

Environmental Informatics: The Foundation, Allied & Related Branches – Analytical Study

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ABSTRACT

Environmental Informatics is the emerging interdisciplinary practicing facet responsible for the applications and utilization of Information Technology in Environment, Nature, and Ecology. Different other areas viz. Geology, Agriculture, Forestry, Geography, Climatology, Oceanography, etc are also important stakeholders of Environmental Informatics. The branch Environmental Informatics also called as Eco Informatics, Ecology Informatics in some contexts. Environmental Informatics is quite different from Environmental Information Technology. Environmental Informatics interconnects both environmental as well as information sciences for the complete natural processes with language common to both humans and computers. This is still a practicing phenomenon; however, in few countries, this can be seen as a branch of study. There are different potentialities to offer Environmental Informatics as an academic branch due to its wider scope and utilizations. The field is practiced by professionals in forestry, agriculture, ecology and environment, corps and horticulture, geography and geology, etc. In this paper, various internal and related aspects of Environmental Informatics in different areas and sectors are analyzed.

Keywords: Environmental Informatics, IT Applications, Informatics, Ecology, Environmental Studies, Eco Engineering.

The society is changing rapidly. Environment is one of the important and valuable concerns for the time being. Since 1960's and 1970's. In the recent past, Environment became an advanced area of study. It is related to few domains viz. Physical Science, Biological Sciences, Information Sciences, Social Sciences^{[1],[11],[13]}. Whereas, Environmental Informatics is the combination of Environment and allied field like Informatics or Information Science or Computing Technology. It is simply the applications of Information Technology or Computing in Environment and Ecology. The field of Environmental Informatics applicable in Environmental Science and also other areas viz.

- ☐ Geology
- ☐ Earth Science
- ☐ Marine Science
- ☐ Climatology
- ☐ Forest Management
- ☐ Geography
- ☐ Agriculture etc.

The field Environmental Informatics is growing day by day as a practicing and interdisciplinary one and it is utilizing in different sectors^{[2],[3],[12]}. Informatics as a branch started in the late 1990's and gradually in the recent past it became a field of study.

Objective

The present paper is conceptual in nature and deals with the following aim and objective but not limited to the following—

- ❑ To learn about the basics of Information Science and Technology with reference to Informatics.
- ❑ To know about the fundamental of the Environment and the study areas related to the Environment in brief.
- ❑ To know about the basics of Environmental Informatics including its evolution foundation and present scenario.
- ❑ To find out the nature, characteristics features, and stakeholders of Environmental Informatics.
- ❑ To know about the important role and applications of Environmental Informatics in different sectors.
- ❑ To learn about the allied and similar branches related to the Environmental Informatics as a glance.

Environment & Informatics

Environment is a kind of place where different tangible and intangible things placed. Moreover, this can be a living or even non-living. In general, it is divided into two types viz.

- ❑ Micro environment and
- ❑ Macro environment.

‘The complex of physical, chemical, and biotic factors (such as climate, soil, and living things) that act upon an organism or an ecological community and ultimately determine its form and survival’

‘The aggregate of social and cultural conditions that influence the life of an individual or community’ The Merriam Webster Dictionary (www.merriam-webster.com)

There are various sub components viz. soil science, agriculture, geology, oceanography, ecology, biology, zoology, climatology, atmospheric sciences, physics, chemistry as part of the environment^{[4],[7],[14]}.

As far as Studies are concerned, Environmental studies is multidisciplinary and an interface of human and environment and closely related with the physical

sciences, economics, commerce, sociology, social sciences to address the environmental related issues. There are few other subjects like Environmental Studies

As far as *Informatics* is concerned it is an information centric branch and closely related to the Information Science. Further, it is also connected and related to a few other subjects like Information System and Information Technology. This means the subjects which are very close to the information can be treated as a relevant one. And all these subjects are very close to Environmental applications. The field Informatics is thus very close to the Environment and Ecological Sciences^{[5],[8],[15]}.

However, it is important to be noted that, Computer Science or Computer Engineering or other Computing Sciences are not so close to Environment. As these fields are hardware centric and very close to the designing and development of computing or computer systems.

Environmental Informatics: Evolution & Basics

Environmental Informatics is the combination of Environment (Including allied branches and subjects) and Informatics (Including allied branches and subjects). In a simple manner, it is the applications of Computing, Technologies, Informatics principles and tools in Environmental Management, Environmental Management, Sustainable Computing and Information Technology practice as well (Refer Fig: 1 for details). Environmental Informatics can be considered as following—

- ❑ Applications of Information Technology and Computing in Environmental spaces.
- ❑ Applications of Environmental principles in Information Technology and Computing.
- ❑ Integration of Environment with Information Technology.

Initially, the branch Informatics was first evolved and gradually it became a field of study and research in major countries and leading universities, worldwide^{[6],[9],[16]}. Before the development of the branch, many other subjects were existed viz.

Environmental Informatics is concentrated with the following technologies for its management—

- ❑ **Software Technology**; this is responsible for the designing, development and management of software which are required in different environmental activities including environmental monitoring, forest management, agriculture, natural resource management, etc.
- ❑ **Database Technology**; this is responsible for creating, developing and managing database in respect of environment viz. ecology, disaster management, agriculture, geology, marine, and oceanography.
- ❑ **Web Technology**; this is the technologies responsible for website designing, development and this is applicable in environmental content gathering and disseminating in different platforms for the environmentalist, common people, etc.
- ❑ **Multimedia Technology**; this is the media combining text, image, audio, video and other media components. As far as Environment is concerned it is responsible for the information presentation and dissemination with the help of multimedia products.

These are the core technologies which are very important in Environmental Management and Development and apart from these few other emerging technologies are also important viz. —

- ❑ Cloud Computing.
- ❑ Virtualization.
- ❑ Big Data Management.
- ❑ Data Analytics.
- ❑ Statistical Management and Applications.
- ❑ Usability Engineering.
- ❑ User Experience Designing.
- ❑ Human Computer Interaction.
- ❑ Internet of Things (IoT).
- ❑ Converged Network.
- ❑ Wireless Network and Sensor.
- ❑ Satellite Technology etc.

All these core and emerging technologies are applicable in different sectors of environment and allied spaces^{[5],[10],[17]}. Among these, important are include the following—

- ❑ Environmental Science
- ❑ Environmental Studies
- ❑ Environmental Management
- ❑ Environmental Engineering etc.

Allied Branches & Environmental Informatics

About Environmental Informatics, we already learned. There are different sub field and areas in which it can be applicable and among these following are important---

Ecological Informatics

Ecological Informatics talks about the design and application of IT and computational systems for the ecological means viz. ecological analysis, synthesis, including forecasting and management. Ecological Informatics is applicable also in the river systems, freshwater lakes and marine systems. Different Information technology components and few from Computing Science like artificial neural networks, genetic algorithms, fuzzy logic and adaptive agents are also important. Moreover in ecological management issues like toxic algal blooms, habitat degradation, conservation of biodiversity and fishery management as well as Ecological Informatics is important. The branch is very close with the Computational Ecology, Data Sciences as well.

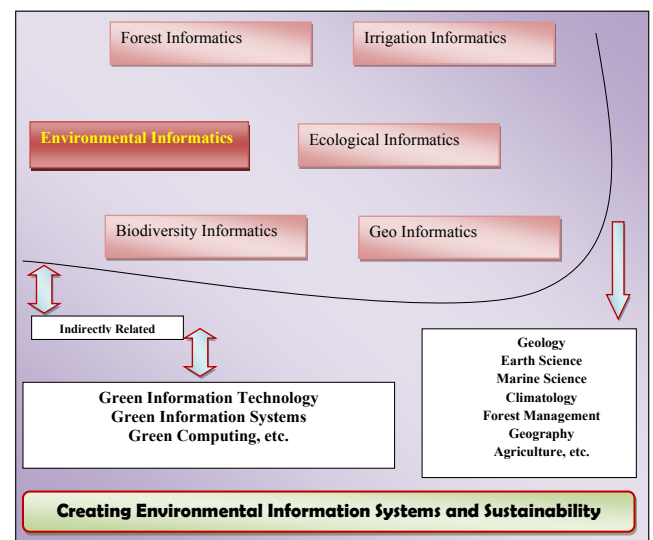


Fig. 1: Ultimate development of Environmental Systems and Sustainable world

Forest Informatics

Forest Informatics can be treated as a branch of Environmental Informatics and more deeply applications of Environmental Informatics specifically on Forest Management and forestry. In other context, it is the emerging area of Environmental Sciences. Though, this branch can also be defined as the applications of Information Science, IT and Computing tools, techniques in Forest related affairs^{[6],[18],[21]}.

In other context, the collection, management, processing, dissemination of data, information and knowledge, and the incorporation of informatics is simply Forest Informatics. Hence it is interdisciplinary and interface of the human, information and forest. Hence close with Forest Science and Forest Management in many contexts. Human readable documents like maps, data sheets, AI, GIS, GPS, Operation Research, Database Management Systems, etc are useful in forest natural resource management. The following are some examples in which Forest Informatics can be applicable—

- ❑ Scheduling of the harvesting
- ❑ Image classification of the forestry
- ❑ Model fitting
- ❑ Optimal sampling crew assignment
- ❑ Treatment timing etc.

Apart from the above, in log bucking problems, optimization problems, etc., Forest Informatics can be applied.

Biodiversity Informatics

Similar to the previous one, *Biodiversity Informatics* is also an important type of Environmental Informatics practice. The term *Biodiversity Informatics* was first coined in or around 1992 and identified the applications of IT, Computing and Information Science principles, technologies and tools in Biodiversity Management. This is emerging in Ecological and Environmental Science as well in a different context.

With *Biodiversity Informatics* practice it may result in improved management, presentation, discovery, exploration and analysis of information and systems in Biodiversity and allied areas. It typically builds on a

foundation of taxonomic, biogeographic, or ecological information stored in digital form, which, with the application of modern computer techniques.

Biodiversity Informatics though a new field but a huge number of professionals and practitioners (also numerous individuals) are involved in the design and construction of taxonomic databases. Simply it is the computerized handling of any biodiversity information but manual documentation also may be part of this.

It is worthy that in some context *Biodiversity Informatics* may be treated as the composed of names, observations, records of specimens. Moreover, it may be the genetic and/or morphological data associated with a specimen or similar facet.

Irrigation Informatics

Irrigation Informatics is an emerging Informatics and interdisciplinary related to Environmental Informatics, Geo Informatics and Social Informatics in many contexts. In some contexts, it is the cross-disciplinary field and use of IT and informatics for the studying and analyzing flows and data management related to irrigation. It is the practice of information processing as well as the engineering of information systems in the biophysical science and part of irrigation wherever information technology or data systems are used, however, the term *informatics* is may not be noticed in some cases and instead of IT applications in Irrigation and Drainage systems^{[7],[19],[20]}.

Agricultural Informatics

Agricultural Informatics is also called Agro-informatics and it is the applications of IT and Computing in agriculture and allied sciences. It is the ideas, techniques and scientific knowledge with the integration of information technology for the management as well as analysis of agricultural data. This branch is very close with the Environmental Informatics and in a simple sense it the applications of following in agriculture and horticulture and sciences—

- ❑ Machine Learning and Deep Learning
- ❑ Artificial intelligence
- ❑ Decision support system

- ❑ Cloud Computing
- ❑ Big Data
- ❑ Geographic information system
- ❑ Web and Usability Designing
- ❑ Genetic algorithm
- ❑ Software Applications and programming language etc.

Agricultural Informatics is very close to the Agricultural Information Technology and Agricultural Information Systems as well.

Geo Informatics

Geo Informatics is close with the Environmental Informatics and may be considered as a branch of Environmental Informatics. In some contexts, it is related to Environmental Informatics and its allied areas only. There are few areas and fields which are close with Geo Informatics and among these important are 'Geo Information Science', 'Geo Information Technology', 'Geo Spatial Technology', etc.

Simply it is the applications of the different Information Technology components viz. Software Technology, Web Technology, Network Technology, Multimedia Technology, etc in Geo Spatial Designing, Development, Mapping, GPS and Remote Sensing activities in different contexts. In another context, it is the application of IT in Geo Information Database development^{[7],[16]}.

Social Informatics

Informatics is a vast field and there are numerous applications in diverse areas. As far as Social applications are concerned Social Informatics are important. Social Informatics is simply the integration of IT and Computing in Social Sciences and Social Services and Sectors. It is in few contexts connected with Environmental Informatics.

Social Informatics is another word can be defined as the combination of both Social Science and Information Science. The core aim of the field is to designing, developing and managing of information systems which are required for social development and local governance. In Social Informatics different technologies of Computing and IT are playing a leading role.

The branch of Social Informatics is related to Social Computing in different contexts. In some narrow contexts, it is the gather and disseminating social data using different applications and tools. But practically it is more than that.

Urban & Rural Informatics

It is already noted that Social Informatics is a branch of Informatics and concentrated on social sciences and sectors. The area Urban Informatics and Rural Informatics are the important branch of Social Informatics and closely connected with Environmental Informatics in few contexts.

Urban Informatics is the application of different IT components, Computing tools, Information Systems procedure and mechanism into Urban Information Management and making intelligent, informative urbanization, metropolitan areas development. Similar to the Urban Informatics, the field Rural Informatics also use the same tools, techniques, technologies for modernizing rural areas and villages. The concept of Smart Village can boom with the support of solid Rural Informatics practice.

Apart from these mentioned sub field of Environmental Informatics, there are other areas as well which are also close and nomenclature as the field and among these few important are as follows—

- ❑ Environmental Information Technology
- ❑ Environmental Information Systems
- ❑ Geo Information Science
- ❑ Geo Information Technology.

Hence, be it Environmental Informatics or Biodiversity Informatics or Geo Informatics or Forest Informatics or any other mentioned or allied Informatics is applicable in different sectors and all these are applicable in different subjects viz.

- ❑ Geology
- ❑ Agriculture
- ❑ Disaster Management
- ❑ Sustainability and Ecology
- ❑ Natural Resource Management

- ❑ Anthropology & Environmental Sociology
- ❑ Nature Management
- ❑ Forestry
- ❑ Geography
- ❑ Climatology
- ❑ Oceanographyetc

There are other subjects as well which are very close to the Environmental Informatics and among these important are—

- ❑ *Green Computing*— Green Computing is the applications of Environmental tools, techniques and principle's applications in the designing, development and management of eco-friendly computer and peripheral. It also focuses on eco-friendly practices of computers in organizations, institutions, and individuals.
- ❑ *Green Information Technology*— As we are aware that Information Technology is broader than Computing/ Computer Applications and thus composite with different components viz. websites, databases, networks, software. And in Green IT all these considered with green designing, development, and management.
- ❑ *Green Information Systems*— This field is close to Green IT but only additional focuses are provided on the organizational development with sustainability. It is also actually noting but the Green Business Informatics practice.
- ❑ *Sustainable Computing & Information Technology*— Green Computing and Information Systems applications can lead the Green and Sustainable Information Technology in a different context. It is wider and emerging.

Hence all these specified areas are close with Environmental Informatics and a combination of both 'Environmental concern' and 'IT/ Informatics' concern.

Findings

- ❑ Environmental Informatics is a broad subject and interdisciplinary in nature. It is also technology focused and different IT components are being used.
- ❑ Environmental Informatics is very close with some

other nomenclature i.e. Environmental Information Technology, Environmental Information Systems

- ❑ Ecological Informatics Forest Informatics, Irrigation Informatics, Geo Informatics, Biodiversity Informatics,etc can consider as a direct important branch of Environmental Informatics whereas Social Informatics, Urban & Rural Informatics can be treated as an indirect branch.
- ❑ Environmental Informatics uses different tools and technologies viz. software technology and programming, websites and technology, database and allied technology, multimedia and allied technology,etc for Environmental Information Management.
- ❑ Environmental Informatics can help to the different subjects viz. Geology, Agriculture, Forestry, Geography, Climatology, Oceanography.
- ❑ Different academic institutes and universities have started academic programs on Environmental Informatics and allied areas and more can be started based on the requirement.

CONCLUSION

Environmental Informatics is thus an interdisciplinary and multidisciplinary field and not only applicable in environment and allied areas but also in Sciences, Engineering, Management & Commerce, Social Sciences depending upon situation and requirement. Professionals from Geology, Earth Science, Marine Science, Climatology, Forest Management, Geography, Agriculture,etc can get the wider benefits of Environmental Informatics. The latest technologies areCloud Computing, Big Data, Geographic information system, Web and Usability Designing, Genetic algorithm, etc. Introducing Educational programs, training, academic events,etc are also important for solid sustainable information system development.

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