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Earth Remote Sensing Data Analysis Center
ERSDAC

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CONTENTS OF STUDY

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- MEASUREMENT OF GROUND DEFORMATION USING INSAR and GPS
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 - Obtaining subsidence effects in Kozlu using InSAR and GPS techniques
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- CONCLUSIONS AND FURTHER WORKS

OBJECTIVES OF STUDY

Underground mining causes subsidence effect on the earth surface. It is possible to monitor this effect by geodetic surveying methods.

However, these methods have some difficulties to apply in places where topography is hilly or forestry or dense urbanization is available.

These difficulties can be overcome using InSAR technique to monitor subsidence effects. In order to study the performance of InSAR on determining subsidence effects, an investigation has been carried out in Kozlu region of Zonguldak Hardcoal Basin, Turkey.

Using JERS-1/SAR and RADARSAT images subsidence areas and amounts have been determined. These results obtained from InSAR have been compared those obtained from GPS observations of a geodetic control points established in the region.

TEST AREA FOR THIS STUDY

3-D model derived ASTER image for test area

In Zonguldak Hardcoal Basin (ZHB), production activities have been continued since the year of 1848.

Up to now the raw coal about 400 million ton has been extracted from the basin which has the area of 15000 km² whose 3000 km² is under the sea.

In this basin, the coal seams are limited to the upper carbonifer layers. These layers, whose total thickness changes between 600-800 m, have a very complex geological structure.

The coal production in the region has been carried out in the production panels with different geometrical pattern and different height, using different production techniques.

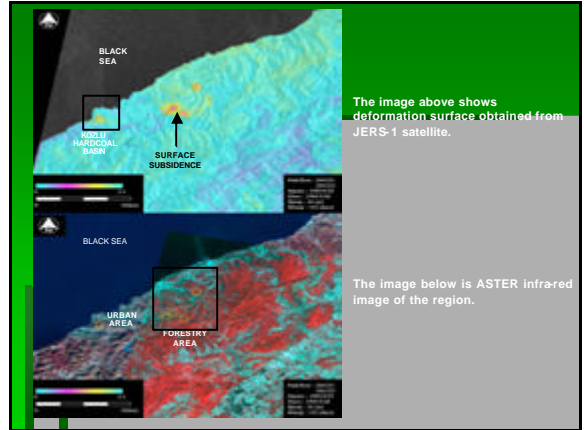
Kozlu region treated in this study is one of the oldest production areas of the basin.

MEASUREMENT OF GROUND DEFORMATION USING INSAR and GPS

At the beginning of this study, a deformation map is formed by differential application of two different images in 1995 taken from JERS-1/SAR satellite.

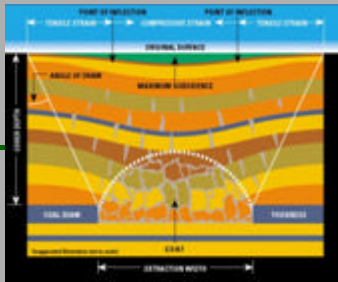
In this map five deformation zones have been detected. The four of these zones are in the forestry area which is not appropriate to apply GPS observation technique.

The only urban area which the subsidence is observed is related to the Kozlu region. In this area a GPS network has been established to confirm the deformations detected by InSAR technique.

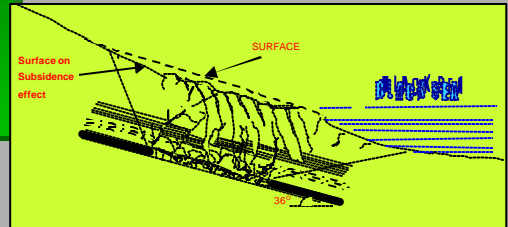


WHAT IS MINE SUBSIDENCE?

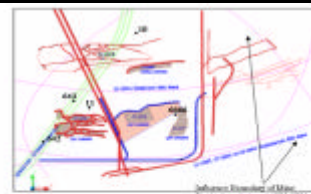
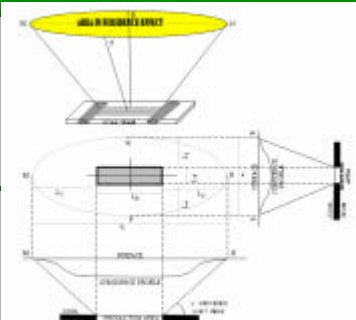
Subsidence can be described as the lowering or settling down of the land's surface. When mining takes place, the earth's forces are redistributed and there is a tendency for the void to close. Some of this effect may be transferred to the surface as mine subsidence. The extent to which subsidence occurs in a particular location depends upon the width and height of the coal extracted, its depth from the surface, and the rock types found in the overlying strata.



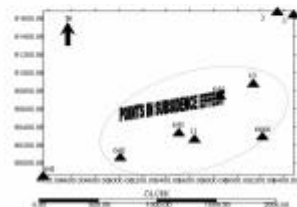
When the subsidence mechanism in the region is investigated it is observed two constitutions in the direction of and the perpendicular direction to the production. It is known that this mechanism is induced by the constant factors relating to geological structure and the variable factors relating to the geometry of production area.



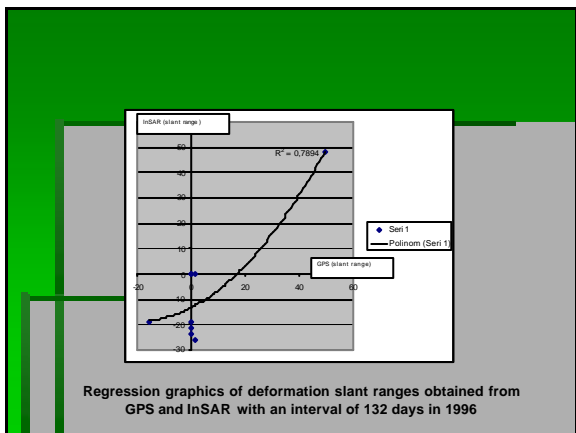
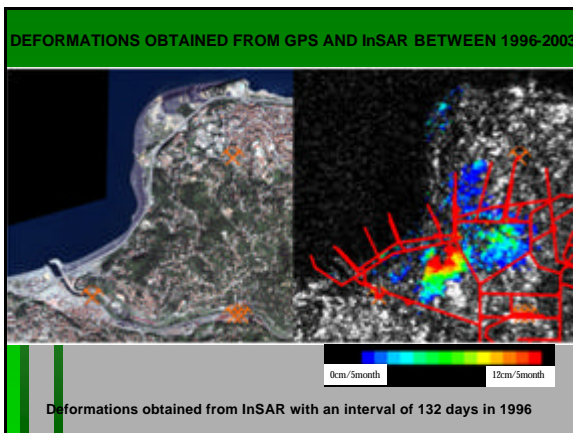
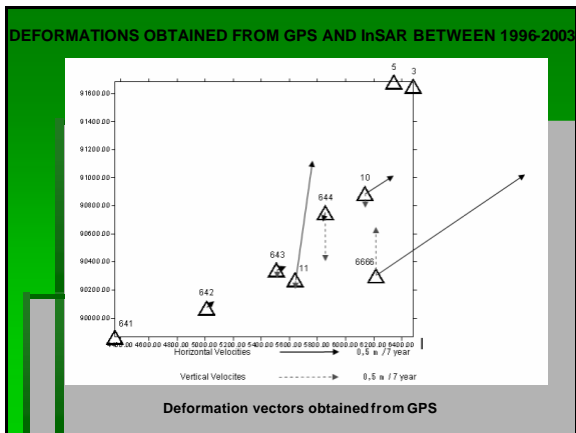
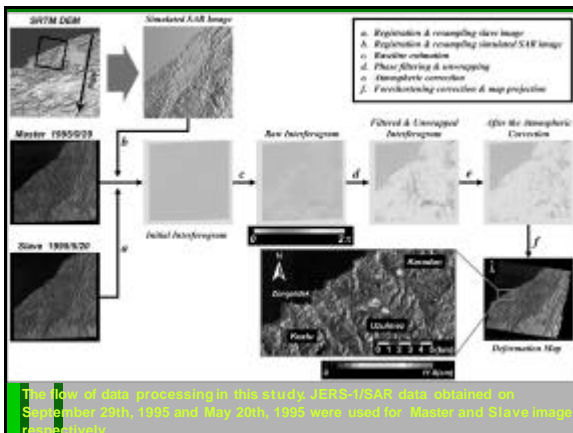
For GPS and InSAR observations, determining the area which subsidence affects on the earth surface is an important issue. The effect area on the earth surface can be determined when the dimensional parameters of the panel constituted in the gallery mined, i.e. width and length of the panel, thickness of the gallery, and lower and upper heights of the panel, are known.



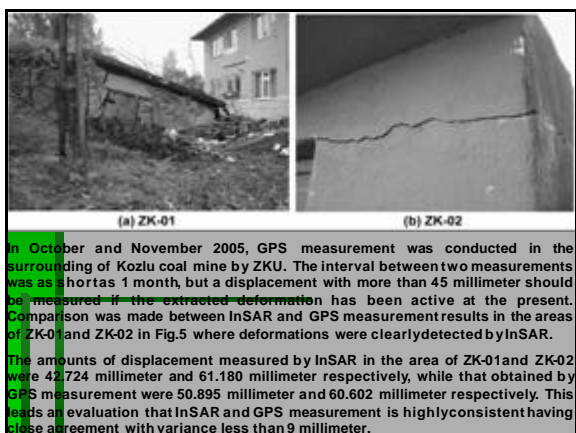
Effect areas of coal seams in the test region

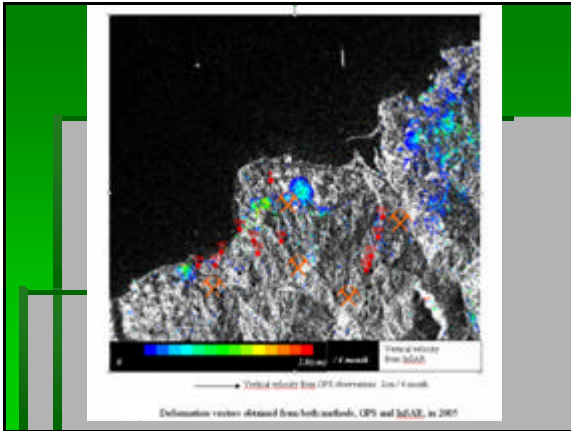


GPS Control points used between 1995 and 2003 in the test region



DEFORMATIONS OBTAINED FROM GPS AND InSAR AFTER 2005





CONCLUSIONS AND FURTHER WORKS

In this study, the subsidence effects on Kozlu region in ZHB which happen between 1996-2003 and between 2005-2006 have been investigated using GPS and InSAR techniques. In conclusion, the followings have been obtained:

1. JERS-1/SAT and RADARSAT have been provided consistent results with GPS. In this way, spatial and temporal details have been possible to produce in Kozlu region.
2. In the same parallel with GPS, differential InSAR analyses have been provided to monitor the deformation in short periods such as 0-5 month
3. Subsidence effects in places where GPS method can not be applied have been successfully determined by InSAR
4. Subsidence effects in places where GPS method can not be applied have been successfully determined by InSAR. As for the accuracy of measurement, InSAR results correspond to the GPS measurement data within 9 millimeter variance. This proved that InSAR provides highly accurate variation measurement with less than 8% of phase (1cm). From the results described above, ground deformation has been taking place in Kozlu coalfield even after 1995.

5. In the future, real-time ground deformation measurement will take over this study by using PLASAR (Phased Array type L-band Synthetic Aperture Radar) loaded on ALOS (Advanced Land Observing Satellite), which was launched in January 2006. In addition, this study will develop to 3D deformation measurement, which integrates complementarily GPS measurement, leveling and multiple spaceborne SAR data.

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WOULD LIKE TO EXPRESS MY
SPECIAL THANKS TO ALL AUDIENCE
FOR YOUR ATTENTION.