	
Texas A&M	16										1		2	2	3		2	1	2	1	2
Colorado State	15						1		1	1		2			1	2	1	1		3	1
Cornell	12	1			1	1	1		2	1			1	1			1	1			1
Oregon State	12						1					2	1	2	2	1	2	1			
California-Berkeley	11						4	1	2			1	1			1	2	1			
Michigan	10				1			1	1	2	2					1		1	1		1
Stanford	10					1					1				1	2	2	2			1
SUNY-Env. Sci. & For.	8			1	1					1	1			1		1	2				1
Delaware	7													1		1	2				
Maryland	7											1				2	1	2	1	1	1
Minnesota	7									1				1			1	1	1	4	
Tennessee	7						1		1		1						1	1	1	1	1
UCLA	7				1							1	2		1	1	1	1	1	1	
Arizona	6											1	2						1	1	
Idaho	6							1				1	2		1		1		2		1
Ohio State	6		1	1								1	2			1					
Washington	6	1									1			1		1		2	1		
British Columbia	5											1	1	1		1	1		1		
Florida	5			1								1	1		1					1	
Iowa State	5						1			1					1				1		2
Penn. State	5								1				3			1				1	2
Virginia Polytechnic	5											1			1						2
Louisiana State	4								1								1	1		1	
McGill	4							1	1						1						1
Michigan State	4															3		1			1
Pennsylvania	4									1	1						1		1		
Utah	4																1	1			1
TOTAL	266	2	1	6	4	5	10	8	11	14	14	14	23	12	13	20	24	24	24	18	19

DOCTORAL DISSERTATIONS

TABLE 2. TOPICAL CATEGORIZATION OF REMOTE SENSING DOCTORATES: INSTITUTIONS GRANTING THREE OR MORE DEGREES PER TOPIC

1. <i>Geology</i> Stanford (5) Kansas (4) Cornell (3) Idaho (3) Iowa (3) Washington (3)	2. <i>Agriculture/Soil Science</i> Purdue (6) Texas A&M (5) Wisconsin-Madison (4) Arizona (3) Kansas (3)	3. <i>Forestry</i> SUNY-Env. Sci. & For. (5) California-Berkeley (4) Minnesota (3)
4. <i>Other Vegetation</i> Colorado State (5) Delaware (3)	5. <i>Land Cover/Land Use</i> UCLA (5) Colorado State (3) Virginia Polytechnic (3)	6. <i>Hydrology</i> Kansas (6) Maryland (6) Texas A&M (6) Michigan (3)
7. <i>Water Quality</i>	8. <i>Oceanography</i>  Stanford (3) Kansas (3)	9. <i>Wildlife/Habitat</i>  Cornell (3)
10. <i>Engineering/ Physical Sciences</i> Purdue (4)	11. <i>Instrumental Methods</i> Purdue (7) Kansas (4) Penn. State (3)	

Author, Title of Dissertation, University, Year, Total Pages. (Major Advisor.)  
DAI Index Volume/Number, Page Number.

For ease in reference, these dissertations have been grouped by topic and then listed alphabetically by author.

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