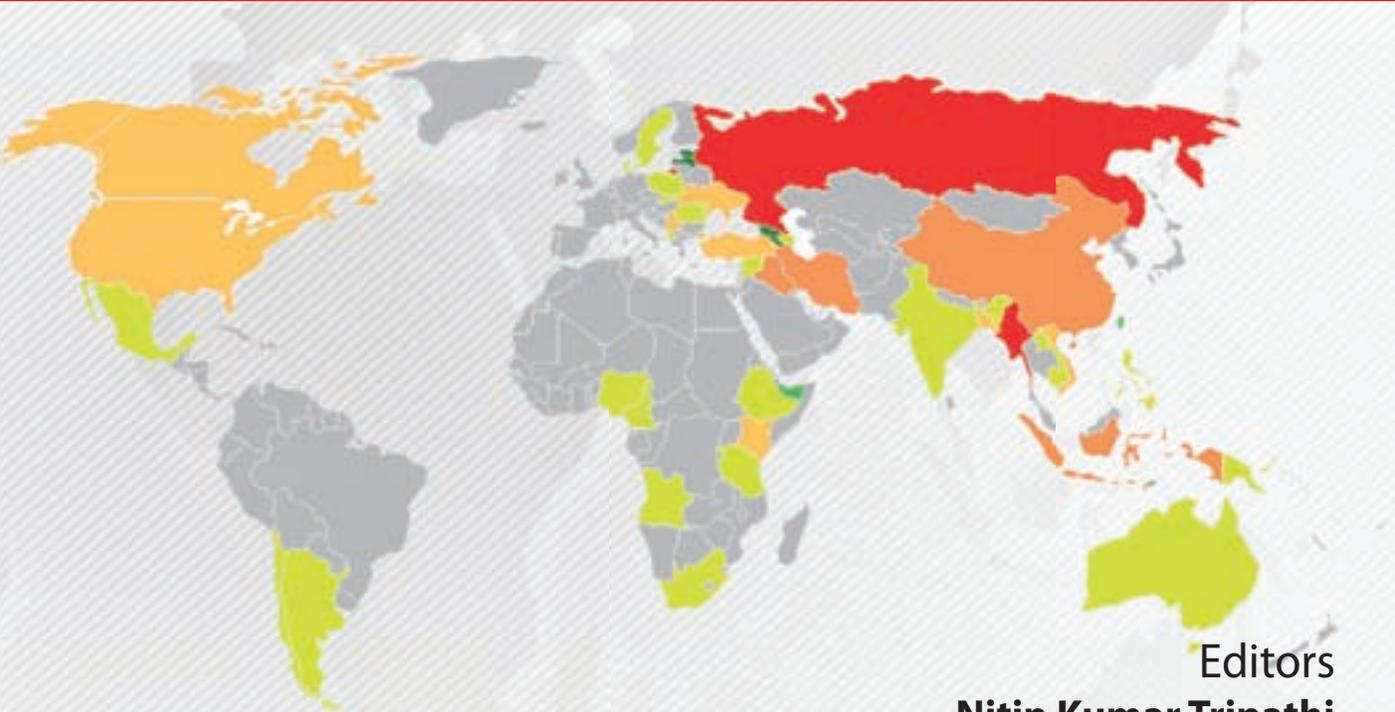


# healthGIS

## Managing Health Geospatially



Editors  
**Nitin Kumar Tripathi**  
**P K Joshi**  
**Hamid Mehmood**

4th International Conference on healthGIS 2011,  
5–6 August 2011, New Delhi, India

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ISBN 978-81-7993-325-1

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Printed from the camera-ready copy provided by the Editors.

### **Suggested citation**

N K Tripathi, P K Joshi, and H Mehmood (eds). 2011. *Managing Health Geospatially*. New Delhi: TERI. pp. 240. [Proceedings of Fourth International Conference on Health GIS, New Delhi, India, 5–6 August 2011]

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### **Published by**

TERI Press

The Energy and Resources Institute

Darbari Seth Block

IHC Complex, Lodhi Road

New Delhi – 110 003

India

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*Fax* 2468 2144 or 2468 2145

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Printed in India

## Preface



**Dr Nitin K Tripathi**

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Health and Education are the foundation of social growth and development. We have to manage the health geospatially to ensure better health for our people. Location of new hospitals should be carefully planned keeping multiple factors in consideration. Geographic Information Systems (GIS) and Global Positioning Systems (GPS) have the potential to integrate data of various kinds and from various sources such as existing maps, tables, locations representing various factors such as physical, geographic, economic, environmental, social, Government guidelines etc. There is a growing adaptation of the geoinformation technologies in health sector in few countries but there exists wide gap in developing countries due to lack of awareness and expertise. I am sure healthGIS conference is able to bring the health and geoinformatics community together and encourage use of these technologies.

HealthGIS 2011 brings you many new innovative applications and approaches of using GIS, remote sensing and GPS into healthcare management, disease surveillance, medicine distribution, telemedicine, and ambulance management for trauma assistance. Esri, MNNIT, and UNIGIS are conducting workshops to train the health sector people and showcase potential of Geoinformation Technologies.

International Journal of Geoinformatics will publish a special issue on selected papers from this conference after peer review. There are five awards in various categories of presentations. Key note presentations from experts from all over the world will surely excite and motivate delegates to collaborate and use this technology for reaching out to all those who need healthcare services and make a healthy world and ready to face the challenges of existing and emerging diseases. I wish a fruitful conference to all the delegates and hope they will be the messengers to their colleagues who could not attend it due to various reasons.



## Preface



### Dr P K Joshi

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*“It is health that is real wealth and not pieces of gold and silver”* said Mahatma Gandhi, an Indian Philosopher, internationally esteemed for his doctrine of nonviolent protest. And health is not merely the absence of disease or infirmity; it is a state of complete physical, mental and social well-being.

In the present context of global environmental changes and climate debates, health is one of the prime issues. The human health services organization shares a mission with other worldwide to help achieve the highest levels of physical and social well-being. Worldwide people are looking for the best treatment services and more importantly facilities which make such services more effective and affordable while optimizing resource use and deliverance. To this, Geoinformatics help leveraging limited resources and multiply the positive impact of benefits to individuals, families and society.

Geoinformatics—an umbrella term covering a wide gamut of GIS and related technologies (remote sensing, global positioning system [GPS], image processing, high bandwidth communication) - is widely believed to play an increasingly important role in our day-to-day life. Health problems have special associations to local geography, especially vector-borne diseases can be effectively analysed using mapping and modelling techniques. This involves mapping current boundaries of a health problem, followed by identifying and plotting of determinant factors and developing models to project distribution. The changes in the boundary of the health problem are noted with respect to demographic distribution and socio-cultural and economic centres of interest to identify potential changes. These can be modelled effectively using remotely sensed climate data sets with GIS and GPS inputs. Typical examples of such applications from the developing world include malaria, dengue, lymphatic filariasis, schistosomiasis, and others.

Geoinformatics improves understanding of the situation, what is needed and how to intervene with prevention, mitigation and adaptation strategies when necessary. It offers organization and analytical set of tools that expand the effectiveness of response to growing demand and limited budgets. This is what 4th International Conference on HealthGIS 2011 is proposed at New Delhi, India. This conference after three grand successful conferences looks at *“Geoinformation technology in healthcare and epidemic surveillance and management”*. It attracts scholars, philosophers and practitioners to discuss geoinformatics in health and health using geoinformatics.

It is indeed a great pleasure to invite all the delegates to this conference. These two days will be about significant and innovative developments. You will, I am sure, go away inspired and buzzing with ideas.

So enjoy the conference.



## Foreword



**Prof. Said Irandoust**  
President Asian Institute of  
Technology

Since the last decade the world has witnessed tremendous changes in social and economic order. These changes still continue and countries such as China, India, and Vietnam are going through rapid economic growth. Many Asian countries are experiencing population growth, which drives demand factors of various facilities. Another change, which is of grave concern, is climate change and global warming. All these have varying impacts on human beings and especially on their health. We witness frequent outbreaks of viral diseases, increasing trends in lifestyle-related diseases such as diabetes, heart diseases, respiratory illness, water borne diseases, e-coli scare etc.

We experience that healthcare centres and services are inadequate to fulfil the demand. There is a need to know “where” these diseases are occurring frequently. People in most of the fast developing world face such challenges and the current health infrastructure needs to be enhanced and modernized to ensure health for all.

Geoinformation Technologies provide powerful tools of remote sensing, global positioning systems and robust decision support systems in the form of geographic information systems. These are being increasingly adopted in disease surveillance, hotspotting and provide valuable input for disease control.

I am very pleased that the Asian Institute of Technology (AIT) has joined hands with TERI University and several other partner institutions to organize the 4th International Conference in New Delhi to ponder over these issues. Delegates coming from various locations of the globe will surely benefit from sharing experiences with each other and I hope innovative ideas and approaches will emerge for collaborative work to ensure global health.



## Foreword



**Prof. Bhavik R Bakshi**  
Vice Chancellor TERI  
University, New Delhi

TERI University with Association for Geoinformation Technology (AgIT) and Asian Institute of Technology (AIT) is pleased to present this specialty HealthGIS 2011 conference during August 5-6, 2011 and a pre-conference workshop on August 4, 2011 to explore and strengthen the uses of Geoinformatics for public health access and decision making.

The theme is very relevant and timely considering the real challenge to save lives from dreaded epidemics. The concept that location influences health is a very old one in medicine. As far back as the time of Hippocrates (c. 3rd century BC), physicians observed that certain diseases tend to occur in some places and not others. In the present era of globalization these may emerge in one country and quickly spread to many others. Status of health and health care can be association with different profiles of the Earth: physical, biological, environment, economic, social, cultural and even spiritual. These are parameters governing distribution and status of disease can be captured and modelled for decision using Geoinformatics.

I am pleased that both the organization institutions are pioneers in introducing Masters' level programs in Geoinformatics in their respective locations. Education, training, research and outreach in the fields of Geographical Information System (GIS), Remote Sensing System and Application allows various professions to use this technology for human, social, economic and physical development of a country at micro and macro levels.

I convey my best wishes for the success of all the events encourage meaningful deliberation, useful recommendations and precise identification of issues that need to be addressed jointly by different governments, educational institutions and industrial sectors in the near future. I greet the scientists, scholars, academicians and industry representatives to the TERI University and congratulate the organizers for their meticulous planning of the event and wish the conference a grand success.



## Foreword



**Gp Capt. Rajiv Seth  
(Retd.), Ph.D.**  
Registrar TERI University,  
New Delhi

As the world develops keeping sustainability in mind, various diseases do tend to crop-up, not only in the developing world but also in developed countries. Often these diseases originate at a particular location and then spread over the planet without following any administrative or political boundaries. A healthy planet is only possible if we monitor it regularly using satellite remote sensing data and Global Positioning System (GPS), analyse it in Geographical Information System (GIS) and disseminate the information using Information Communication Technology (ICT). And no one can deny that for sustainable development, we need a healthy planet.

Although using maps to identify and study locations of diseases was done even in the 19th century, there is a need now to look at integrating available technologies (remote sensing, GPS, GIS, ICT and others) into identifying sources of diseases, potential areas of spread and the hotspots, for better governance. The scope of using geoinformatics for real time surveillance for disease control is beyond doubt. Various applications of geoinformatics are being used for allocation of health services and their delivery, but the potential for improving operational applications is tremendous.

I am pleased that the Asian Institute of Technology (AIT) and the TERI University are jointly organising the 4th International Conference on Health GIS on 5-6 August 2011. This would be an opportune occasion for experts from the geoinformatic arena to get together with those from the health area, to strategize on synergistic planning of health care systems and surveillance and management of epidemics.

I welcome all delegates to the conference, and wish them a fruitful two days.



## Geomedicine: A Patient's Perspective



**Dr Bill Davenhall**

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Geomedicine is the practical application of public health knowledge to personal health intervention, either by physicians or the health seeking consumer. The presentation will describe how the inclusion of a geographically accurate place history within the context of a medical encounter can provide a richer source of clinically relevant information to accelerate diagnosis, increase the likelihood of medical compliance, and engage the patient in a productive partnership with medicine and health. Medical research published over the past half-century describes that as much of 30% of all known morbidity and mortality is a direct result of living or working in and around unhealthy physical and social environments. Linking generalized medical and public health knowledge to geographically specific environmental and social conditions at the personal (household, neighborhood, community, etc.) level has great potential for increasing a physician's contextual understanding of the patient's work and social environments that may have contributed to their current health status. Geomedicine ultimately changes the way our physicians will come to understand the impact of our personal environments while at the same time making the health seeking consumer an informed partner in their own health journey.



## GIS –based Information System for the Management of Water Quality Data



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Geographic Information System (GIS) is used to display and facilitate interpretation of water-quality data of a River and the Groundwater System of a district in Kerala. Here we report the fluoride problem of Alappuzha district and water quality status of Periyar River using GIS based information system.

The fluoride problems of Alappuzha was studied by collecting water samples from 67 locations which comprised of 25 open well samples, 8 filter point well samples, 20 shallow tube well samples, 22 deeper tube well samples and 2 bore well samples. The effects of fluorides on the health of man are generally from dissolved fluoride present in drinking water sources. Particulate fluorides can be suspended and dispersed as a contaminant in drinking water. Invariably all the open wells and filter point wells of the study area tap the recent alluvium. Majority of the shallow tube wells of the area tap the recent alluvium with the exception of certain tube wells which tap both the Warkali and recent alluvium together or the Warkali aquifer alone which in turn forms the topmost aquifer layer of the tertiary aquifer system. The spatial representation of the chemical parameters namely calcium, bicarbonate, chloride, fluoride, pH and EC were deciphered using GIS separately for the various vertical layers of the aquifer viz, shallow, intermediate and deep. Zonation map was prepared using GIS for various water quality parameters for shallow and intermediate aquifers of the study area for various seasons. It has been observed that almost all the open well samples and the filter point well samples had fluoride concentration much below the desired limit. Shallow tube well and deeper tube well samples recorded higher content, almost irrespective of the sampling season. There is a marked spatial variation (both in the horizontal and vertical aspects) with regard to the distribution of fluoride in the ground waters of the study area.

The fluoride content being higher in water samples collected from water abstraction structures tapping deeper aquifers. A significant positive association was noted between the source of drinking water and prevalence of dental fluorosis in the study area. The prevalence is high among children who use pipe water for drinking purposes. This can be associated with the increased fluoride content in the deeper tube wells which form the source of water supply through pipes in urban and rural areas.

GIS platform was used to study the spatial and temporal variation of water quality of Periyar, a major river in Kerala. The River with an aerial extent of 5398 sq km is one of the largest river basins in the State. Periyar River has the multiple uses including catering to need of drinking water requirement of Kochi Corporation, Aluva Municipality and Paravoor Municipality and number of panchayaths like Kadamakudi and Puthencruz. It serves as sources for many irrigation and power requirements. Water quality analysis indicates that iron, alkalinity and phosphate were on a higher side in the downstream of the river. The Dissolved Oxygen (DO) values varied between 6.27mg/l to 8.47 mg/l. Biochemical Oxygen Demand (BOD) varied between 0.34mg/l & 2.07 mg/l. Bacteriological analysis confirmed the presence of total coliform and E.Coli in almost all the samples Biological analysis showed the high nutrient enrichment in the downstream towards the Manjummal region (according to the chlorophyll value) and comparatively high pollution index value (Palmer's pollution index) was recorded towards the downstream.

Canadian Council of the Ministers of the Environment (CCME) Water Quality Index of Periyar river was calculated for 34 stations during the four seasons (post-monsoon-2005, pre-monsoon-2006, pre-monsoon-2007 and post- monsoon - 2007). Fifteen parameters, which include pH, turbidity, colour, total dissolved solids, alkalinity, total hardness, calcium, magnesium, chloride, nitrate-N, sulphate, iron, total coliforms and faecal coliforms and dissolved oxygen, were used for the calculation.

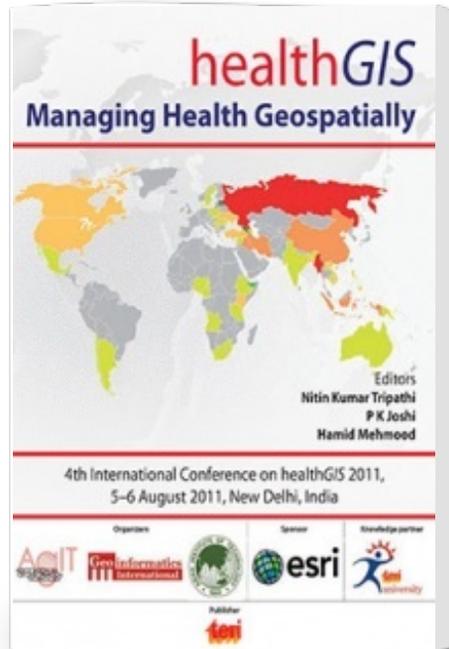
The index values of most of the stations are in the range of 65-79, which indicates that the upstream part of the River is stations have fair water quality, which means that they are occasionally threatened. However, six stations in the downstream showed marginal water quality, which indicate that they are frequently threatened.

Classification of different stations in Periyar River reveals that most of the stations fall under the class C that implies that the water in these stations can be used as drinking water with conventional treatment and disinfection. About 13 stations are in the class E, and water can only be used for irrigation, industrial cooling and waste disposal.

The water quality data was correlated with stream flow which clearly indicates the deterioration of quality with reduced flow. Rapid urban growth of Greater Kochi Region during the last 100 years supports the high pollution levels in the downstream of the River



# HealthGIS : Managing Health Geospatially



Publisher : TERI Press

ISBN : 9788179933251

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