

# The Value of Earth Observations: Methods and Findings on the Value of Landsat Imagery

## Introduction

The U.S. Geological Survey (USGS) provides a variety of Earth observation information to the public at no cost, such as data from the streamgage and Landsat programs. These data are used extensively in managing and monitoring natural resources, natural hazards, and the impacts of climate change. Given the budget difficulties and potential data gaps faced by Earth observing systems around the globe, understanding the socioeconomic and scientific value of these data will be useful to decision-makers for the next decade and more. Recent USGS research on Landsat data has advanced the literature in this area by using a variety of methods to estimate value.

Landsat satellite imagery has long been recognized as unique among remotely sensed data due to the combination of its extensive archive, global coverage, and relatively high spatial and temporal resolution. Since the imagery became downloadable at no cost in 2008, the number of users registered with USGS has increased tenfold to over 50,000 registered users while the number of scenes downloaded annually has increased over a hundredfold to over 5 million scenes. It is clear that the imagery is being used extensively, and understanding the benefits provided by open access to the imagery can help inform decisions involving its provision.

However, the value of Landsat imagery is difficult to measure for a variety of reasons, one of which stems from the fact that the imagery has characteristics of a public good and does not have a direct market price to reflect its value to society. Further, there is not a clear understanding of the full range of users of the imagery, as well as how these users are distributed across the many different end uses this data is applied to.

Three approaches were used to explore the value of Landsat imagery:

1. Online survey of Landsat users registered with USGS,
2. Case studies of the application of Landsat in water resources, and
3. A requirements assessment to identify operational or decision-supportive uses of Landsat.

Sarah Ryker  
 sryker@usgs.gov  
 Acting Associate Director  
 Climate and Land Use Change  
 Reston, VA

Timothy Newman  
 tnewman@usgs.gov  
 Program Coordinator  
 Land Remote Sensing  
 Reston, VA

Holly Miller  
 millerh@usgs.gov  
 Social Scientist  
 Policy Analysis and Science Assistance  
 Fort Collins, CO

U.S. Department of the Interior  
 U.S. Geological Survey

## Survey of Landsat Users

More than 11,000 current Landsat users responded to a survey in 2012. The contingent valuation method was used to estimate the benefits to users. This approach is recommended to measure the value of non-market goods such as Landsat. The users were categorized into established (41%) and new/returning (59%) users based on their use of Landsat before it became available at no cost. **The annual economic benefit from Landsat imagery obtained from EROS in 2011 was just over \$1.79 billion for U.S. users.** This estimate does not represent the entire societal benefit from Landsat imagery because it accounts only for the benefits received by direct users (that is, those that download scenes directly from USGS). Any benefits users receive from derived or value-added products that include Landsat imagery were not estimated. The full contingent valuation results, along with information about the users and uses of Landsat imagery are available in the full report (Miller and others, 2013, <http://pubs.usgs.gov/of/2013/1269/>).

Table 1. Annual aggregate economic benefits to U.S. Landsat users registered with the U.S. Geological Survey from Landsat imagery distributed by the Earth Resources Observation and Science (EROS) Center in 2011.

Landsat user group	Number of scenes obtained in 2011 from EROS	Average economic benefit per scene	Annual economic benefit
Established	1,687,600	\$912	\$1,539,090,755
New/returning	692,508	\$367	\$254,150,615
<b>U.S. total</b>	<b>2,380,108</b>		<b>\$1,793,241,370</b>

## Requirements Assessment

In 2012, under direction of the White House Office of Science and Technology Policy (OSTP), a National Earth Observation Task Force conducted an assessment of 362 Earth Observation systems (space, air, land, and sea platforms) with regard to their contributions within a framework of 13 societal-benefit areas. Among 132 satellite systems considered, Landsat ranked second highest in impact, surpassed only by the Global Positioning System. Findings from this assessment informed the forthcoming National Plan for Civil Earth Observations, which is due for release soon from OSTP.

In a related 2013 effort, a USGS National Land Imaging Requirements Pilot Project elicited 151 distinct, representative Federal-agency applications where Landsat data are used routinely to produce consistent services or information products. The study identified operational or decision-supportive uses of Landsat in a broader variety of fields than was previously recognized. The associated USGS report (Vadnais and Stensaas, 2014, <http://dx.doi.org/10.3133/ofr20141107>) highlights key requirements such as the need for an 8-day (or fewer) satellite site-revisit cycle, 30-meter pixel resolution, and simultaneous Visible to Short Wavelength InfraRed (VSWIR) and thermal measurements. For example, the assessment found that 60% of elicited threshold user requirements call for 8-day or more frequent revisit.

## Case Studies

In 2013, more than 20 case studies focused on the applications of Landsat imagery in water resources were conducted to shed more light on the benefits accrued from the imagery and to gain a better understanding of the program's value to water resources users. The case studies tell a more qualitative story of how Landsat imagery is used and what its value is to different private and public entities. A few case study findings are outlined below.

### Private Sector

E. & J. Gallo, the largest winery in the world, is **using Landsat imagery during the growing season to improve yield and grape quality while decreasing the amount of water applied by 20-30%**, depending on the region. The improvements in grape quality have led to increases in wine prices and, in turn, to an increase in revenue.

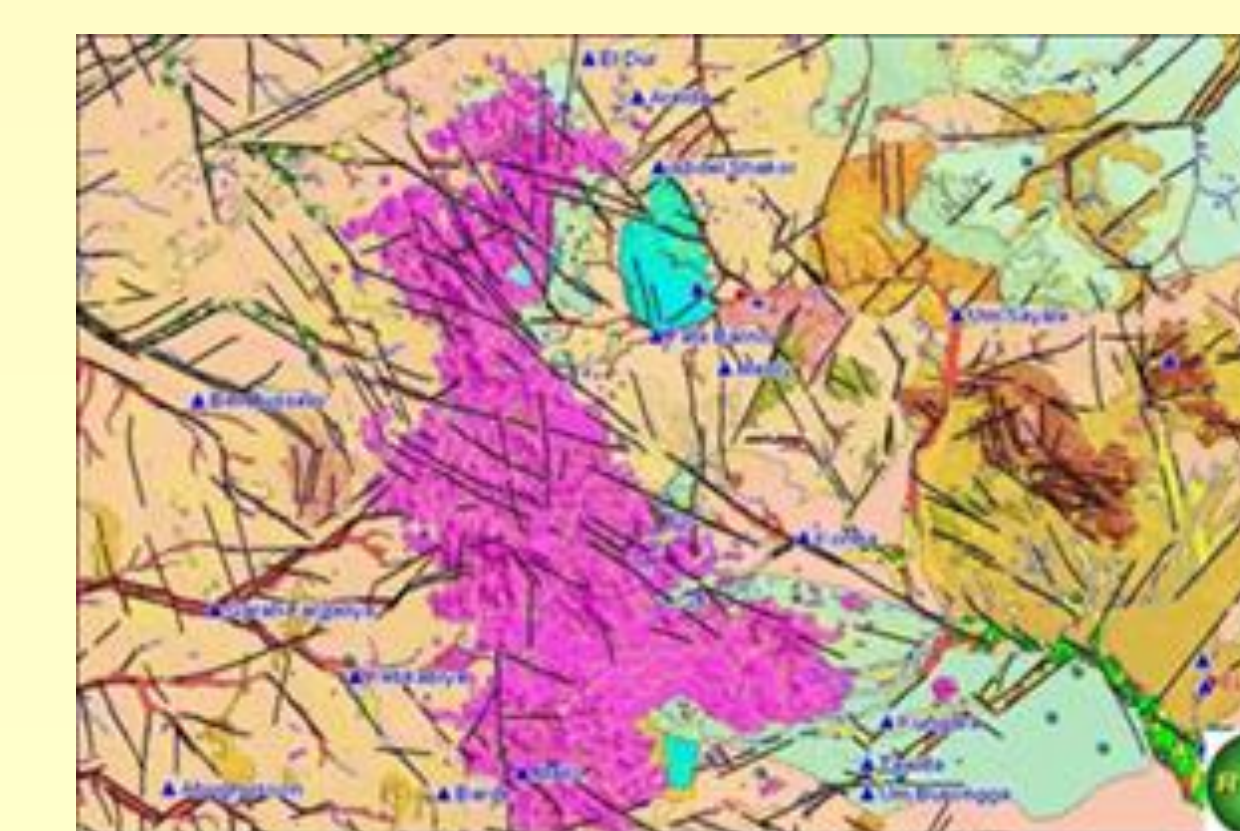
### State Government

The State of Wyoming is using Landsat imagery in the METRIC model to assess evapotranspiration so they can more efficiently meet their annual consumptive use reporting requirements under the Upper Colorado River Basin Compact. **The use of Landsat and METRIC has yielded consistent savings from a third to as much as one half of the total costs compared to on-the-ground methods.**

### Humanitarian Aid

Amid the Darfur Crisis in 2004, more than 250,000 Sudanese refugees were forced to relocate to camps in the desert landscape of eastern Chad. Many refugee camps did not have access to water on site. Every passing day without an adequate supply of water meant the loss of 200 children's lives in the camps and water trucking cost millions of U.S. dollars per day. **Radar Technologies International used Landsat imagery in their WATEX System to help identify and drill 1,800 water wells, with a drilling success rate of 98 percent, contributing to the survival of hundreds of thousands of people.**

Figure 1. Potential water drilling sites map for West Darfur, Sudan, produced by WATEX (left) and a successful water well in Wadi Gaga Campsite, Eastern Ouaddai, Chad (right).



## Conclusions

Though valuing a public good such as Landsat imagery can be difficult, using a variety of methods provides different types of valuations. The valuations can then be tailored for use in varying policy situations with different audiences. The approaches used for valuing Landsat imagery can also be used to estimate the value of other Earth observations and information with public good characteristics. While determining the full value of Landsat imagery and similar data sources may not be possible, the use of multiple valuation approaches can provide ample evidence of the benefits accrued from such information.