INTEGRATING SPACE TECHNOLOGIES IN PUBLIC HEALTH SURVEILLANCE PROGRAMS: FROM THEORY TO OPERATION

INTEGRACIÓN DE LAS TECNOLOGÍAS ESPACIALES EN PROGRAMAS DE VIGILANCIA DE SALUD PÚBLICA: DE LA TEORÍA A LA OPERACIÓN

Pascal Michel[1,2], Stéphanie Brazeau[1,2], Nicholas Ogden[1,2] and Shannon Kaya[3]*

1. Public Health Agency of Canada; 2. Groupe de Recherche en Épidémiologie des Zoonoses et Santé Publique, Faculté de Médecine Vétérinaire, Université de Montréal, Québec, Canada ; 3. Canada Centre for Remote Sensing, Natural Resources Canada. * email: Pascal_Michel@phac-aspc.gc.ca.

ABSTRACT

There seems to be a notable gap in the operational integration of space technologies within public health organizations in most parts of the world. This is in contrast with the significant increase in activities over the past ten years by a wide array of scientists to specifically address public health and epidemiological issues linked with environmental determinants. This reflects not only the sizeable challenge of transdisciplinary collaborations among scientists and organizations with different mandates, but also speaks directly to the need to explicitly frame the integration of space technologies into recognized public health surveillance functions and in synergy with other fast developing medical diagnostic (i.e. genomics, nanotechnology), analytical (i.e. Geographic Information Systems, modeling) and information (i.e. internet based data capture and alert systems) technologies. After nearly 40 years of documenting the possible contributions of these technologies to enhance public health research and health surveillance, a sustained effort must now be put towards demonstrating the added-value of functional, cost-effective and operational solutions with measurable effects on public health functions and outcomes.

RESUMEN

Pareciera que hay una brecha notable en la integración operativa de las tecnologías espaciales en las organizaciones de salud pública en muchas partes del mundo. Esto está en contraste con el aumento significativo de las actividades en los últimos diez años, mediante una amplia gama de científicos para tratar específicamente los problemas de salud pública y epidemiológicos relacionados con determinantes ambientales. Esto refleja no sólo el reto importante de colaboraciones transdisciplinarias entre los científicos y las organizaciones con diferentes mandatos, sino también habla directamente de la necesidad de formular explícitamente la integración de las tecnologías espaciales en reconocidas funciones de vigilancia en salud pública y en sinergia con otros países en desarrollo rápido de diagnóstico médico (es decir, la genómica, la nanotecnología), análisis (es decir, sistemas de información geográfica, modelado) y de información (es decir, la captura de datos basada en internet y los sistemas de alerta) tecnologías. Después de casi 40 años de documentar la posible contribución de estas tecnologías para potenciar la investigación en salud pública y vigilancia de la salud, el esfuerzo sostenido debe ahora dirigirse a demostrar el valor añadido de las soluciones funcionales, rentables y operativas con efectos mensurables en funciones de salud pública y sus resultados.

Keywords: surveillance, space technologies, remote sensing, transdisciplinary science, public health, epidemiology, review.

Palabras clave: supervisión, tecnologías espaciales, sensores remotos, ciencia transdisciplinaria, salud pública, epidemiología, revisión.

INTRODUCTION

From a technical perspective, there are three broad areas of space technologies with direct operational applications and possible significant benefits to public health surveillance. These are satellite communication, global positioning systems and remote sensing space technologies. In health research, the application of these space technologies has evolved considerably over the past ten years and this is mainly a consequence of enhanced considerations given to geographical determinants and location as key factors to explain the complex relationship of a wide range of diseases, as well as rapid and notable progress in the temporal, spatial and spectral resolution and availability of various space technologies and products.

More recently, space technologies have also been proposed to better support operational needs specific to public health practice, including areas such as early warning systems for infectious diseases, health surveillance programs as well as for emergency preparedness and field response.

There seems to be a notable gap in the operational integration of space technologies within public health organizations in most parts of the world. This short paper intends to give a specific overview of the use of remote-sensing technologies for public health research and surveillance activities and to discuss alignment of initiatives in this area with public health functions for better integration and operational application.

RESULTS AND DISCUSSION

The focus of public health activities is to prevent rather than treat a disease through surveillance, early intervention and the promotion of healthy behaviors. Key functions underpinning public health programs most often include elements such as: disease and injury prevention; health promotion; health protection; health surveillance; population health assessment; emergency preparedness and field response. These functions are developed, framed and supported by the inter-dependent contribution of policy, technology, science and knowledge. From a disciplinary perspective, the field of tele-epidemiology (or landscape epidemiology) is well-identified to space technologies. In short, tele-epidemiology provides consistent, large-scale, and rigorous earth observations that help in understanding, predicting and combating diseases for which the environment or the geographic distribution of exposures play an important role in their epidemiology. However, the scope of tele-epidemiology reaches far past the simple use of space technology, as it defines the disciplinary convergence of epidemiology, ecology, environmental sciences and space applications. Not only do we have new and improved means of measuring environmental characteristics, but this ability is framed in within a rich scientific paradigm aiming at bringing new knowledge about the relationship of populations with their surroundings.

For national and international authorities, few key drivers may significantly contribute to a renewed interest in such technologies and their integration into core public health functions. The first one relates to the increased need to explicitly frame regional issues into a global context. Recent spread of pandemic strains of avian and swine influenza, issues relating to microbial hazards in drinking water, climate change as well as emerging and re-emerging vector borne diseases have clearly demonstrated the necessity to study and to take action on multi-scale phenomena including very large scale determinants such as climate, economy and population migrations. The second driver relates to the recognition of a higher complexity in the transmission and exposure to important pathogens leading to a more articulated desire of transdisciplinary for gaining new knowledge and sustainability for proposed interventions and policies. A compelling illustration of this force is the recent traction gained by the “One World, One Health” vision as initially proposed by the Wildlife Conservation Society which explicitly embraces the notion of interdependence of human, animal and the environmental health. Finally, the possibility to observe earth features at any location and at almost any time has brought a sustained interest not only for the ability to gain knowledge on a health phenomena in remote locations, but for the ability to promptly react to emergencies following large scale disasters.

Parallel to this public health vision, one must recognize the ever growing role of medical, analytical and information technologies to help us tackle large and multi-scale complex public health issues. By providing consistent, rigorous and large-scale data on earth features and activities, remote sensing is seen as a significant technological advancement aimed at supplementing current land-based information which may be obsolete, missing or biased due to rapid

changes in population dynamics, events occurring in remote locations or distributed over large geographical areas. Over the last ten years, we have observed a marked increase in the level of activities documenting the application of remote sensing technologies for epidemiological or public health purposes (Figure 1). Most of this effort has been, however, linked to demonstrating conceptual aspects or gaining focal knowledge on a given disease. Surveillance, as one of the key functions of public heath, is usually framed as a long-term, on-going and pragmatic activity aimed for action (field intervention, preventive measures, policy direction, etc).

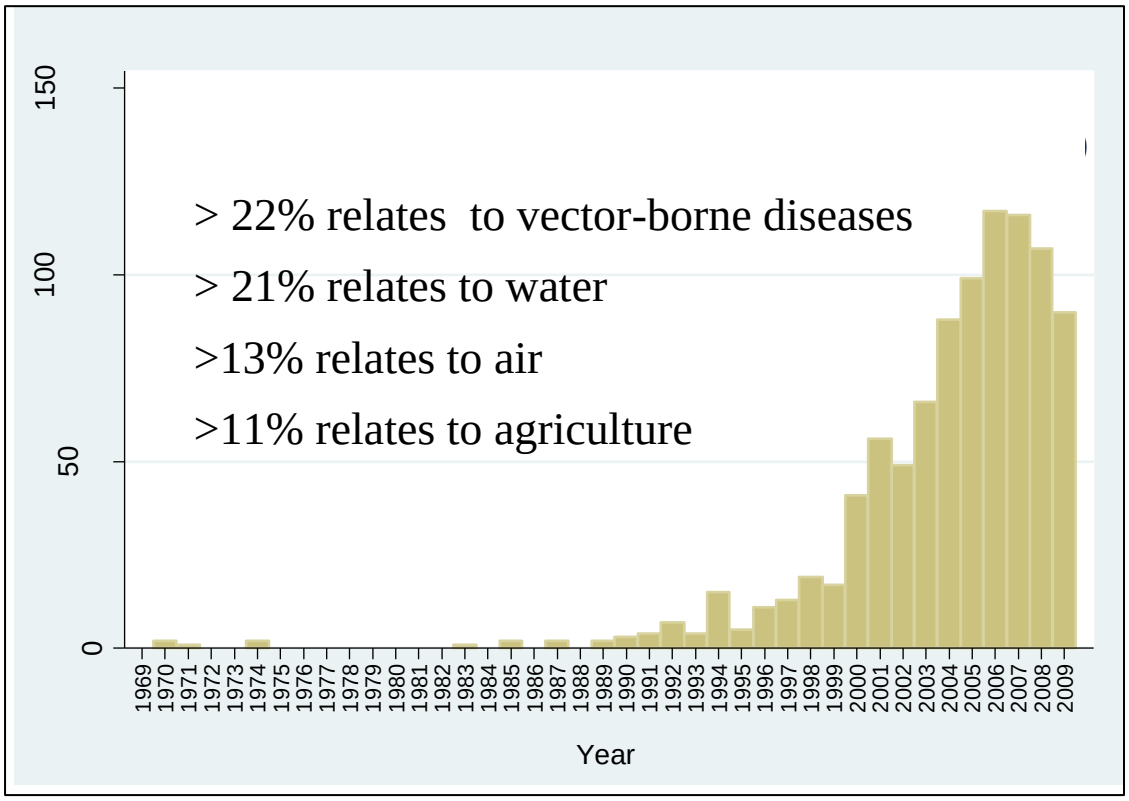

Figure 1. Published articles linking remote-sensing to epidemiology or public health over the past 40 years.

Early-warning systems and modeling aimed at predicting outbreaks and epidemics represent sub-activities of surveillance. Like in other key public health functions, technology is not seen as an endpoint, but rather as a leverage to gain better knowledge for more efficient actions. In that view, to justify the operational integration of any technologies (i.e. population genomics, geomatics, modeling), and of remote-sensing in particular, into surveillance programs, the presentation of the benefits of these technologies as elements to address key drivers in current public health issues is needed but insufficient. With now a few decades of experience, we should be moving from arguing applicability and feasibility of remote-sensing to demonstrating ongoing initiatives illustrating added-value, reliability and action-oriented approaches. More broadly, we should move the current technology focus, to the promotion of a transdisciplinary knowledge on population health (Figure 2).

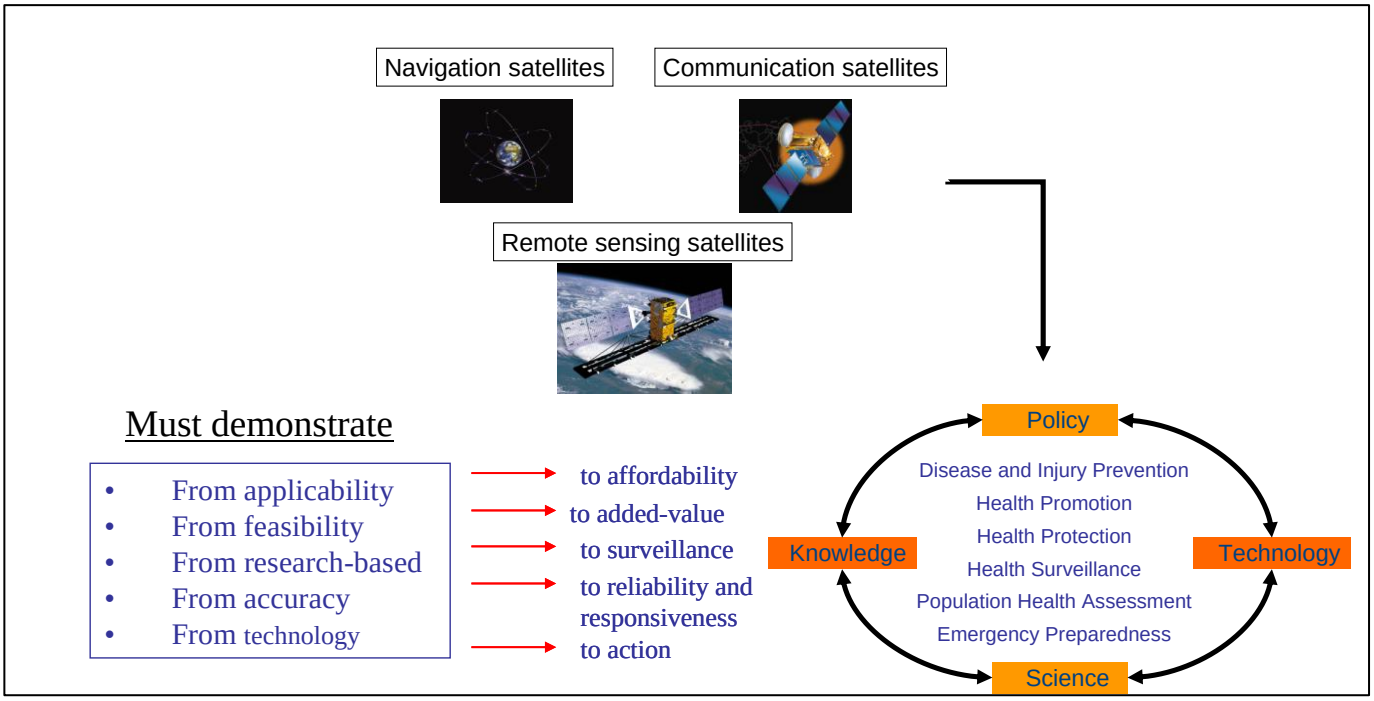

Figure 2. Linking space technologies to public health functions – a next step.

Finally, another important aspect currently limiting the integration of space technologies in surveillance and early warning systems for health outcomes relates to organizational leadership and mandate to develop operational programs in this multi-sectorial scientific domain. Considering that such systems are likely to be based on a multi-source (ground-based, space-based) and a multi-technological (space, information, analytical, medical) model, public health organizations might be hesitant in investing in these initiatives without the strong support of space agencies, communication and information technology sectors and partnership of experts from academia and the private sectors.

CONCLUSIONS

Space technologies, and particularly remote sensing represent a strong contribution to a new transdisciplinary approach of exploring and monitoring environmental links to public health outcomes. Better alignment of these contributions to public health functions and surveillance objectives are needed to move the potential use of these technologies to broad operational surveillance applications. Continuous discussion at the international, national and regional levels is strongly needed to pursue visions for the deployment of such promising technology.

LITERATURE CITED

Ford, T.E., R.R. Colwell, J.B. Rose, S.S. Morse, D.J. Rogers, T.L. Yates. 2009. Using satellite images of environmental changes to predict infectious disease outbreaks. *Emerg. Infect. Dis*. 15(9):1341-6.

Herbreteau, V., G. Salem, M. Souris, J.P. Hugot, J.P. Gonzalez. 2007. Thirty years of use and improvement of remote sensing, applied to epidemiology: from early promises to lasting frustration. *Health Place*. 13(2):400-3.

Kalluri, S., P. Gilruth, D. Rogers, M. Szczur. 2007. Surveillance of arthropod vector-borne infectious diseases using remote sensing techniques: a review. *PLoS Pathog*. 3(10):1361-71.

Lleo, M.M., M. Lafaye, A. Guell A. 2008. Application of space technologies to the surveillance and modelling of waterborne diseases. *Curr. Opin. Biotechnol*. 19(3):307-12.