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A Spatial Information Infrastructure for linking environmental and health data: the approach to information fusion including uncertainty handling in the EO2HEAVEN project

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The presentation will describe work being undertaken in the EU FP7 Project 244100 EO2HEAVEN (Earth Observation and ENVironmental modelling for the mitigation of HEAlth risks) on three different case studies. The project is developing a Spatial Information Infrastructure to study the impact of environmental factors on health. The basis is the fusion of data from in-situ and remote sensors, geospatial and health databases, as well as models. Relevant technical issues addressed are: disparity of formats, terminology from several disciplines, diverse spatial-temporal data resolution and coverage, usage of standards and best practices. The following organizational and ethical issues are equally important: multiple data owners, controlling access to data and fusion results.

The fusion of area measurements (e.g. obtained remotely by a satellite) and point measurements (e.g. observed by in-situ sensors) with usually different spatial-temporal resolution and coverage require advanced techniques including the handling of uncertainty. The EO2HEAVEN system aims to provide a set of adequate services and models e.g. to adjust the different resolutions, to handle intermitted data series (e.g. due to sensor unavailability or communication interruptions) or to identify and handle measurement outliers (e.g. due to sensor failures). The uncertainty of the sensor measurements (e.g. a given manufacturer accuracy of the sensor) is encoded in the sensor model language description (SensorML) of each sensor. The EO2HEAVEN fusion process takes account of the measurement data accuracy by acquiring it automatically from the SensorML descriptions. The result of the fusion algorithm is a coverage, i.e. a set of estimated property values for the sampling points together with a quantified description of their uncertainty. The uncertainty is described as a statistic (such as variance) or a probability distribution. The descriptive markup language UncertML (Williams, M. et al. 2009) is used to encode the accuracy information into the XML fusion result file.

Special requirements are to be addressed in EO2HEAVEN for health data and the correlation with environmental data. For example, legal restrictions to the traceability of health data to single persons and therefore the need for aggregation are a challenge. Long term effects of environmental parameters on health must also be considered in describing possible correlations with an associated uncertainty.

To allow medical personnel to analyse and detect possible correlations of health data with environmental data, the EO2HEAVEN system will provide a powerful and user friendly visualisation e.g. by maps (with cities and streets etc) with semi transparent data grid overlays (e.g. data heatmaps). This includes also the adequate visualisation of the uncertainty in diverse illustrations such e.g. as a heatmap using in parallel both colour scale (in areas with certain results with a low variance) encodings and gray scale (in areas with uncertain results above a given variance level) encodings.

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