

GeoS4S Module GIS for Health

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Abstract

Health sector has emerged a major area where GIS and other geoinformatics tools are being increasingly applied. Health sector and experts of disease control and spatial epidemiology are keen to use GIS to see the geographic extent of their work and disease patterns, trends and risk zones so that they can provide best services in limited resources and can have a bigger picture of the disease spread and outbreak. This module is part of the GeoS4S project co-funded under ERASMUS + by European Union. This module presents the application of GIS for disease surveillance and establishing its' causative factors using various type of strong and rich repertoire of geospatial tools of analysis. This paper presents an overview of the lessons, hands on exercises and assignments that will help the students to attain the objectives of the learning of this new are of application of GIS. The course is prepared considering its scope as online material for self-learning but it may very well be used direct teaching in traditional class room setting in an institution.

Key Words: Disease Surveillance, Disease Database, Geovisualisation, geo-statistical analysis, spatial patterns, trends, risk zonation

1. Introduction

Due to emergence of many deadly epidemics such as dengue, malaria, diarrhoea, respiratory diseases, and also many life style diseases there is increasing need to study them geographically and analyse the data of diseases and other contributing factors geospatially. This module is aimed to fill this gap and provide online course to the students

1.1 Module Description

Public health departments, NGOs related to healthcare and disease control and many researchers associated with child and women welfare are increasingly adopting Geographic Information Systems for creating information system for disease incidence, query and analysis. This course fulfils the knowledge requirements and skill generation in this direction. This course will focus on new trends, concepts and essential technologies used for disease surveillance, hotspot mapping and healthcare planning. It is based on theory and hands on learning methodologies. Students will be provided with historical background of health geography, understanding the importance of geospatial factors related to health and importance of environmental and socio-economic factors influencing the health. Health database is scarce so techniques for primary data collection using Google questionnaire, mobile apps and crowdsourcing will be taught. Linking various kind of spatial database available from secondary sources with current land use/ land cover maps and disease records will be taught through exercises. Geovisualisation of disease data, trend and hotspot are very powerful techniques in awareness and planning strategies to control disease outbreak. Various kinds of visualization options available will be explained with examples and hands on exercises.

Current and future satellites for environmental observations specifically related to health applications, mapping of disease locations, diseases' transmission in tropical and sub-tropical regions, ecological and use of environmental/ social/ economic data for predicting disease.

1.2 Learning Outcome

1. Understand applications of geoinformatics for climate change and impact on health,
2. Understand applications of geoinformatics for air and water pollution monitoring and its relationship with human health,
3. To be able to handle data from various sources related to disease and other factors and conduct analysis of trends and patterns, and

4. To be able to identify and analyse causative factors for disease outbreak and conduct risk analysis and finally create risk zonation maps for disease control and prevention.

2. Module Structure

2.1 Module Overview

Course will be delivered online. All lessons and notes will be provided in structured progressive manner leading from basics, concepts to final application development. This module is equivalent to 6 ECTS. There are 14 lessons. Each session is 90 minutes duration with 15 minutes of discussion and Q/A sessions. This also comprises of 150-170 Hrs student learning effort.

2.2 Summary of Lesson Content

The content and goals of each lesson are as follows:

- *Lesson 1: Overview of GIS and its applications in Health* - It comprises of overview of GIS and scope in the health sector with examples.
- *Lesson 2: Public Health Concept*- This lesson describes public health mechanism involving sanitation, water and air quality requirements and how they are monitored using geospatial data collection and analysis. It also explains with examples how public health facilities can be managed.
- *Lesson 3: Health Geography* – Introduces health geography issues, challenges, scope and solutions. It also touches on spatial epidemiology concept and extensive use of GIS.
- *Lesson 4: Spatial Factors Affecting Health* – Overview of various factors, agents and situations responsible for diseases are discussed. Lesson explains the link of locations to various diseases based on environment and socio-economic and climatic conditions.
- *Lesson 5: Database Development* – Importance of remote sensing in database development is shown with examples. Section also introduces conventional and ICT based data collection. Content also shows embedding the health, disease and other ancillary data in main database.
- *Lesson 6: Geovisualisation Techniques of Health Data* – It contains an introduction to cartography of spatial data representation in the context of health, geospatial representation of health data, attribute linkage maps, charts and graphical representations and ring maps.
- *Lesson 7: Geostatistical Trend Analysis of Disease Data* – Section demonstrates implementation of GIS data analysis techniques specially related to trend of disease using GIS software through exercises.
- *Lesson 8: Geostatistical Pattern Analysis of Disease Data* - Geostatistical pattern analysis, cluster analysis, local clusters, spatial autocorrelation analysis are explained in the context of disease in the geospatial context.
- *Lesson 9: Disease Hotspot Analysis* – Explanation related to disease hotspot and their mapping and analysis are explained from concept to hands on exercises on case studies.
- *Lesson 10: Disease Risk Modelling* – Disease risk modelling involving climatic, environmental, physical and social factors are discussed. Creation of risk zone maps is taught.
- *Lesson 11: Mapping Habitat of Agents of Disease* - Spatial relationship of habitat of mosquitoes and environmental, climatic and social factors are contained in this lesson and explained with examples. Application of remote sensing data for habitat mapping is also introduced.
- *Lesson 12: Case Study of Vector Borne Disease* - GIS application case studies in Dengue disease surveillance, hotspot analysis, habitat analysis and risk zonation is contained in this lesson.
- *Lesson 13: Case Study of Water Borne Disease* – Lesson contains GIS application case studies for diarrhoea related to disease surveillance, hotspot analysis, habitat analysis, and risk zonation.
- *Lesson 14: Case Study of Airborne Disease* – Lesson contains GIS application case studies for Lung diseases, surveillance, hotspot analysis, location analysis and risk zonation.

3. Hands on Session

Module is designed to have hands on session to develop the necessary skills on software to develop applications on the topics explained in the lessons and discussed. These skill development domains are carried out using laboratory exercises / tutorials using various remote sensing and GIS data and software. In this module there are six exercises which cover topics such as:

- Exercise 1: Health Geography and Spatial Epidemiology

- Exercise 2: Data Geovisualization Techniques
- Exercise 3: Geostatistical Disease Trend Analysis
- Exercise 4: Hotspot and Spatial Autocorrelation
- Exercise 5: Disease Risk Models and Mapping
- Exercise 6: Disease Risk Models and Mapping

The software MS Excel, ArcGIS, Google Apps, Geoda will be used in this module. Students are supposed to have basic competencies on these software. Dataset are provided with each exercises and also assignments. Some exercises and assignment may require knowledge of advance statistical tools and their knowledge. Some reading materials are provided to help students.

4. Teaching and Learning System

Lessons 1 to 4 cover the concept of relating geography and GIS with health and disease. Students from GIS or public health or even medical background may learn this module and may require to link their primary field of specialization with other field and these lessons may help them. Lessons 5 to 9 help learning the tools of GIS and geostatistics and visualization. These lessons also give opportunities to learn analysis and understanding the spatial linkages of diseases with various factors, trends and patterns. Lessons 10-11 help creating map products involving modeling for risk zonation and habitat mapping of various type of diseases and agents. Lessons 12 to 14 are case studies of vector borne, water borne and air borne diseases. Students are also given exercises and assignments to learn such issues. Students will be given exercises to understand and apply various statistical and modeling tools for disease mapping, trend analysis, patterns and dynamic diffusion analysis. They will also be trained on finding local factors influencing the particular disease in an area.

5. Evaluation System

Students are supported by adequate explanation while doing the exercises but as a part of the evaluation of the learning rendered by the module and assimilated by the students assignments are given. There are 5 assignments as described below:

- Assignment 1 "Geospatial factors affecting Human Health": 10 Marks
- Assignment 2 "Geohealth database development techniques": 15 Marks
- Assignment 3 " Geovisualisation Techniques of Health Data": 10 Marks
- Assignment 4 " Geostatistical Trend Pattern Analysis of Disease Data ": 15 Marks
- Assignment 5 "Spatial Autocorrelation and Hotspot Mapping": 20 Marks
- Assignment 6 "Miniproject on Spatial Analysis and Disease Risk Zonation": 30 Marks

These assignments will be given after relevant lesson is completed. Students can go through the content of the lessons and answer the questions in the assignments and submit it for evaluation purpose. The grades will be given by the instructor. Exercises will be assisted so they will not be graded but checked by the instructor and feedback will be given to the students.

6. Notes / Instructions / Suggestions to the Students

This module consists of 14 lessons in total which amounts to a minimum of 90 hours of effort required for studying the core material. Most of the lessons equal to about 6-7 hours, excluding exercises, assignments and reading material. Some other lessons are more challenging and for the study of their core material more time (~ 10 -15 hours each) is required. Module is prepared keeping requirements of studying online. Notes are provided to explain the content of the lessons slides. In addition some reading materials are also provided to help them understand the lessons more clearly. Self-study of these additional reading materials is essential to understand some key points in detail. Students will be assisted by trained faculty or tutors for exercise sessions but they have to do the assignments by themselves.

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