A new study combines historical records with remote sensing and GIS technologies to estimate the risk to surrounding communities from crop spraying with pesticides.

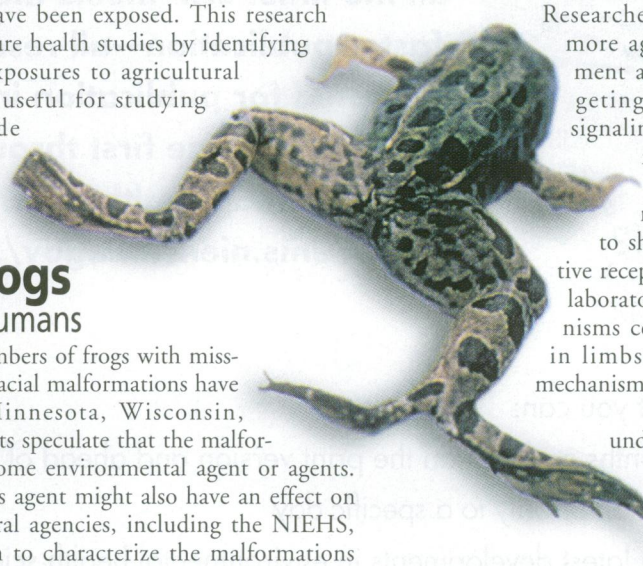
Using Landsat satellite images of vegetation, the researchers were able to classify the different types of crops that had been planted in a three-county area of south central Nebraska. A Landsat satellite sensor detects reflected energy in infrared, red, and green wavelengths. The relative reflected intensity of these wavelengths can be used to identify different types of vegetation. Checking the resulting patterns against historical crop maps that have been maintained by the Nebraska Farm Service Agency allowed the researchers to classify and validate the farm field cover as either corn, sorghum, soybeans, alfalfa, rangeland, or bare soil. In turn, this information, along with data about the type, timing, and quantity of pesticide most likely to have been applied to a particular crop and the proximity of residences to crop fields, was integrated by GIS software to create maps revealing probable exposure to agricultural pesticide spray over time.

The study showed that approximately 22% of the residents in this extensively farmed part of Nebraska lived within 500 meters of farm fields and may have been indirectly exposed to crop pesticides. In the study, 15% of residents of towns lived within 500 meters of the crop fields and so may have been exposed. This research should aid in the design of future health studies by identifying populations with potential exposures to agricultural pesticides. It should also be useful for studying factors affecting pesticide concentrations in house dust.

–W. Conard Holton

Malformed Frogs

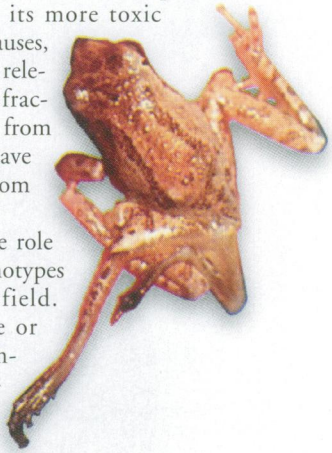
Making the Leap to Humans



Since the mid-1990s, large numbers of frogs with missing and extra limbs and craniofacial malformations have been found in ponds in Minnesota, Wisconsin, Vermont, and Canada. Scientists speculate that the malformations are being caused by some environmental agent or agents. There is some concern that this agent might also have an effect on human health. State and federal agencies, including the NIEHS, have been conducting research to characterize the malformations and determine their source. In December 1997, the NIEHS sponsored a workshop to present these findings and provide insight into problems and strategies applicable to continuing investigations. The findings are reviewed by James G. Burkhart and colleagues in this month's issue [*EHP* 108:83–90].

While a definite source for the malformations has yet to be identified, research has confirmed the existence of the problem and narrowed the field of likely candidates. Information gathered by the Minnesota Pollution Control Agency indicates that malformations among wild amphibians have increased dramatically at some locations over the last 3–5 years. Neither larval flukes nor bacteria appear to be responsible for the malformations. Data from wild frogs and from laboratory studies using the South African clawed frog, *Xenopus laevis*, indicate the involvement of waterborne agents.

No striking patterns of metal or chemical contamination have been found in water from affected sites sampled by the agency. Neither the insecticide methoprene nor its more toxic degradation products, suggested as possible causes, have been found at any sites in biologically relevant concentrations. However, teratogenic fractions have been identified in water sampled from the affected sites, and limb malformations have been induced in *Xenopus* using pond water from these sites.



Particular interest is being focused on the role of retinoids, which can induce all limb phenotypes observed in the malformed frogs in the field. Researchers suspect that one or more agents in the environment are in some way targeting a developmental signaling pathway that is retinoid-responsive.

However, efforts using different cloned retinoid receptor binding assays have failed to show any direct correlation between a positive receptor assay and malformation of wild and/or laboratory frogs. Further research on the mechanisms controlling growth and pattern formation in limbs is needed to identify any agents and mechanisms involved.

The authors indicate that a thorough understanding of the environmental chemistry and hydrogeology of the affected sites will be necessary to pinpoint a source of the malformations. They point out that environmental degradation of man-made compounds can lead to products with different, and often more toxic, characteristics than the parent compound. They suggest that researchers need to consider how the effects of man-made agents vary depending on the water matrix (alkalinity, hardness, pH, etc.) and on the naturally bioactive components found in the environment.

It remains unknown whether the malformations are in any way relevant to human health. To date, researchers have not found sufficient evidence to warrant an epidemiological study of human birth defects in the affected areas. Solving the complex mystery will require cooperation between state and federal agencies and collaboration among chemists, toxicologists, field and research biologists, and hydrogeologists. **–John S. Manuel**