



MEASURING COMMODITIES OPEN GRAIN STORAGE

USING SATELLITE TECHNOLOGY TO MEASURE STORAGE OF COMMODITIES

Understanding and predicting commodity supply requires a wide variety of data points and an understanding of what is stored and where.

Using satellite data it is possible to monitor the location and volume of a given commodity, for example, grain, along with the intensity of delivery vehicles going to and from storage depots.

Combining optical images, physics and a little trigonometry it is possible to accurately calculate the size of grain stores.



“

Combining optical images with a little textbook trigonometry, it is possible to calculate the volume of stored grain

”

In countries with the appropriate climate, grains such as wheat can be stored outside in open warehouses. Countries like UAE, Saudi Arabia and many in Africa often use open warehouses.

These warehouses are ideal candidates for surveillance by satellites. However, a simple picture of the grain does not tell the full story, nor does it provide the level of detail required. To calculate volumes of grain requires the right satellites, with the right imagery and the right trig function!

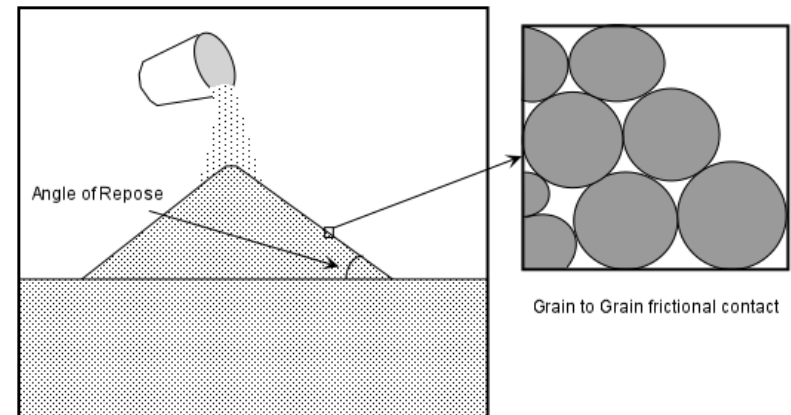
UNDERSTANDING GRAIN STORAGE

Grain is put into a storage pile at a warehouse either by movable elevators or by catapulting it in. As the grain is added a natural slope will form - known as an '**angle of repose**'.

This angle is determined by the friction between individual grains and varies with the structure and size of different grains - there are databases of this information available.



Knowing the angle of repose and length of the storage pile means that accurate estimates of the volume of grains can be made.



CALCULATING VOLUME

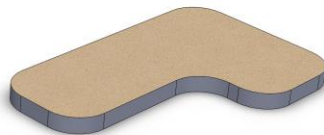
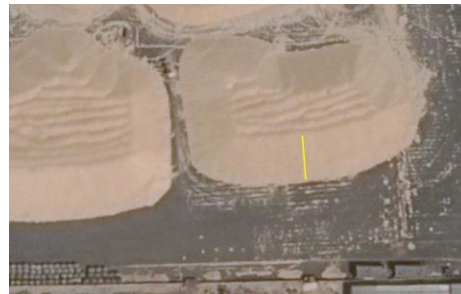
To calculate the volume of grains stored requires the following steps

1. Acquire current image
2. Calculate the area of each pile
3. Calculate the height of pile
4. Multiple the area by the height to get volume
5. Correct volume - allowing for the slope

Step 2



Step 3



Step 4



Step 5

CALCULATING HEIGHT

Calculating the height of the pile is done by trigonometry.

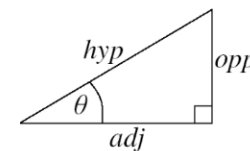
- Measure projected slope in image (Step 3)
 - 20m in this instance
- Estimate the angle of response
 - 25° based on the standard tables
- Trigonometry to calculate height
 - 9.3m

Seeds

Barley (cv. 'Bedford')
 Durum wheat (cv. 'Wakoma')
 Oats (cv. 'Harmon')
 Rye (cv. 'Gazelle')
 Rapeseed (cv. 'Candle')
 Sunflower (cv. 'Sundak')
 Soybean (cv. 'McCall')
 Triticale (cv. 'Carman')
 Wheat (cv. 'Neepawa')
 Fababeans (cv. 'Ackerperle')

Repose Angle

24
 24
 28
 25
 24
 21
 —
 23
 26
 29



$$\tan(\theta) = \frac{opp}{adj}$$



Heimdal Satellite Technologies

CONTACT

Filipstad Brygge 1
0252 Oslo
Norway

Oslo: +47 21 08 49 01

London: +44 (0) 20 3885 0850

Email: info@hsat.space

Website: hsat.space

