Space Technology in Environmental Health (Emerging Vial Disease)

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ABSTRACT: The emergence of viral diseases transmitted is nowadays a central problem in the world. Problem, which is becoming very critical in developing countries, where the health systems are not yet enough developed to face the bursting of such diseases. Emerging viral diseases constitute one of the major threats to human being that are arising in the modern world. Besides bio-chemical and medical researches, new orientations are developed to understand the environmental dimensions of such emergence. Questions concerning the inter-plays between the environmental and disease dynamics are building up new investigations, both in remote sensing and GIS, for the elaboration of levels of organization of space and environment in relation to incidences, to gain understandings in these issues. Environmental attributes attached to land cover types: area, spatial heterogeneity and physical state, are derived from remote sensing and applied to uncover related dimensions of the Dengue disease.

KEY WORDS: Remote Sensing, GIS, Environment, Spatial analysis, Emerging Viral Disease

INTRODUCTION

The study of how disease and health care are distributed across the face of the earth is nothing new. Now we have new tools - GIS, RS, GPS – to present and understand health data. The scientists have researched the connections between health and the environment (Laura L., 2000). Remotely sensed data can be used to identify, monitor and evaluate environmental factors between vector and environment relationships. Also, GIS can create a link between spatial data and their related descriptive information (Non-spatial data) such as socio-economic and medical data. Both spatial and temporal change in environment condition can be important to determine the diseases transmission.

In 1985, the National Aeronautics and Space Administration (NASA) initiated the Biosphere Monitoring and Disease Prediction Project, the aim of which was to determine if remotely sensed data could be used to identify and monitor environmental factors that influence malaria vector populations (Wood et al. 1991). Recently, GIS and RS started to be used to evaluate and model the relationships between environmental factors/indicators and the incidences of viral diseases. DHF is now a significant public health problem in most of the countries in the tropical areas of the South-East Asia and Western Pacific Regions. The disease is among the ten leading causes of hospitalization and death in children in at least eight tropical Asian countries. Geographers and epidemiologists explain some of the ways geographical information systems can be applied in human and environmental health.

Environmental approach of emerging viral diseases is a particularly complex research. Indeed it is generally acknowledged (WHO, 1997) that human exposure is caused by the inter-plays of social, economical, cultural, natural and artificial environments.

This communication explores the potential associations of some dimensions of the physical environment, with different incidence levels of a disease. Space technology, mainly remote sensing, allows the establishment of the necessary environmental knowledge, the land cover and its related attributes: area, location, spatial organization (homogeneity/heterogeneity) and state (physical/biological).

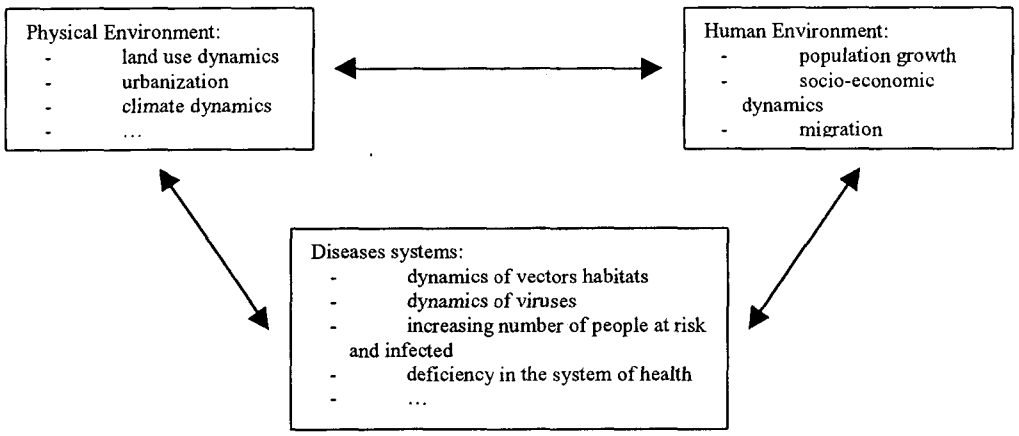
EMERGING VIRAL DISEASES (EVD)

At all times, the infectious illnesses, and among them the viral diseases transmitted or not by vectors, were in the center of the questions of health in the inter-tropical zone and in particular in developing countries. During the last 20 years, the viral diseases did not stop developing themselves. Some facts:

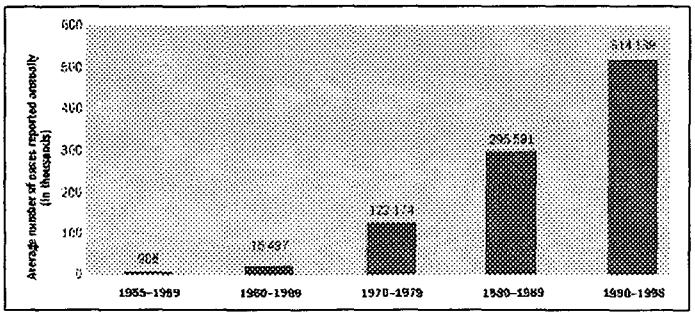
The Fever of Lasa, West Africa (300 000 cases per year); the Illness of the forest of Kyasanur, India (500 cases per year); the Fever of the valley of the Rift, Africa (several thousands of case under epidemic form); the Dengues fevers, in Asia and in South America (50 to 100 millions cases per year); the hemorragic Dengue, several hundreds of thousands of case per year; the Hantaan virus, 150 000 cases of infection in China per year; the yellow fever, in 10 years more than 20 000 cases in Africa and in South America; the Japanese encephalitis, 30 000 to 50 000 cases in South-Asia per year; other viruses are a real threat for the developing countries, the virus West Nile (1996, 600 cases in Romania; several deadly cases in New York in 1999), the viruses of the tick-encephalitis of Central Europe to the coast of the Pacific, the limits of their extension being in constant progression.

The infectious illness prevention in the developing countries is one of the short-term applicable health policies with an expected high rate of success (Widened Program of Vaccination, ...). For this, it is necessary, among other things to understand the mechanisms of apparition of the illness and the dynamics of its extension. It must in particular aim at the identification and the control of the risk factors.

Basically the emergence and spreading of diseases would result from the following dynamic interactions:



The global incidence of DF and DHF has grown dramatically in recent decades.

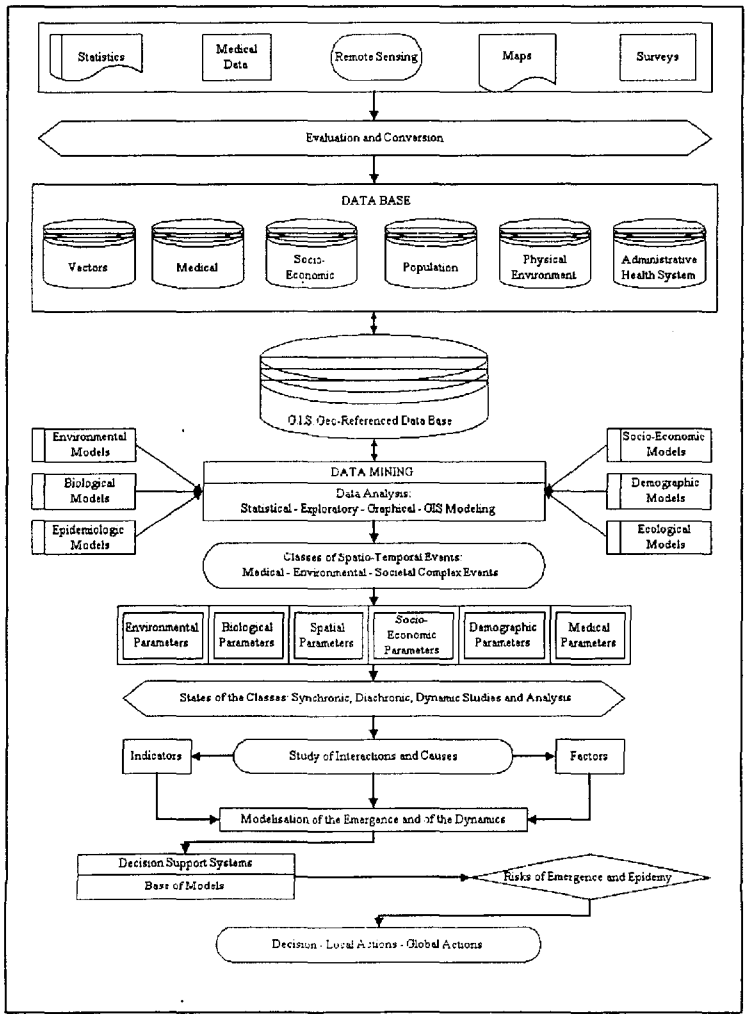


Dengue/dengue hemorrhagic fever, average annual number of cases of reported to WHO, 1955-1998

APPROACH

Environmental mapping of the province is achieved according to the classification currently used in Thailand by the Ministry of Science and Technology for the Environment (TEI, 1996). Remote sensing supervised process produces a map with a nomenclature of seven items: urban, grass (and golf course), water, paddy fields, mixed orchard, crop, and transplanted paddy fields, plus unclassified. Spatial organization (homogeneity/heterogeneity) of these land cover categories is realized through an unsupervised texture based classification (Andrianasolo & al, 1999), attaching to each land cover type, a level of spatial disorder. Physical/biological state of the land cover is assessed through an application of the vegetation index (Jensen, 1986) derived from the visible and near-infrared wavelengths. Such vegetation index allows qualifying the land cover in terms of more or less water, bare soils and green vegetation. The objective is to find out associations between land cover and classes of diseased sub-districts. The aim is first to gather knowledge and build a database about the environmental conditions of the emerging viral diseases; causal relationships studies would take place only after insights in the complexity of the interplay between environment at large and the emergence are uncovered.

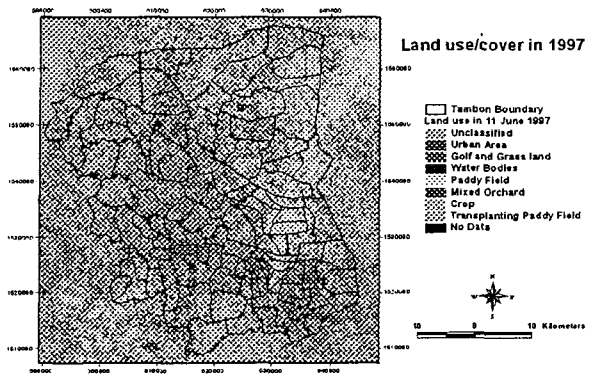
The following figure demonstrates the implementation of such general approach aiming at the elaboration of a system, for knowledge discovery and research and decision support. This type of system relies essentially on a data base upon which is Functioning a base of models.



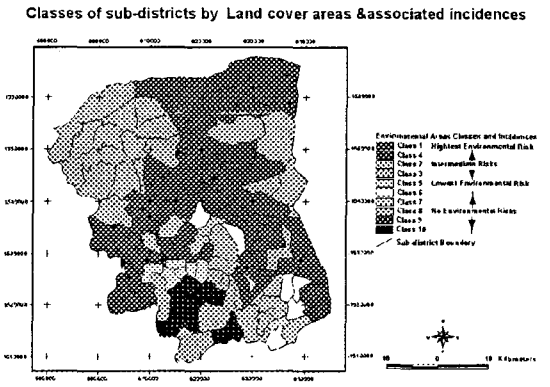
ENVIRONMENTAL CLASSIFICATIONS OF SUB-DISTRICTS

Parameters: Land use/cover areas

The sub-districts are organized in classes according to the distribution of the land cover (Map1) areas. Ten classes (Map2) are obtained, depicting 10 different environmental behaviors of the administrative entities, characterized by distributions and densities of the disease cases.



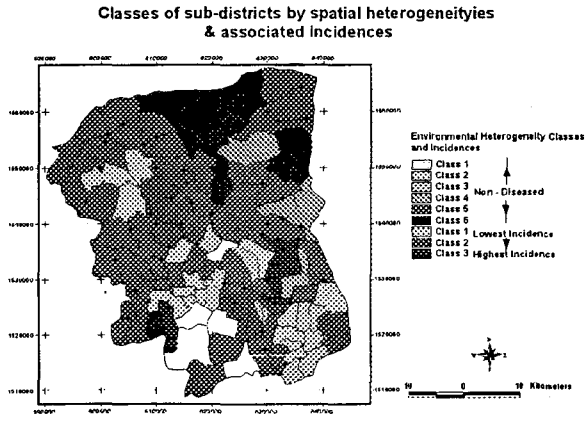
Map 1: Land use/cover



Map 2: Classes of sub-districts by land cover areas & associated incidences

Parameters: Land use/cover spatial heterogeneities

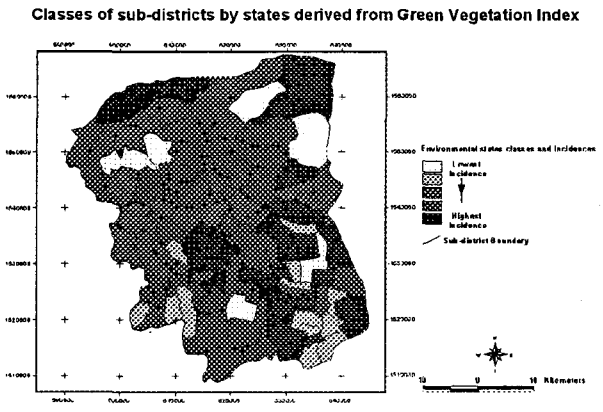
The sub-districts are organized in classes according to the distribution of the land cover types heterogeneity. Nine classes (Map3) are obtained, depicting 9 different land cover spatial organization behaviors of the administrative entities.



Map 3: Classes of sub-districts by spatial heterogeneities & associated incidences

Parameters: Land use/cover states according to green vegetation index

The sub-districts are organized in classes according to the distribution of the land cover types states. Five classes (Map4) are obtained; depicting 5 different land cover states behaviors of the administrative entities.



Map 4: Classes of sub-districts by Green Vegetation Index & associated incidences

CONCLUSION

The fundamental spatial methodology for the creation of the majority of the data is based on remote sensing and GIS. Which in the framework of what would be the development of a new epidemiology, is calling for some researches in the application of space technology and science.
These results highlight the great complexity of the environmental health issues. They demonstrate that to advance forward, and before discussing causal relationships and/or risk zones establishment, a complete system approach has to be built up to explore, break down the complexity and gather out coming factual and punctual results. This would allow seeking for regularities and actual knowledge.

Our approach here is involving databases, GIS, remote sensing, data analysis and mining. Remote sensing is playing a central and fundamental role in that without it, knowledge on the physical environment: location, area, heterogeneity, physical and biological state would be actually difficult to acquire in the same synoptic and exhaustive way.
The approach developed here is potentially usable even with the inclusion of the socio-economic environment. Which constitutes our next steps, to really tackle this problematic at all the necessary dimensions, and to demonstrate that information, spaces and science technologies are an inherent part of this sustainable development essential issue.

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