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AGRICULTURAL PARCELS MEASUREMENT ON VHR SAR IMAGES

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OBJECTIVE & SCOPE

The main objective of this study was identifying agricultural parcels on VHR SAR images and assessing the area measurement accuracy regarding different image parameters like resolution, polarization, orbit direction, etc. The set of TerraSAR-X: Spot Light (SL) and Strip Map (SM) images in various polarization modes and CosmoSkyMed Spot Light (1m) in singular polarization were acquired under different incidence angle and orbit direction over test site in South France. Data provided for testing covered the spring and summer season from March to July 2008. The identified on the digital orthophotos (ADS40) parcels established the set of 42 parcels which was examined on the VHR SAR data. Three operators measured each parcel 3 times on radar images and digital orthophoto independently. The detection of anomalous measurements (outliers) was made within each group of observations (i.e. parcels) using the Grubbs and Cochran tests. Then, for each parcel the variance of measurements translated into a perimeter based buffer was estimated on each type of image separately. Furthermore, the scrutiny of eliminated outliers to exam the reason of gross mistakes was undertaken. The results indicate that firstly all parcels were recognizable on the X-band SAR data. Secondly average buffers of 2.26m, 1.99m and 1.17m were found on SM multiband (GSD 6m), SL multiband (GSD 2m) and SL monoband (GSD 1m) SAR data respectively. Finally, the reproducibility limits which gave the accepted difference between two operators when measuring the same parcel were calculated making possible comparison with other sensors like digital aerial orthophoto in this study. For aerial orthophoto this value reached 0.81m, for Spot Light mode from 2.89m to 6.71m depending on additional parameters and 6.36m for Strip Map image. The new SAR sensors as TerraSAR-X or Cosmoskymed involved different approach to agricultural lands photointerpretation than the usual techniques applied on optical images. The same objects appear in different manner depending on SAR image parameters therefore some examples are presented on this poster.

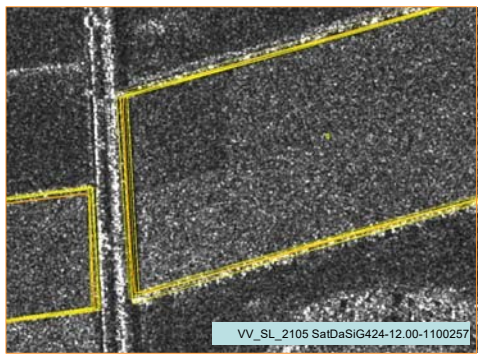
DATA

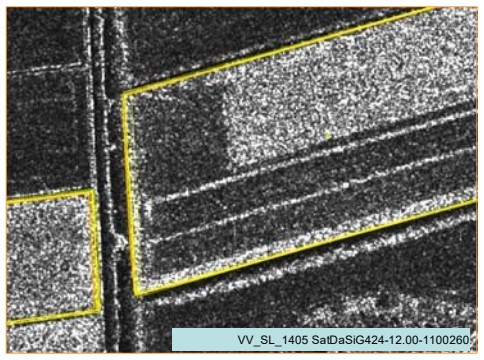
VHR X band SAR programmed data over agricultural test sites in South France: 1 st site (42 parcels) was covered with SpotLight mode data (4 TerraSAR, 2 Cosmo), 2 nd site (79 parcels) was covered with StripMap colour comp (1 image of TerraSAR). Reference areas & perimeters were derived from orthophoto (ADS40, 0.5m GSD) acquired in May 2003. All TerraSAR-X data were processed and provided by Infoterra GmbH and CosmoSkyMed data by Agenzia Spaziale Italiana.

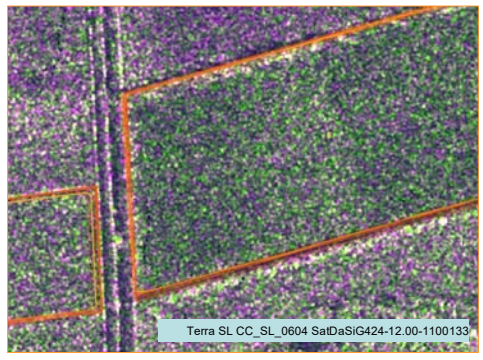
EXAMPLES OF THE MEASURED PARCELS

Ascending orbit, Shallow angle | Descending orbit, Steep angle | Descending orbit, Shallow angle

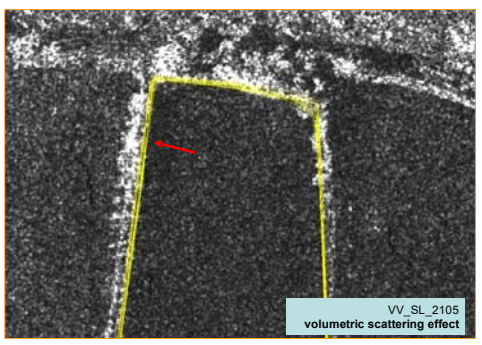
GREEN COVER Harvest

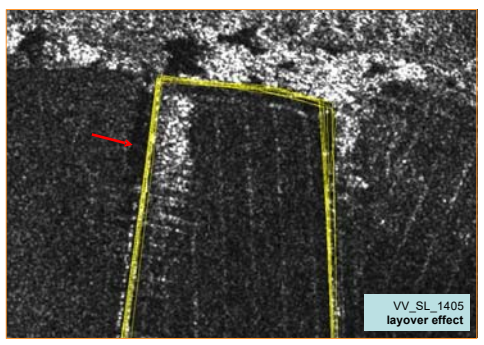


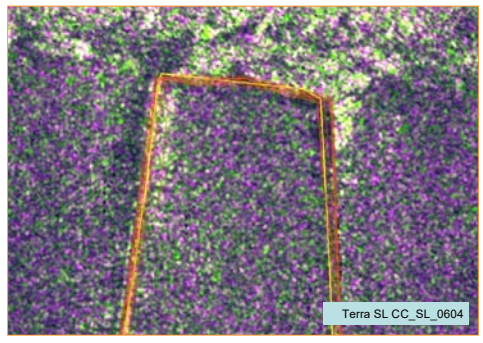




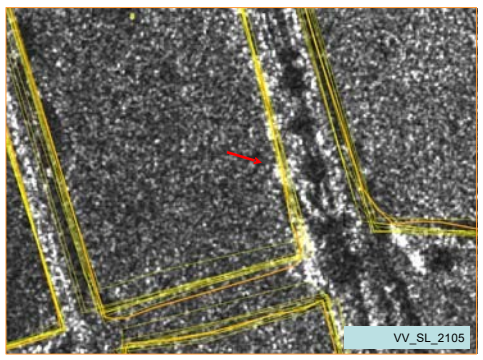
TREES Layover

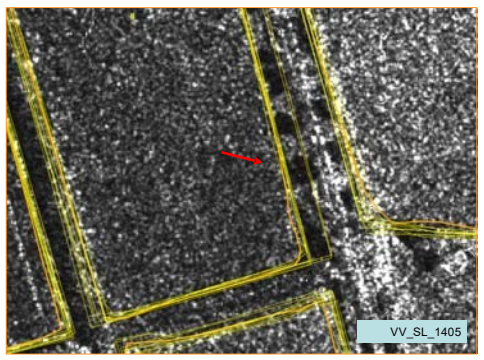


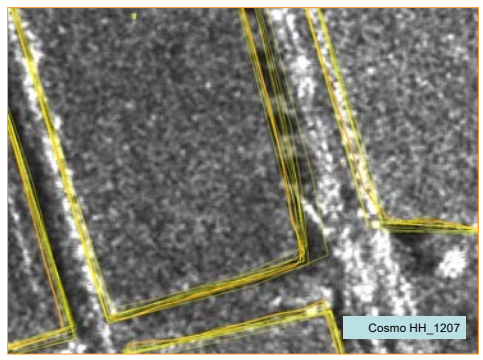




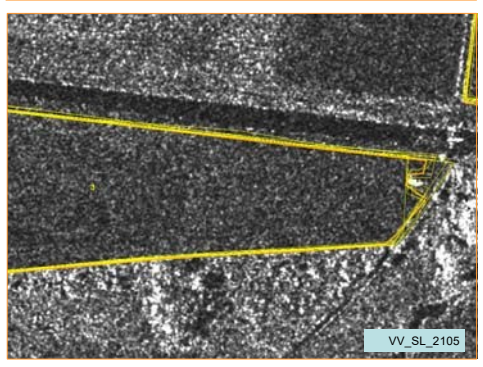
BARE SOIL Shadow

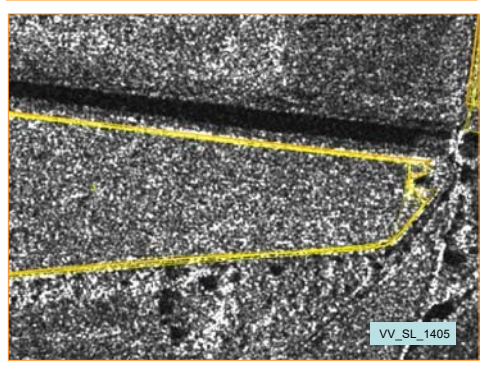


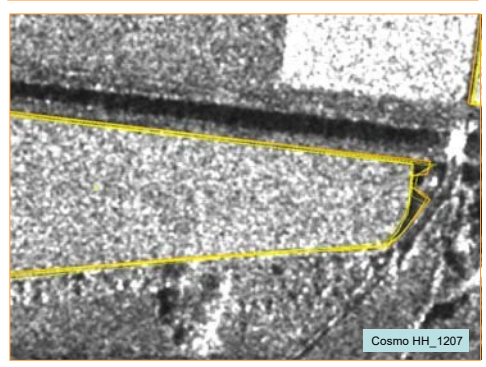




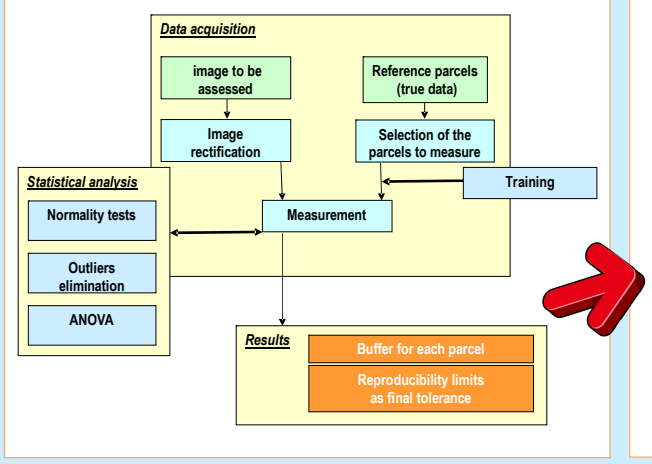
BUILDINGS Displacement







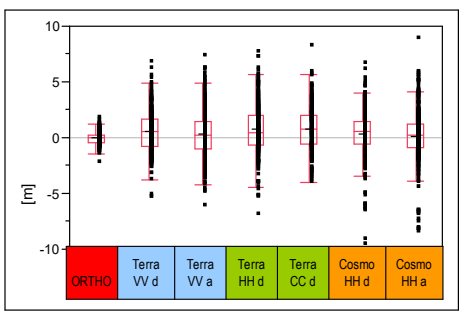
SCHEME OF VALIDATION PROCEDURE

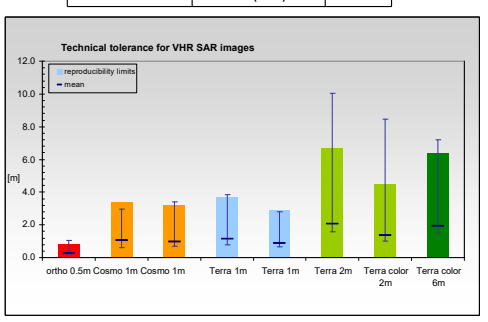


STATISTICAL ANALYSIS OF THE BUFFER VALUE

1. Anomalous of the measurements detection and outliers elimination
2. Analysis of variance (ANOVA)
3. Determination of tolerance for the measurements as reproducibility limits

image	No of outliers	%
Terra_1m	8 (378)	2%
Terra_1m	11 (378)	3%
Terra_2m	11 (378)	3%
Terra_CC_2m	7 (378)	2%
Cosmo_1m	21 (378)	6%
Cosmo_1m	27 (378)	7%
SM_CC_6m	59 (711)	8%
total	144 (2979)	5%





CONCLUSIONS

- 100% of the parcels are mutually recognised on both orthophoto and VHR SAR data
- ¾ 144 outliers out of almost 3000 observations (5%)
- ¾ The same tolerance for both sensors TerraSAR-X and CosmoSkyMed
- ¾ Estimated tolerances: ~3m on HSL (1m), ~6,7m on SL (2m) are higher than the maximum 1.5m requested by the actual EU regulation
- ¾ Compensative effect of multipolarized information on lower resolution ~4,5m on colour SL (2m) and ~6,4m on colour SM (3m) image
- ¾ Significant effects on buffer variability: incidence angle and orbit direction, no effect of polarization

DISCUSSION

- ¾Photointerpretation on VHR SAR more difficult than on optical images
  - Advanced training on radar image nature
  - Photointerpretation guidelines are necessary
- ¾ Main problems not with parcels recognition but with border delineation
  - Difficulties with features recognition
  - Features interpretation relating on image parameters
- ¾ To achieve less variation and less overestimation the images acquired under the shallow incidence angle and ascending direction are recommended
- ¾With regard to reproducibility limits the SAR tested images can be considered as secondary solution for CwRS in accordance with European CAP requirements

Designed by Joanna Pluto-Kossakowska

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Basis of SAR interpretation

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Backscatter coefficients

- Very high (above -5dB)
  - Man-made objects
  - Terrain slopes towards radar
  - Very rough surface
- High (-10 to 0dB)
  - Rough surface
  - Dense vegetation (forest)
- Moderate (-20 to -10dB)
  - Medium level of veg
  - Agricultural crops
  - Moderately rough surface
- Low (below -20dB)
  - Smooth surface
  - Calm water, road
  - Very dry terrain (sand)

Slant-range distortion

Layover

Extreme form of elevation displacement or foreshortening in which the top of a reflecting object (such as buildings or trees) is closer to the radar (in slant range) than are the lower parts of the object. The image of such a feature appears to have fallen over towards the radar. Also defined as the displacement of the top of an elevated feature with respect to its base on the radar image. The effect is more pronounced for radars having smaller incidence angle.

Foreshortening

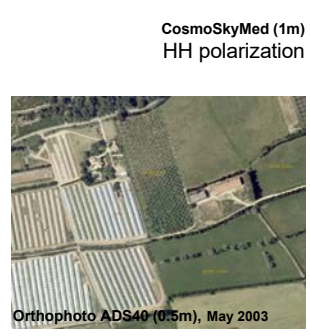
Occurs when the radar beam reaches the base of a tall feature tilted towards the radar (e.g. a mountain) before it reaches the top. Because the radar measures distance in slant-range, the slope (a to b) will appear compressed and the length of the slope will be represented incorrectly (a' to b') at the image plane.

Shadowing effect

increases with greater incident angle θ, just as our shadows lengthen as the sun sets.

Incidence Angle - is the angle defined by the incident radar beam and the vertical (normal) to the intercepting surface. In general, reflectivity from distributed scatterers decreases with increasing incidence angle.

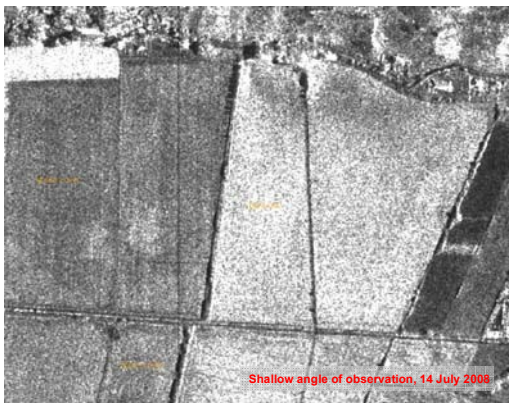
Sources:
http://www.radartutorial.eu
http://envisat.esa.int/instruments/asar/
http://www.radarsat2.info/

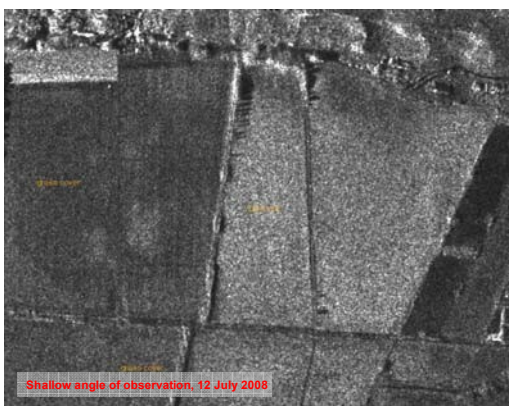


Ascending pass

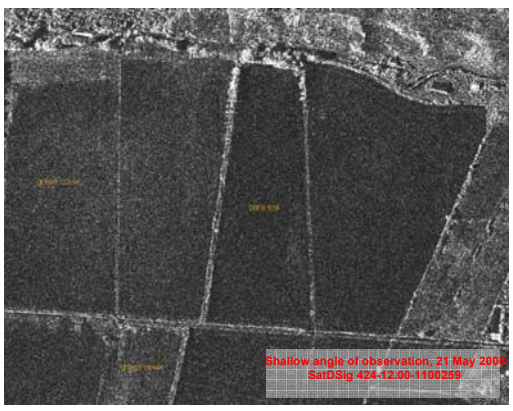
Descending pass

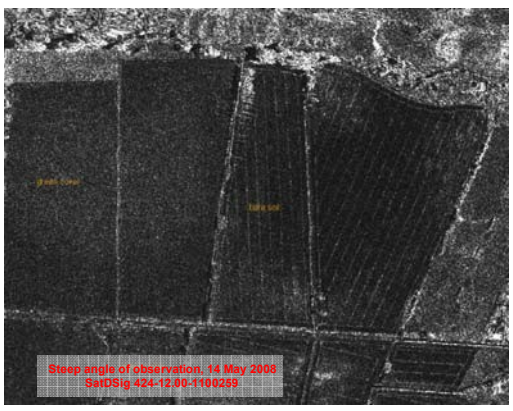
CosmoSkyMed (1m)
HH polarization





TerraSAR-X (1m)
VV polarization





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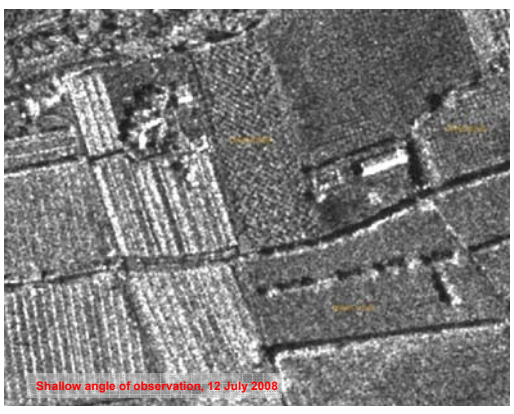

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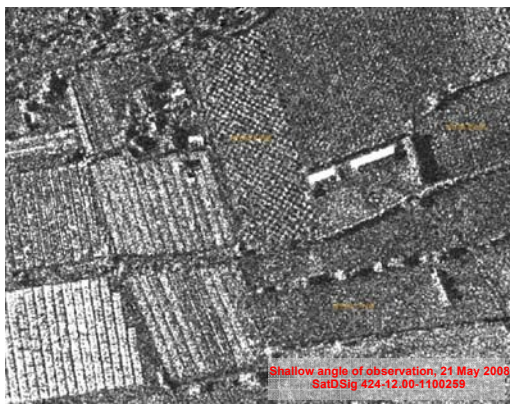
VV polarization



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