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What a sensor sees

Center for Biodiversity and Conservation

Biodiversity Informatics Facility

The mission of the Biodiversity Informatics Facility is to be a leader in the development, application, and promotion of rigorous biodiversity informatics methods and tools to provide new insights in conservation, ecology, and evolution.

The Biodiversity Informatics Facility applies information technologies to collect, organize and analyze biological and environmental data from expeditions, remote sensing, natural history collections, modeling and databases. Through research that applies cutting-edge spatial analysis technologies, we aim to discover new insights and develop new methods in ecology, evolution and conservation biology. Through training initiatives and the development and distribution of software and scripts, we aim to strengthen the capacity of students, educators, researchers, conservation practitioners, and the broader public to study and better understand biodiversity.

How to cite this document:
Author(s). Year. Title. Version. American Museum of Natural History, Center for Biodiversity and Conservation. Available from http://biodiversityinformatics.amnh.org. (accessed on date)

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When we look at an image it is easy to assume that each pixel is simply an average of the reflected energy within a square corresponding to a pixel in the image. This is not the case. First of all, the detectors in a sensor are more sensitive to light in the center of the detector than toward the edge of the field-of-view (what the detector "sees"). This change in sensitivity across a detector is roughly Gaussian in nature. This means the features in the center of the field-of-view contribute much more to the pixel value than pixels toward the edge. Also, although pixels typically appear square in an image the light recorded to determine the digital number of a pixel comes from a circular (or elliptical if the sensor is not looking straight down) area that covers roughly twice the surface area of the area covered by the pixel in the image. In other words, land cover in adjacent pixels can have an influence on a pixel's value and distribution of features within the detectors field-of-view will affect the value of a pixel.

To illustrate these effects, we use two synthetic images and two high resolution satellite images. In the figures below, the green circle represents the approximate field-of-view of a detector and the green box represents a 30m pixel (size of Landsat pixel) projected on the ground. The two boxes to the right of the image show what an actual Landsat pixel looks like (top box) and what the pixel would look like if the area within the square was averaged (bottom box). The pixel value (digital number) for each representation is under each box.

We would like to thank James C. Storey from Science Applications International Corporation, contractor to the U.S. Geological Survey for providing us with Landsat sensor response data that was used to calculate the pixel values for the near-Gaussian response above.

30 meter pixel value using the near-Gaussian response of the detector

Pixel value based on the mean reflectance within a 30 meter square

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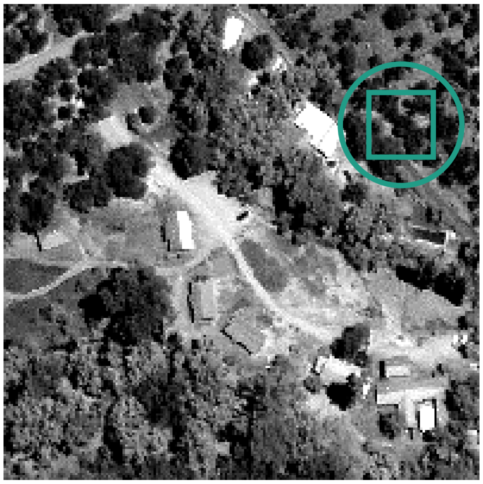
30 meter pixel value using the near-Gaussian response of the detector

Pixel value based on the mean reflectance within a 30 meter square

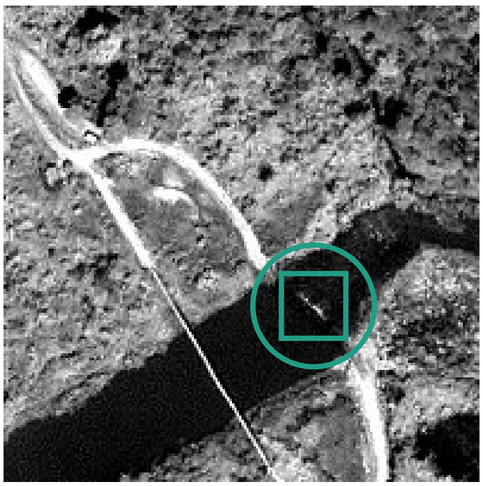


52

30 meter pixel value using the near-Gaussian response of the detector

46

Pixel value based on the mean reflectance within a 30 meter square



24

30 meter pixel value using the near-Gaussian response of the detector

20

Pixel value based on the mean reflectance within a 30 meter square