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# SPACE TECHNOLOGY IN HUMAN HEALTH APPLICATIONS REGARDING ENVIRONMENT-RELATED DISEASES: A CRITICAL COMMENT

# APLICACIONES DE LA TECNOLOGÍA ESPACIAL EN SALUD HUMANA SOBRE ENFERMEDADES RELACIONADAS CON EL AMBIENTE: UN COMENTARIO CRÍTICO

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## ABSTRACT

The application of space technology to the environment monitoring and the development of disease modelling will allow researchers in the human health community to characterize an increasing range of variables that are key to understanding the spatial and temporal patterns of the risk of disease transmission.

## RESUMEN

La aplicación de la tecnología espacial para el monitoreo del ambiente y el desarrollo de modelos de enfermedades, permitirá a los investigadores en salud humana caracterizar un creciente intervalo de variables que son clave para entender los patrones espaciales y temporales de los riesgos de transmisión de enfermedades.

**Keywords:** environment monitoring via satellites, critical points in space technology applied to health, environment related diseases and outbreaks.

**Palabras clave**: monitoreo del ambiente a través de satélites, puntos críticos en tecnología espacial aplicada a la salud, enfermedades relacionadas con el ambiente y brotes.

## INTRODUCTION

Vector and waterborne diseases are considered environment-related pathologies and the influence of climatic factors in their emergence and spread is quite clear. The seasonal nature of many of these diseases has long been recognized, but only recently has the environment become a major element in their systematic study (Ivers and Ryan, 2006; Fisman, 2007).

The monitoring of environmental and climatic factors, that influence the emergence, persistence and spread of microbial pathogens and their vectors and reservoirs, has improved considerably since space technologies have been applied (Beck *et al.*, 2000; Colwell, 1996). The increasing satellite coverage and quality of sensors and data have prompted the use of satellites and their application to biological and medical sciences also with the aid of computer-assisted image processing and sophisticated geographical information systems (GIS).

Among the so-called 'cross-disciplinary' applications, landscape epidemiology (also called tele-epidemiology) is the one that uses the largest range of satellites, including earth observation satellites to monitor atmosphere, vegetation, habitats and water and telecommunication satellites for data collecting, transmission and localization.

A number of obstacles, including cost, inadequate spatial, spectral, or temporal resolution and availability of adequate data, have restricted the use of remote sensing in the user community. Moreover, the scope of satellite applications, despite their substantial theoretical potentialities, appears limited both by their technical nature and the models developed (Moloney *et al.*, 1998; Herbreteau *et al.*, 2007).

In a recent near-exhaustive review, using Internet search engines and specific keywords, the authors found that for some infectious diseases with a major public health impact and for some emerging diseases, remote sensing has not proved to be the wonder tool that scientists expected, and surprisingly it has never been used to analyze the dynamics of environment-related diseases. According to these researchers (Herbreteau *et al.*, 2007), remote sensing falls far short of its expected potential owing to fundamental barriers to its implementation for health applications.

## INTEGRATING SPACE TECHNOLOGY IN HUMAN HEALTH APPLICATIONS: POSITIVE AND NEGATIVE ASPECTS

There is a number of key advantages in using satellites in predicting epidemic outbreaks and in disease analysis and modelling: i) large amount of data obtained from the permanent monitoring of the environment enabling the identification of environmental patterns and trends; ii) possibility of predicting outbreaks in specific areas with times compatible with the preparation of an adequate response; iii) development of a growing database which will provide future generations with increasingly accurate predictability and iv) possibility of large coverage, including isolated, remote areas which would otherwise not be monitored and allowing equal access.

However, data recorded by earth observation satellites have to be processed and integrated and these are two important issues in the application. The integration of the data is also very important in the context of the whole application: integrated data from many sources, such as population studies, clinical cases, environmental and climatic data, microbiological information, have to be used to develop disease predictive models and early warning systems for an early alert on outbreak risks.

On the other hand, some critical issues in health applications using satellites cannot be excluded. As an example, no single spatial, temporal, or spectral resolution is universally appropriate for any predictive model and thus we need differentiated tools for studying environment-related diseases at different levels (Herbreteau *et al.,* 2007). Besides, in many cases the correlation between environmental variables from remote sensing and geospatial data from other sources are poorly defined and usually simplified. In this respect and as an example, the possibility of using satellites for measuring chlorophyll concentrations on the basis of ocean color has been extensively adopted, largely diffused and proposed to calculate the quantity of phytoplankton.

However, this calculation is far from being easy and accurate in areas close to the coast, as revealed when an attempt was made to establish a correlation between Adriatic Sea chlorophyll concentrations measured in situ and those downloaded from Envisat/MERIS and MODIS/Aqua ocean color sensors (Lleo et al, 2008). Similarly, the monitoring of water turbidity as an indicator of the concentration of suspended organic matter, proves difficult in areas close to the coastline because runoff from rivers, re-suspension of sand, silt and a number of other substances from the bottom by tides, waves and storms can change the colour of the near-shore waters. In this connection, it is necessary to develop specific algorithms that in many cases are only valuable at a regional level.

Some of the most important technical barriers in using satellites for monitoring the environment are now being solved. This is the case of the factor limiting the use of remote sensing for the study of environment-related diseases, the cloud covering during the most critical period for the transmission of some diseases, the rainy season which now is being overcome thanks to the arrival of synthetic aperture radar (SAR) that can penetrate through clouds.

## CONCLUSIONS

The application of space technology to the environment monitoring and the development of disease modelling will allow researchers in the human health community to characterize an increasing range of variables that are key to understanding the spatial and temporal patterns of the risk of disease transmission. The improved capabilities of modern satellites, when combined with the increased computing power and spatial modeling capabilities of geographic information systems, should extend the scope of remote sensing to include operational disease surveillance and control. Despite the still numerous limitations and barriers in the use of satellites and their integration in complex systems and models, the new satellite capabilities now allow exploration of risk factors previously beyond the capabilities of remote sensing and put researchers in a position to analyze the effects of environment on disease outbreaks.

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