US Environmental
Protection
Agency

Aerial Photography to Support Chemical Exposure Assessments

The use of aerial photography to support environmental assessments has increased dramatically in recent years. At the same time Federal and State agencies have focused their attention on the public's exposure to toxic chemicals that have escaped during manufacturing activities, from storage or waste sites, or from transportation accidents, into urban areas. The EPA's National Exposure Research Laboratory in Las Vegas through its Environmental Photographic Interpretation Center (EPIC) has played a central role in applying photointerpretation techniques to assess the adverse environmental effects of many of man's activities.

Aerial photography has been used to study the environmental impact of industrial facilities, coal extraction, septic tank failures, hazardous waste sites, and wetlands development. For example, during fiscal year 1998 Laboratory scientists supported environmental assessments of more than 100 hazardous waste sites. EPA scientists are also using aerial photography to improve monitoring of air, water, soil, food, and other environmental pathways in order to assess the degree and extent of chemical exposures to man.

Innovative uses of photointerpretation techniques are being explored to support studies of human exposures to toxic chemicals. Earlier projects using aerial photography have been directed to such problems as pollutant leakage into waterways or aquifers used for drinking water supplies, and the proximity of human populations to chemical spills and explosions. However, only recently have serious efforts been made to link aerial photography capabilities in a systematic manner with the design of exposure monitoring networks.

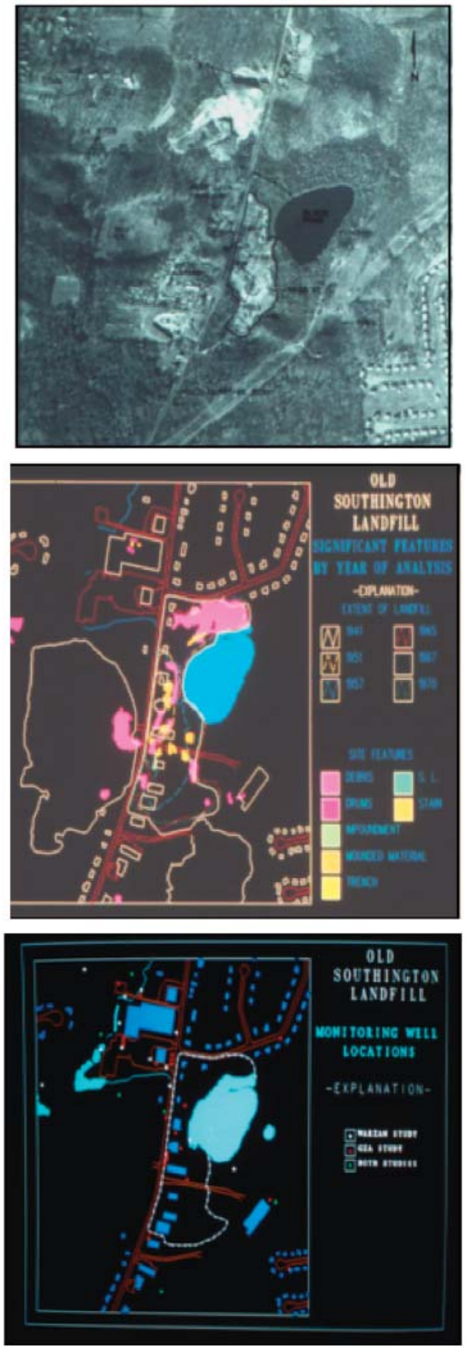

Figure 1. *Shows an aerial photograph of a waste disposal site in 1957 (top). Analysis of a series of historical photos for the site from 1941, 1951, 1957, 1965, 1967 and 1970 allowed for the delineation of the extent of the landfill for each year. Using a GIS, a color-coded map (bottom left) was produced which showed the location of features such as drums, impoundments, stains, etc. Also depicted are monitoring well locations (bottom right) for evaluating changing water quality and potential chemical migration from the site.*

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Identifying Chemical Sources and Potential "Hot-Spots"

Aerial photography, when used in conjunction with collateral data such as information from EPA industrial waste discharge permits, can be very useful in pinpointing possible sources of the environmental chemicals of concern. Factories, smokestacks, waste discharges, dumps, and vehicles can all be located and counted. The resulting inventories of emission sources provide basic data for choosing appropriate monitoring methods and sites.

Both operating and abandoned facilities can often be recognized in photographs taken over a period of many years. Abandoned facilities are of particular concern because they are commonly forgotten, restructured or lost, and may be unsuspected but potential sources of pollution. Their location and identification through use of historical aerial photography can aid in the design of a monitoring network.

Finding the location and mapping the size of "hot-spots" which are areas of high chemical concentration, presents problems since most chemicals aren't visible. Aerial photographs show possible routes of chemical migration away from a source, such as swales or drainage channels, to low points where chemicals may accumulate. By referencing interpreted aerial photographs, investigation or monitoring teams can sample soil or other media from the locations most apt to be confirmed as hot spots thereby reducing the costs of the monitoring program.

Characterizing Population Distribution Patterns

The deployment pattern of monitoring systems should correlate the contamination profiles with the spatial location, pattern and distribution of potentially affected human and ecological populations. Aerial photography is a powerful tool in determining human population densities in specific geographical locations and thereby guides the location of monitoring sites.

Specifically, aerial photography provides a means for sub-dividing census tract information into smaller geographical subunits more useful for designing exposure monitoring networks. For example, housing counts can provide residential population estimates, as shown in Figure 2. A similar estimate of the labor force in an area can be determined by counting commercial buildings. These estimates help to determine population densities for specific areas and times of day.

Aerial photography can also be used to pinpoint areas with populations of special concern such as high density apartment complexes as contrasted to sprawling residential areas; business district shopping malls as distinct from office buildings and rural malls; or industrial areas that are open to the environment as distinct from those that are enclosed. Also, schools, playgrounds, and hospitals can be located. Again, these distinctions help to determine the locations of monitoring sites.

Figure 2. *Photos like these can be used to determine human population densities. Images acquired from high altitude platforms (left) and even spacecraft can provide valuable information on population distributions and densities over large urban and regional areas. More detailed aerial photographs (right) or higher resolution satellite images can be used to zoom in on populated areas to provide more localized information on building types in residential, commercial, and industrial areas.*

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Locating Locally Grown Food

Possible contamination of food supplies is a major concern in chemical exposure assessments. Aerial photography is very effective in identifying the location and distribution of agricultural crops and garden plots which have the potential for contamination in the geographical areas under study. For example, in connection with the nuclear power plant accident at Three Mile Island, all dairies in the area were rapidly located and inventoried according to the potential extent of contamination with the aid of aerial photographs. Aerial photointerpretation methods are also suitable for locating and categorizing small garden plots at risk from air emissions or along drainage routes from hazardous waste sites.

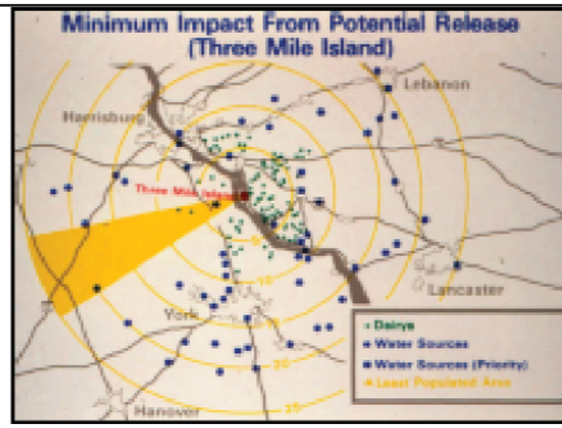

Figure 3. *Three Mile Island with nearby agricultural plots and an associated map (developed from an analysis of aerial photographs) showing the distribution of dairies, water sources and potentially impacted populated areas within a 25 mile radius of the facility.*

Characterizing Terrain Roughness

Because of the complexity of changing meteorological conditions, mathematical models of the air flow over an area are essential to determine the patterns of ambient pollution concentrations to which people are exposed. These models can provide the basis for determining the best location for air sampling stations.

An important input for such models is information that characterizes the roughness of the terrain over which air pollutants flow. This roughness is not only the natural contour of the earth, but includes man-made structures that extend upward from the surface of the earth into the normal air flow. Land use categories, determined from interpretation of aerial photographs, can be related to roughness given the characteristics of the specific geographical area (e.g., topography, height of forests, height and density of buildings). Figure 4 illustrates how an area is classified, using aerial photointerpretation methods, by land use categories.

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Figure 4. *A land use/land cover classification of an image produced through the aerial photointerpretation process. The classification system was developed by the USGS and is a hierarchical system. For example, in the photo above, the classification divides the landscape into categories such as: 13 (industrial); 21 (cropland and pasture); 24 (farmsteads and farm-related buildings); and 43 (mixed forest).*

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