DEVELOPMENT OF A DECISION SUPPORT SYSTEM FOR TECHNOLOGICAL RISK MANAGEMENT WITH THE COMBINED USE OF REMOTE SENSING AND GIS

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Abstract

The radiation reaching a moderate resolution satellite sensor at the event of a fire caused by an industrial accident is a combination of the radiation emitted from the resulting fire, the thermal radiation from the Earth's surface and the short wave (solar) radiation which is reflected at the surface of the Earth. Taken that: a) solar energy dominates the visible and near infrared parts of the spectrum, b) the radiation emitted from the surface of the Earth is the one which dominates in the middle and thermal infrared parts and c) in the middle infrared part of the spectrum, both the solar and terrestrial radiation provide weak signals, it yields that the spectral channel in the range from 3 to 5 μm has the maximum probability for detecting a fire on the basis of its temperature. Flares at chemical works and on oil or gas rigs may have temperatures in the rage 1000 - 1500 ° K. They are incandescent because carbon particles in a large flame at 1000 ° K may have an area of the order of 30 x 30 m^2. A much smaller fire with dark surroundings, such as at night or at the sea where there is no glint, could be detected at about one tenth of pixel size, say 10 x 10 m^2.

In recent years, and due to a number of incidents involving fires in industrial installations and warehouses, research has been oriented towards the definition of the properties and of the amount of the plume particulates generated by different materials, including pesticides, under varying fire conditions. The aerosols of a plume produced by an industrial fire can be broadly classified into two main categories: the first is the dense plume category, or areas with heavy aerosol loading, which is found over the broader disaster region. The second is the haze-like plume, which has been transported by meteorological conditions to several kilometres from the site of the accident. Similar plume dispersions take place during forest fires. Satellite data have been used for the analysis of the emitted smoke in order to quantify the gaseous output from forest fires. This technique relies upon the premise that if atmospheric aerosol concentrations are measurable by a satellite sensor, then the mass of CH_4, CO and other trace gases within a plume can be estimated using empirically derived correlations. The plume particulate may be detected by satellite sensors due to scattered radiation. However, satellite images have not been widely used in atmospheric dispersion studies mainly for two reasons: firstly, they are not well suited for the detection of

atmospheric pollution because satellite sensors are generally not tuned to the absorption bands of the pollutants; secondly, the spatial resolution of satellite data is too low for the study of plumes produced in local scale pollution episodes. The optical characteristics of a plume relate to the dimensions of the aerosols and water droplets. In particular, aerosols scatter the reflected short-wave radiation, thus they can be detected in the visible channel of a satellite sensor if it has the appropriate spatial resolution. Landsat Thematic Mapper (TM) has the advantage of a spatial resolution of about 30 m, consequently TM channel 1 (centred at 0.48 μm) may be used for plume detection. The disadvantage of TM is that Landsat data are collected every 16 days over a given area. However it is an interesting tool for studying aspects of atmospheric diffusion, such as the shape and the spread of plumes as a function of distance from the source.

In the past, software packages have been developed for Technological Risk Assessment based on numerical modelling. In this paper a GIS based Technological Risk Assessment Tool is presented. The system has the capabilities to combine satellite derived information from moderate (NOAA) and high (IRS, SPOT, Landsat) resolution satellites, as well as in-situ data in order to monitor the toxic plume patterns and to estimate the impacts of technological accidents to natural and human environment.