Spatial interactions of environmental factors: toward a conceptual approach for modeling chemicals in human health risk assessment

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Chemical substances emitted from various source activities move in the environment through transport, transfer and transformation processes, and thus vary over space. Yoshida and Teguchi (2008) have evaluated oral intake of plastic additives via the ingestion of vegetables, fish, meat and dairy products by integrating environmental fate and exposure models. Environmental factors that affect human health and well-being are unequally distributed through space. People move from one place to another, and experience different exposure environments as a result. Consequently, population numbers and their susceptibility, exposures and health status are differentially distributed over space. The spatial dimension plays a key role in human health risk assessment. Human health risks have strong spatial logic and risk analysis involves a fundamental spatial component. Geography represents the context in which human health risks occur and provides a natural laboratory to study associations between environment and human health. Although geographical information system (GIS) has been used as a tool at the field of natural hazard risk management, the application of spatial analysis to human health risk assessment remains limited. There are obvious advantages in developing a fusion between a philosophy of risk management and the power of GIS. It is expected that numerous spatial (and temporal, also) objects can be integrated into risk assessing support system based on GIS technologies in order to explore human risk patterns over space more efficiently as a useful risk indicator.

Our ultimate objective is to support the detailed assessment of human health risks by modeling the dynamic nature of chemicals and exposure population. We try to employ a transportation system to evaluate the risk posed by exposure via ingestion in daily life. The aim of this study is to develop and implement a spatial transportation model of agricultural products in terms of spatial interactions. Spatial interactions reflect relations of complementarily and competition between the locations and act as a driving force in the transformation and the dynamics of spatial systems. The subject of this paper is the spatial transportation model developed for vegetables. We have reported the framework along with an initial prototype model of spinach in Japan (Lai & Yoshida, 2008). The general gravity model enables a reasonable interpretation of spatial transportation model between location A and B : a drawing power from B to A is defined as the product of relative attraction from B and distance decay function between A-B; an estimated value at A is proportional to observed value at A and the drawing power of A-B. In order to accommodate the spatial emphasis, we discuss the complexity of transport processes for agricultural products in environmental, demographic, and socio-economic contextual factors which include road network, land cover, land use, topography, location, population, life style, traffic, economic activities, and so on. Integrated with the known Dose-response relationship, health risks can be estimated at high accuracy. Overall, there are increasing uncertainties in the human health risk assessment and GIS provides powerful tools for the capture, manipulation, integration and visualization of data. By means of linkage to routine health data, GIS provides rapid and visual representation of risk situations and is superior to scenario analysis. Besides, it is also possible to identify and characterize populations at any risk level and to assess exposures of small population groups on the basis of their location with dynamic, flexible and robust models.

[Reference] Yoshida K. and Teguchi N., Development and validation of an assessment system for human health risks of plastic additives, Proc. SRA-JAPAN Annual Conference, Vol.21, 437-442, 2008