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Research Activities, Opportunities & Possibilities in Environmental Informatics: International Scenario & Indian Potentialities

P. K. Paul[1], P. S. Aithal[2], A. Bhuimali[3], K.S. Tiwary[4], & Ricardo Saavedra[5]
[1]Executive Director, MCIS, Department of CIS, Raiganj University, India.
[2]Vice Chancellor, Srinivas University, Karnataka, India.
[3]Vice Chancellor, Raiganj University (RGU), West Bengal, India.
[4] Dean (Science & Management), Raiganj University (RGU), West Bengal, India.
[5]Director & Chair, International Programs, Azteca University, México.

Abstract
Environment is an important concern and also treated as a knowledge field viz. Environment Science, Environment Studies, Environment Engineering, Environment Management, etc. Environmental Informatics is the combination of Environment which includes allied branches and subjects from the environment side and Informatics which includes all allied branches and subjects from the informatics and IT side. All the environment-related subjects can get the benefit of Environmental Informatics for their different sorts by different means. Environmental Statistical applications also need Computational tools and so Environmental Informatics will be the right solution for such concern. Environmental Informatics uses different tools, techniques, and sub-technologies of Information Technology and few also from the Computer Science or allied branches. Due to its wider benefits and different applications, many educational institutes are offering the field with Bachelors, Masters and Research Degrees in the concerned field as well as in allied fields. As far as research is concerned the research in different forms are conducted by academicians, researchers and scientist. This paper provides comprehensive details on Environmental Informatics research opportunities and potentialities in Indian and international context.

Keywords: Environmental Informatics, Ecological Informatics, Geo Informatics, Emerging Technologies, Educational Programs, Research Degrees

Introduction

Environmental Informatics has wider aims and objectives than Geo Informatics and like branches. Environmental Informatics has scope for complete environmental solutions in a different context and also comes with the solutions of environment, ecology, agriculture, oceanography, climatology, forestry, anthropology, etc. [1], [5], [9]. For Environmental solutions and services, different types of Information Technology tools and components are being used. Various IT components viz. Database Technology, Web Technology, Network and Communication Technology are using for various activities in the environment and ecology. Various educational programs viz. Certificate, Bachelors, Masters, etc are offered in Environmental Informatics and related programs internationally [2], [3], [11]. Even in other allied departments and centers also Environmental Informatics related research is noticeable in some countries. There are different ways and policies in which at the research level this field or its subfield can be introduced [4], [18], [20].

Objective

As the title of the paper is 'Research activities, opportunities & possibilities in Environmental Informatics: *International Scenario & Indian Potentialities,* this paper has intention the following aims and objectives —

- To learn about the basics of Environmental Informatics including its background, features, characteristics in brief.
- To dig out the benefits and functions of Environmental Informatics for various environmental affairs and also in social development and management.
- To learn about the technologies which help in better Environmental Informatics practice and also its subfields as well.
- To learn about the existing educational and research programs in the field and also in allied areas.
- To know about the possible research programs at the Doctoral level including Post Doctoral or Higher Doctoral Degrees.
- To learn about the possible degrees and nomenclature even at Masters level in different streams.
- To oversee sample courses in Environmental Informatics and also possible emerging technologies in which research can be conducted.

Environmental Informatics: The fusion of Environment and Information Science

Environmental Informatics is about the planning of different activities viz. energy, environmental, agriculture and ecological systems, etc by environmental decision support systems and with proper Environmental Informatics practice. Environmental Geo spatial services viz. GIS, Remote Sensing, GPS, etc can be useful directly. Different allied areas viz. environmental chemistry and biochemistry can get the benefit of the field [6], [8], [16]. Environmental applications viz. in environmental phenomena vis. atomic, molecular and macromolecular scales, etc Environmental Informatics practice tools or technologies may be used. Further candidates with other allied degrees can also enter into the subjects by gaining skills, knowledge and research as the field further applied in other disciplines as well [12], [21].

- Designing, developing, modeling and implementing chemical, biological, environmental processes, etc are required by Environmental Informatics support.
- Activities of the websites related to the environment, ecology, agriculture, etc are possible with the help of Environmental Informatics [5], [12], [22].
- Modeling of biotechnological systems is required by the support of Environmental Informatics.
- Multimedia tools, graphics, 3D tools, visualization systems are required for environmental systems and ecological interface, etc and here Environmental Informatics tools are used.
- Artificial intelligence including machine learning, deep learning, etc can be used by Environmental Informatics.
- Managerial aspects viz. Environmental management, environmental statistics and risk analysis become easy [13], [23], [26].

Due to such benefits and functions, Environmental Informatics can be thus useful for different sectors and areas because this is still growing.

Academic Degrees in Environmental Informatics with reference to the Research Degrees: International Scenario

Environmental Informatics as an interdisciplinary field gaining rapidly and many universities have started PhD program in the field of the Ecology or Environment oriented department. However, in a few universities, this is also offered as the Computing oriented department as a research area. Table: 1 in this regard offers details herewith.

Table: 1-Existing Research Degrees in Environmental Informatics and allied field

Existing Degrees of Research Level on Environmental Informatics
MPhil
PhD
MSc-PhD Integrated
Post Doctoral Fellowship

Even Post Doctoral Fellow position also offered by some of the universities and institutes and most the scholars works in different areas such as (these are also offered the Degree programs in most of Bachelors or Masters programs)—

- Digital Earth
- Introduction to Environmental Informatics
- Environmental Modeling
- Applications in Environmental Informatics
- Spatial Statistics for Natural Resources
- Partial Statistics for Natural Resources lab[10], [17], [24].
- Land Processes and Climate Interactions
- Digital Earth and Big data
- Climate Modeling, etc.

As far as leading universities are concerned a few important educational institutes that offer programs in this field are depicted in the table: 2.

Table: 2- Few Degrees in Environmental Informatics and allied field

Universities	Degree
Auburn University, Alabama, US	BS Geo Spatial Environmental Informatics
Wuhan University, China	BSc Geo Environmental Informatics
Northern Arizona University, United States	BS Informatics (Environmental Informatics)
Georg August University of Göttingen, Germany	BSc-CS and MSc-Environmental Informatics Integrated
University of North Carolina at Chapel Hill, US	BS-Environmental Science & MS-Information Science Dual Degree Offered jointly by College of Environment, Ecology and Energy with School of Information and Library Science
Virginia Polytechnic Institute and State University, US	BS Environmental Informatics
The University of Applied Sciences, Germany	BSc Environmental Informatics and Business Information Systems (Dual Degree)
Joma Kenyatta University of Agriculture and Technology, Kenya	MSc Environmental Information Systems
Georg August University of Göttingen, Germany	MSc-PhD Environmental Informatics Integrated

University of Leicester, UK	Post Graduate Certificate in Environmental Informatics Regular On Campus Only Full Time/ Part Time
University of Michigan, US	MS Environment & Ecology (Environmental Informatics)— *Geo Spatial Data Science*
University of Kassel Germany	MSc Environmental Informatics
Tennessee Tech University	Masters in Environmental Informatics (Professional)

Environmental Informatics degrees in Asian countries are offered only in a limited way in a few universities through allied programs i.e. Geo Informatics. However, at the Research level, some institutes offer this research area in their offering [14],[19], [25]. Though, here they are not entitled to the degree specifically in Environmental Informatics. In India, one institute called the Indian Institute of Information Technology and Management (IIITM), Kerala, India offering an MPhil program in allied branch i.e. Eco Informatics.

Table: 3- Sample Courses of Ecological Informatics at MPhil Program at IIITM, Kerala

Universities	Degree	Papers/ Courses
Indian Institute of Information Technology and Management (IIITM), Kerala, India	MPhil Ecological Informatics 1 Year	Core Courses Research Methodology Literature Review & Seminar Informatics (Information Systems, Spatial Informatics, Programming and Database) Ecology Urban Ecology Biodiversity and Conservation Application of Remote Sensing and GIS in Environmental Management

This program is mixed up with the courses and research methods and research components. The candidate thus also can go to industry for practical job sector with and this degree can be apart from the research areas/ jobs.

Environmental Informatics and Technologies and research areas

It has already been learned that Environmental Informatics is a combination of Environment allied subjects which include allied branches and subjects from the environment side and Informatics and which includes all allied branches and subjects from informatics and IT side. Among the components of IT, a few important are include—

- Web Technologies.
- Database Technologies.
- Network Technologies.
- Multimedia Technologies
- Software Technologies, etc.

As far as the latest components of IT is concerned few important possible research areas are mentioned in Table: 4.

Table: 4- Emerging technologies in Environmental Informatics and possible areas

Technologies	Possible topics/ areas
Big Technologies	Basics/ Overview/ Challenges/ Issues/ Trends Potentialities in Environment/ Agriculture/ Forest Management,etc
Data Science and Analytics	Challenges/ Issues/ Trends Potentialities in Environment/ Ecology/ Agriculture/ Forest Management,etc
Advanced Networks	Trends/ Possibilities and Potentialities in Ecology/ Environment/ Agriculture/ Forest Management,etc
Cloud Computing	Challenges/ Issues/ Trends Potentialities in Environment/ Ecology/ Agriculture/ Forest Management,etc
Internet of Things (IoT)	Challenges/ Issues/ Trends Potentialities in Environment/ Ecology/ Agriculture/ Forest Management,etc
Converged Networks	Challenges/ Issues/ Trends Potentialities in Environment/ Ecology/ Agriculture/ Forest Management,etc
Statistical Tools	Challenges/ Issues/ Trends Potentialities in Environment/ Ecology/ Agriculture/ Forest Management,etc

However, in respect of research areas from the environment possible areas may be from (but not limited to) environment, ecology, agriculture, oceanography, climatology, forestry, anthropology, etc

Environmental Informatics and Possible Degrees: International & Indian Context

Environmental Informatics research degrees are mainly offered as PhD in Environmental Informatics or allied branches but mainly PhD Geo Informatics or similar nomenclature. And the universities offering Masters program are mainly coursework based but there is a potentiality to offer Research based Masters degree in Environmental Informatics and subfield. And in a country like India instead of MS, the MSc/MTech can be offered. Sample and possible degrees are depicted in Table: 5.

Table: 5- Possible Degrees in Environmental Informatics subfields at Masters level

Masters by Research Degree Track (Sub Field of Environmental Informatics)
MSc/ MS/MTech by (Research)-Environmental Informatics MSc/ MS/MTech by (Research)-Ecology Informatics MSc/ MS/MTech by (Research)-Forest Informatics MSc/ MS/MTech by (Research)-Agricultural Informatics MSc/ MS/MTech by (Research)-Irrigation Informatics

Environmental Informatics as an interdisciplinary program can also be offered as a specialization in Informatics or Information centric degrees or in Computing or Computing track. Some of the sample degrees are proposed and suitable in western countries and in India also depicted in Table: 6.

Table: 6- Possible Degrees of Environmental Informatics in Informatics/ Computing at Masters level

Masters by Research Degree Track (Field of Informatics & Computing)
MSc/ MS/MTech by (Research)- Informatics (Environmental Informatics)
MSc/ MS/MTech by (Research)-Information Science (Environmental Informatics)
MSc/ MS/MTech by (Research)- Information System (Environmental Informatics)
MSc/ MS/MTech by (Research)-CS/CSE (Environmental Informatics)
MSc/ MS/MTech by (Research)-Computer Applications (Environmental Informatics)
MSc/ MS/MTech by (Research)-Computing Environmental Informatics

Environmental Informatics is a broad field and consists of different subfields related with the Agriculture, Forestry, Ecology, etc. Thus mentioned (in Table: 7)areas can be offered at PhD degree as well.

Table: 7- Possible PhD Degrees in Environmental Informatics&subfields

Environmental Informatics & Sub Fields
PhD-Environmental Informatics
PhD-Ecology Informatics
PhD-Forest Informatics
PhD-Agricultural Informatics
PhD-Irrigation Informatics

It is recommended that these programs should consist of courses at masters level for real output and make the educated for the industry level as well. Further, in the Informatics MPhil/PhD programs the Environmental Informatics can be introduced. Refer Table: 8 for more details.

Table: 8- Possible MPhil/PhD Degrees in informatics with Env. Informatics track

Information Track
MPhil/PhD-Informatics (Environmental Informatics)
MPhil/PhD-Information Science (Environmental Informatics)
MPhil/PhD-Information Systems (Environmental Informatics)
MPhil/PhD-Information Technology (Environmental Informatics)
MPhil/PhD-Information & Communication Technology (Environmental Informatics)

While Environmental Informatics concentration-based Computing/ Computer sciences possible programs are listed in Table: 9. It is worthy to note that, Information track programs would be more suitable for industrial output as it is less designing and development centric.

Table: 9- Possible MPhil/PhD Degrees in Computing with Env. Informatics track

Computing Track
MPhil/PhD-Computer Science (Environmental Informatics)
MPhil/PhD-Computer Science & Engineering (Environmental Informatics)
MPhil/PhD-Computing (Environmental Informatics)
MPhil/PhD-Computer Applications (Environmental Informatics)

Environmental Informatics is high end program, truly interdisciplinary in nature thus also available in different universities as Post Doctoral Fellow programs. Further, it may be offered as Post Doctoral Degrees in such countries where such degrees are already introduced and recognized. Moreover, the researchers and academicians working in Environmental Informatics or allied areas may also avail such degrees based on their credentials and contribution. Few possible such programs are listed in Table: 10 herewith.

Table: 10- Possible Post Doctoral Degrees in Env. Informatics & subfields

Post Doctoral Degree Track (Sub Field of Environmental Informatics)
DSc-Environmental Informatics
DSc-Ecology Informatics
DSc-Forest Informatics
DSc-Agricultural Informatics
DSc-Irrigation Informatics

Conclusion

Environmental Informatics as a branch of the study of informatics, is gaining rapidly internationally recognition due to its wider benefits. There are numerous topics and branches within Environmental Informatics ranging from the environment to informatics. Even societal and anthropological areas can also be part of this area. Different universities are making efforts to offer this interdisciplinary for important to different stakeholders. Emerging technologies viz. big data analytics, cloud computing, IoT, converged network and communication which are good areas of research in Environmental Informatics and also its other subfields. Research degrees are still mainly offered as PhD degree but there are potentialities to offer other degrees viz. MPhil, Masters by research in different streams and in different subfields of Environmental Informatics. Countries like India and other developing nations may start easily this field either as a full-fledged manner or as specializations in different subjects.

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