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ENVIRONMENTAL INFORMATION SCIENCE AS A FIELDOF VARIOUS RESEARCH LEVELS: OPPORTUNITIES, CHALLENGES & SUGGESTIONS IN INDIAN CONTEXT

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Abstract

Since Environment is an important concept therefore many subjects are available on Environment viz. Environment Science, Environment Studies, Environment Engineering, Environment Management,etc.The Applications of Management in the environment called as Environmental Management and similarly,applications of Informatics and Computing are known as Environmental Informatics. However, there are other allied branches and subjects than Environmental Informatics and these can be known as allied branches and subjects. Different kind of environment related subjects gets the benefits ofEnvironmental Informaticsby different means. Environmental Informaticsis theright solution for different concerns. Different tools, techniques and sub technologies of Information Technology, Computer Science are important in environmental related activities for the wider benefitsand many educational instituteshave started educational programs on the field started with Bachelors, Masters and Research Degrees including in the allied fields. IT and Computing as emerging and rising in different areas therefore in the environment and allied areas also such technologies are adopted in different segments. At the research level, many institutes and organizations have started the academic program; though there are many potentialities in the inclusion of Environmental Informatics at the research level. This paper is a kind of policy based which discussed about the potentiality of Environmental Informatics at the research level with reference to the issues, challenges, and possible solutions.

Key words: *Environmental Informatics, Emerging Technologies, Educational Programs, Sustainability, Research Degrees.*

Introduction

Environmental Informatics is similar to Geo Informatics but it has a wider scope than Environmental Informatics with complete environmental to ecology, agriculture, oceanography, climatology, forestry, anthropology, etc [7], [8], [13], [18]. Various Information Technology tools and components are being used in Environmental Systems viz. Database Technology, Web Technology, Network, and Communication Technology, etc. which are worthy in environmental and ecological management. Different kinds of academic programs with different level viz. Certificate, Bachelors, Masters, etc are available on Environmental Informatics internationally. Environmental Informatics is noticeable in some countries in their research programs as a topic of interest in other subjects viz. Geography, IT, Computing, Earth Sciences, etc [1], [5], [9]. However, there are potentials to launch subjects on Environmental Informatics and allied areas at the research level; and in this work, such are depicted. Different proposed policies may be introduced accordingly [4], [17], [21].

Objective

As the title of the paper is 'Environmental Information Science as a Field Research Level: *Opportunities, Challenges & Suggestions in Indian Context',* this paper has intention the following aims and objectives —

- To know very basic on Environmental Informatics with its background, features, characteristics in brief.
- To know about the basic functions of Environmental Informatics regarding social development and management.
- To know about the technologies for better and healthy Environmental practice and also its subfields as well.
- To know about the available academic programs in Environmental Informatics and also in allied areas.
- To know about the possible research programs at Doctoral Degrees including at Higher Doctoral Degrees.
- To know about the possible degrees and nomenclature with research concentration at the Masters level with multiple streams.

- To know about the opportunities, challenges, and issues regarding the Environmental Informatics.

Environmental Information Science: The Foundation

Environmental Informatics is employable in the energy, environmental, agriculture and ecological systems, etc. using decision support systems and healthy Environmental Informatics practice. Various tools and systems such as GIS, Remote Sensing, GPS are useful in environmental information system practice [2], [5], [10]. Further in environmental chemistry and biochemistry also Environmental Informatics is worthy and important. Various tools or technologies are useful in proper environmental assessment, management and development. In designing, developing, modeling and implementing environmental processes, and biological systems, etc. Environmental Informatics is considered as important, and valuable [4], [11], [22]. There are many concerns regarding Environmental Informatics viz.—

- In designing and development of the websites related to the environment, ecology, agriculture, etc. Environmental Informatics skills are important.
- Modeling of biotechnological systems is supported by the Environmental Informatics using Multimedia tools, graphics, 3D tools, visualization systems.
- Artificial intelligence, machine learning, deep learning, etc are being used by Environmental Informatics.
- With the help of IT Applications in the environment (i.e. Environmental Informatics), some of the activities become easy viz. Environmental management, environmental statistics and risk analysis become easy [6], [16], [26].

Environmental Informatics is therefore useful in different sectors and areas, and these are rising gradually due to its importance and need. The field of Environmental Informatics is also known as Environmental Information Science.

Academic Degrees in Environmental Informatics

Environmental Informatics as a field of study is available at different levels in many universities internationally [3], [12], [20]. Environmental Informatics is also available as Geo Spatial Environmental Informatics, Geo Environmental Informatics, Environment and Ecology with Informatics, GIS, and other specializations. Table: 1 here depicted the list of programs and institutes in detail.

Table 1
Few Degrees in Environmental Informatics and allied field

Universities	Degree	Subject
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 & MSc Integrated	BSc-CS and MSc-Environmental Informatics Integrated
University of North Carolina at Chapel Hill, US Offered jointly by College of Environment, Ecology,and Energy with School of Information and Library Science	BS & MS Degree	BS-Environmental Science & MS-Information Science Dual Degree
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 Integrated	Environmental Informatics
University of Leicester, UK	Post Graduate Certificate in Regular On Campus Only Full Time/ Part Time	Environmental Informatics

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 Professional Studies	Environmental Informatics (Professional)

Environmental Informatics is an interdisciplinary field therefore in many universities research can be led upto PhD degree in Ecology or Environment oriented department or it may be offered in the Computing oriented department as a research area. Table: 2here offered the existing degrees.

Table 2

Existing Research Degrees in Environmental Informatics and allied field

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

Some of the areas which fall within the Environmental Informatics are includes (but not limited to the following)—

- Digital Earth
- Introduction to Environmental Informatics
- Environmental Modeling
- Applications in Environmental Informatics
- Spatial Statistics for Natural Resources
- Partial Statistics for Natural Resources **lab.**

- Land Processes and Climate Interactions
- Digital Earth and Big data
- Climate Modeling, etc [10], [23], [25].

There are only a few universities that offer Environmental Informatics Research Degrees, however, in India, one institute called Indian Institute of Information Technology and Management (IIITM), Kerala, India offering an MPhil program in allied branch i.e. Eco Informatics. As Environmental Informatics merged with the 'Environment and allied branches' and on other hand 'Informatics and allied branches' therefore it includes various technologies such as—

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

As far as Information Technology components are concerned some of the important are mentioned in respect of Table: 3

Table 3

Emerging technologies in Environmental Informatics and possible research areas

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

However it is worthy to note that such technological applications are also be offered in other areas (apart from the Environment) ecology, agriculture, oceanography, climatology, forestry, anthropology, etc [15], [24], [26].

Opportunities in Research based Degrees in Environmental Informatics: International & Indian Context

There are different ways to introduce Environmental Informatics as a field of study at the research level viz. Masters, MPhil, and Doctoral (with provision for Higher Doctorate).

At Masters with Research Concentration—

Environmental Informatics can be offered at the masters level with the concentration of either on Environmental Informatics or allied and subfields viz. Ecology Informatics, Agricultural Informatics, Irrigation Informatics, etc. Some of the proposed programs are depicted in Table: 4 with different concentration viz.—

- Science (Basic & Higher)
- Technology & Engineering

Here Science MSc (Basic) may be considered for the general BSc (3 Years Duration) whereas MS is referred roas higher and for the BS/B Tech.

Table 4

Possible Degrees in Environmental Informatics subfields at Masters level

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

At PhD Level with allied areas—

As far as the Doctoral level is concerned it is important to note that Environmental Informatics can be offered not only on Environmental Informatics but also in other allied and subfields similar to the Masters by Research. Refer Table: 5 regarding the potential and possible programs.

Table 5
Possible PhD Degrees in Environmental Informatics&subfields

Environmental Informatics & Sub Fields at PhD levels
PhD-Environmental Informatics
PhD-Ecology Informatics
PhD-Forest Informatics
PhD-Agricultural Informatics
PhD-Irrigation Informatics
PhD-Informatics (Environmental Informatics)
PhD-Information Science (Environmental Informatics)
PhD-Information Systems (Environmental Informatics)
PhD-Information Technology (Environmental Informatics)
PhD-Information & Communication Technology (Environmental Informatics)
PhD-Computer Science (Environmental Informatics)
PhD-Computer Science & Engineering (Environmental Informatics)
PhD-Computing (Environmental Informatics)
PhD-Computer Applications (Environmental Informatics)

Further Environmental Informatics can be offered with the Computing oriented subjects as specializations viz. Computer Science, Computer Applications, Computing, Information Science, Information and Communication Technology, etc. Further in Environmental and allied areas also Environmental Informatics or similar nomenclature may be offered viz.—

- Environmental Science
- Environmental Management
- Environmental Engineering
- Forestry/ Forest Management
- Oceanography
- Ecology
- Disaster Management, etc.

Table 6

Possible MPhil/PhD Degrees in Computing with Env. Informatics track

Computing and Environmental Track
MPhil -Informatics (Environmental Informatics)
MPhil -Information Science (Environmental Informatics)
MPhil -Information Systems (Environmental Informatics)
MPhil -Information Technology (Environmental Informatics)
MPhil -Information & Communication Technology (Environmental Informatics)
MPhil- Computer Science (Environmental Informatics)
MPhil-Computer Science & Engineering (Environmental Informatics)
MPhil-Computing (Environmental Informatics)
MPhil-Computer Applications (Environmental Informatics)

Additionally, Environmental Informatics can be offered with the MPhil Degree in the areas or allied areas as mentioned and proposed in Table: 6. Further, in some of the universities and educational institutes, Post-Doctoral Degrees are offered and, in this context, proposed degrees are depicted in Table: 7.

Table 7
Possible Post-Doctoral Degrees in Environmental 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
DSc-Environmental Informatics & Big Data
DSc-Environmental Informatics & Cloud Computing
DSc-Environmental Informatics & IoT
DSc-Environmental Informatics & Artificial Intelligence
DSc-Environmental Informatics & Robotics etc

Challenges, Issues & Possible Solutions

Though there are different opportunities available regarding Environmental Informatics as a research program at different levels but still there are many issues and challenges in this regard.

Rules and Regulation—

In each and every country (or in some country) there is a provision from the Governmental level on rules and regulations on academic and research degrees including nomenclature, degrees to be offered, duration, specialization, financing, etc. Therefore, the proposed degrees also need to accommodate according to the need.

Interest and Willingness—

Interest of the concerned university and educational institute should also be considered as important and required. In general, Universities are offered coursework-based Masters therefore special interest is required in this context. Similarly, MPhil/PhD normally offered with the Environmental Science (or allied areas) and Information Science (or allied areas) but special attention and steps are required regarding the offering of proposed specializations.

Coursework—

In many universities, coursework becomes common and important but running the coursework is difficult due to many reasons viz. organizing and offering various courses, timing, syllabus formation, etc. At MPhil and PhD level there should be proper coursework based on specializations.

Financing—

Financial aspect is another important criterion required in offering Environmental Informatics research programs by the university; and therefore, proper budgeting, financial support should be offered.

Government Efforts—

A proper effort from the Government level is very important and must be rendered by the government bodies and institutions.

Conclusion

Environmental Informatics is the study of both informatics and the environment both and it is gaining rapidly internationally. There are numerous topics and branches within Environmental Informatics including societal and anthropological areas therefore various other emerging technologies viz. big data analytics, cloud computing, IoT, converged network, and communication should bring in healthy Environmental Informatics practice. Research degrees should be offered with the MPhil and PhD and specializations is expected to offer by ensuring all the support to the universities including planning, initiatives, proper funding, executing new and appropriate norms and regulations, etc.

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