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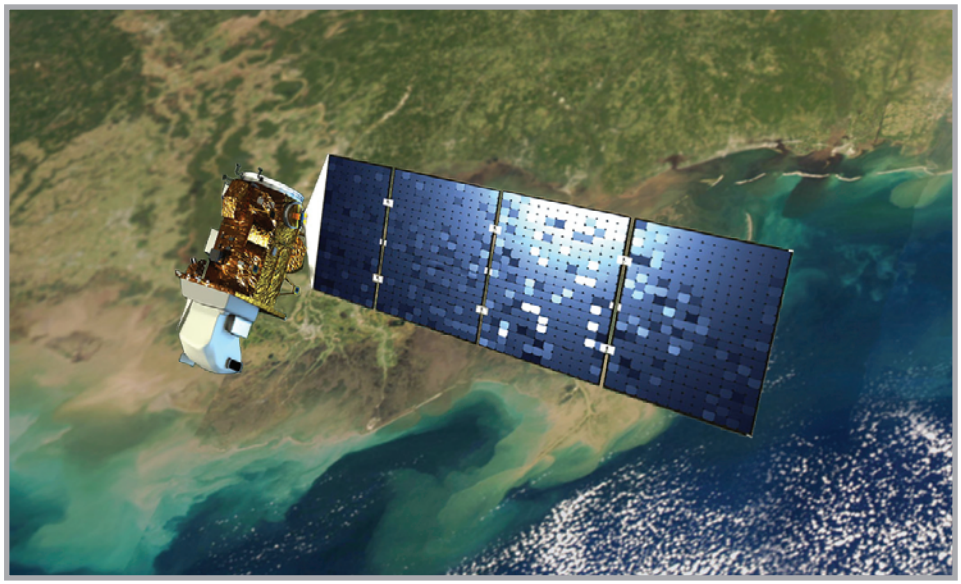
What is the Economic Value of Satellite Imagery?

Does remote-sensing information, such as that from Landsat and similar Earth-observing satellites, provide economic benefits to society, and can this value be estimated? Using satellite data for northeastern Iowa, U.S. Geological Survey scientists modeled the relations among land uses, agricultural production, and dynamic nitrate (NO_3^-) contamination of aquifers. They demonstrated that information from such modeling can allow more efficient management of agricultural production without sacrificing groundwater quality. Just for northeastern Iowa, the value of such remote-sensing information was shown to be as much as $858 million ± $197 million per year, which corresponds to a current value of $38.1 billion ± $8.8 billion for that flow of benefits into the foreseeable future.



This image shows the next satellite in the Landsat Program, the Landsat Data Continuity Mission, scheduled to launch in February 2013. The U.S. Geological Survey and NASA jointly manage the Landsat Program. Since 1972, Landsat satellites have collected information about Earth from space. This science, known as remote sensing, has matured with the Landsat Program and provides information crucial to evaluating the dynamic changes caused by both natural processes and human practices. (Modified NASA image.)

The value of remote-sensing information, such as that from Landsat and similar Earth-observing satellites, has been expressed in many different ways—advances in science, innovations in technology, and cost savings. Recently, in a case study in a 35-county region in northeastern Iowa, U.S. Geological Survey (USGS) scientists demonstrated that Landsat imagery and other moderate-resolution land-imagery (MRLI) would have significant economic value when used in combination with Earth-science information, such as environmental, geologic, and ground and surface water data, to monitor agricultural production and protect groundwater resources.

Landsat image within a 35-county region in Iowa studied by the U.S. Geological Survey. Acquired in 2007 at the peak of the U.S. midwestern growing season, this image shows healthy cropland (corn and soybeans) in greens, cleared and developed land in pinks, and water bodies (ponds and the Iowa River) in dark tones. Each pixel in the image covers an area of 30 by 30 meters of the ground. (USGS image.)

Agriculture and Groundwater Resources in Northeastern Iowa

Representative of many agricultural States in our Nation's heartland, Iowa produces significant crops of both corn and soybeans. Iowa also produces about 30 percent of the Nation's ethanol, much of which is generated from corn. Corn and other agricultural production often includes heavy application of nitrogenous fertilizer that can degrade groundwater quality. In Iowa, more than 80 percent of the population depends on groundwater for their drinking water. The northeastern Iowa study region includes more than 600 watersheds, more than 30,000 wells, and two primary aquifers.

USGS scientists modeled the relations among land uses, agricultural production, and dynamic nitrate (NO_3^-) contamination of aquifers in the northeastern Iowa study region. The USGS study sought to inform decisions about public health regulations by identifying changes in the distribution of agricultural production that would increase the value of crops without sacrificing groundwater quality. The analysis focused on the use of MRLI to balance the management of the production of corn and soybeans against the risk of exceeding the Environmental Protection Agency's maximum contaminant level of nitrate for potable groundwater resources.

The scientists used Earth observations and other scientific information in an integrated

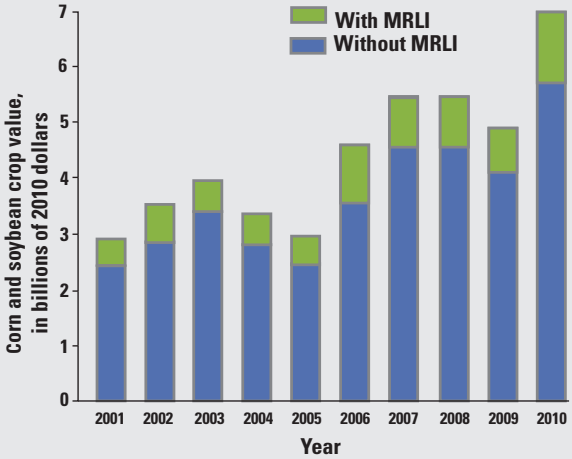
assessment approach to demonstrate the usefulness and relevance of MRLI and applied economic, agricultural production, hydrologic, hydrogeologic, and nitrogen loading and dynamics models to estimate a value of information (VOI) for MRLI. A VOI analysis is a comparison of what can be accomplished with higher quality information versus what can be accomplished without it. The integrated assessment approach uses MRLI as an improved, more comprehensive source of information for the land uses in a region. As its source of interpreted MRLI data, the USGS study used the Cropland Data Layer (CDL) classified by the National Agricultural Statistics Service, for the period 2001 to 2010.

The Value of Satellite Imagery

The results of the USGS study include (1) geospatial models that integrate remote sensing, hydrology, agricultural information, and other environmental science data to estimate levels of nitrate pollution, (2) estimates of the likelihood of the long-term survival of potable groundwater resources, and (3) VOI estimates for remote sensing from increasing the total value of the regional corn and soybean crops. The economic value of the MRLI (in 2010 dollars) used for the northeastern Iowa study region is estimated to be $858 million ± $197 million per year, which corresponds to a current value of $38.1 billion ± $8.8 billion for that flow of benefits into the foreseeable future. If such estimated benefits from the use of satellite imagery were to be expanded to the rest of the United States, the economic value to the Nation would be enormous.

Using cropland information derived from Landsat and similar Earth-observing satellites, U.S. Geological Survey scientists modeled the relations among land uses, agricultural production, and dynamic nitrate (NO_3^-) contamination of aquifers in northeastern Iowa. Corn is a primary crop of Iowa (USGS photo). Its production often includes heavy application of nitrogenous fertilizer that can affect groundwater quality. In Iowa, groundwater pumped from aquifers, and often stored in water towers (inset; Iowa Department of Natural Resources photo), is used as the source for drinking water by as many as 80 percent of residents.

In this case study, the U.S. Geological Survey demonstrated the economic value of remote-sensing data by using improved agricultural production and nitrate-leaching estimates made possible by Earth-observing satellites, such as Landsat. The USGS and NASA jointly manage the Landsat Program. The Landsat Data Continuity Mission, the next satellite in the Landsat Program, is scheduled to launch in February 2013. The research described here is only one example of the potential range of uses and values of the Landsat Data Continuity Mission and is one part of the USGS's mission to provide reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life.



Bar graph showing the annual flow of economic benefits (2001–2010) with and without the availability of moderate-resolution land imagery (MRLI) for the 35-county northeastern Iowa region used as a case study by the U.S. Geological Survey. For northeastern Iowa, the economic value of the MRLI (in 2010 dollars) used for the study is estimated to be $858 million ± $197 million per year, which corresponds to a current value of $38.1billion ± $8.8 billion for that flow of benefits into the foreseeable future.

Additional Reading

Forney, W.M., Raunikar, R.P., Bernknopf, R.L., and Mishra, S.K., 2012, An economic value of remote-sensing information—Application to agricultural production and maintaining groundwater quality: U.S. Geological Survey Professional Paper 1796, 60 p., available at http://pubs.usgs.gov/pp/1796/.

Miller, H.M., Sexton, N.R., Koontz, L., Loomis, J., Koontz, S.R., and Hermans, C., 2011, The users, uses, and value of Landsat and other moderate-resolution satellite imagery in the United States—Executive report: U.S. Geological Survey Open-File Report 2011–1031, 48 p., available at http://pubs.usgs.gov/of/2011/1031/.

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