Detail Submission Information

**Dragon Project**

ID 2563
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Title Agriculture and Land Use : ENVISAT applications in Fujian Province
Type The Dragon Project
Class Peer Review
Cost Reproduction costs
Primary Application Domain Renewable Resources
Location China

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**Team Composition, Experience, Innovation and Contribution**

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The team consists of European and Chinese specialists of radar remote sensing, agriculture monitoring using remote sensing and GIS, mapping of land use land cover. The team has long experience in the following topics related to the project:
- co-ordination of international projects,
- analysis of SAR data,
- in-situ experiments in agriculture monitoring,
- physical modelling of radar backscatter from land surfaces,
- development of pre-operational software for SAR data,
- development of pre-operational use of remote sensing and GIS in agriculture and land use monitoring

Experience

Cl. Annex: Background experience of the team members
1. New methodology development for land use and crop discrimination and classification based on
   - multi-temporal, dual polarisation ASAR data,
   - multi-scale approach at local and province scale (High resolution ASAR to Wide Swath ASAR and full resolution MERIS),
   - links with other Dragon application projects on rice, forest, drought etc..
2. Research on the retrieval of crop biophysical parameters and on their use in crop monitoring programme,
3. Assessment of decadal change in land cover/use by combining AASAR with ERS (and possibly other sensors).
4. Complementing the existing SARTOOLS with adapted pre-processing and processing methods for large area applications

Contribution

The project aims at stimulating enlarged exploitation of ESA missions within China and fostering increased scientific cooperation between Europe and China.

Executive Summary and Schedule

1. Objectives of the project:
   To develop and validate methodology using ENVISAT data for three main issues:
   1.1 Land use, land cover classification, with emphasis on agriculture and forestry, in interaction with the related Dragon application projects.
   1.2 Agricultural monitoring by retrieving crop and soil biophysical parameters.
   1.3 Land use, land cover changes using historical and/or archived ERS data.

2. Research content
   2.1 Methodology research
   Land use, land cover and crop classification using ENVISAT SAR
   - To investigate novel methods exploiting the new features of ENVISAT ASAR in land use, land
cover and crop classification: multitemporal dual-polarisation, multi-incidence,
- To investigate scaling approach for regional mapping from high resolution (ASAR Narrow Swath) to medium resolution data (ASAR Wide Swath)

Vegetation monitoring
- To investigate retrieval of surface parameters from ENVISAT data (soil moisture from ASAR WS, crop biomass from ASAR NS, LAI and IPAR from MERIS data).

Executive Summary

2.2. Application projects at Fujian
- Land use change monitoring
- Forest monitoring
- Productivity estimation

Estimation of Net Primary Productivity of the region.
Contributing to the Dragon rice project by using crop growth models for rice yield prediction.

2004:
April 2004: KO
April-December: Acquisition of ENVISAT data (ASAR, MERIS) on the test region
Ground data collection on test sites
July-December: Data analysis.

2005
Jan-December: Data analysis, Methodology development and Applications.

2006
Jan-April: Acquisition of ENVISAT data
December: Interim Report

2007
Jan-April: Writing of reports and publications
April: Final report

Detailed Description

General information on the Fujian area
1. Test site description: The test site is the Zhangzhou District in the south of Fujian province, between 116°53'-118°09'E and 23°32'-25°13'N. The area is 12897 km², among which about 77% is below 500m. The main land use types are arable land (12.91%), garden plot (13.45%) and forest (52.49%). Longhai County or Zhangpu County in Zhangzhou District may be the primary test sites.

2. Crop types and their calendar: In Zhangzhou, the warm climate (annual average temperature is 21°) and the abundant precipitation are propitious to various crop types characteristic of warm and humid sub tropical regions. The main crop types are rice, sweet potato, potato, sugarcane. The growth season of all crop types spreads all year round, from spring to winter. The rice growth calendar is approximately from April to October.

3. Existing maps: relief maps with scale 1:250000, DEM data of 1:50000, land use and land cover map in Longhai county with scale 1:10000, basic forest resource map in Zhangpu county with scale 1:10000.

4. Ground data: Field survey, and monitoring of rice can be conducted in 2004-2005 Historical total area and yield for the main crops will be collected for every county.

Research contents

Remote Sensing (RS) and Geographic Information System (GIS) techniques have an important contribution to make in sustainable development, particularly in areas such as southern China, where productive agricultural land is being lost to rapid urban development and primary forest cover is diminishing fast. Repeat acquisitions of satellite remote sensing images provide a unique source of information for recording and monitoring the rate and distribution of changes in land cover at both municipal and provincial levels. SAR data are important because of the persistent cloudy conditions experienced in southern China.

The proposed work will have three parts: 1) Methodology development on the use of ENVISAT data for land surface mapping and monitoring of surface parameters, 2) Applications of the methods on topics prevailing in the Fujian project test area and 3) Internet and location based systems development.

I. Methodology research:
The proposed work will concentrate on developing and validating methodology using ENVISAT data for:
- Land use, land cover classification, with emphasis on agriculture and forestry
- Land use, land cover change detection
- Retrieving vegetation and soil biophysical parameters.

The methodological research will be conducted using data acquired in the Fujian area, but will be performed in conjunction with other application projects (e.g. on rice, forestry, drought) on different test areas in China.

1. Land use/land cover and crop classification
Land use and land cover and crop classification is usually performed using high resolution optical data such as Landsat TM and SPOT HRV data. For regions in China having a large diversity of land use and crop types, the main limitation of optical data is cloud cover, which prevents multi-date data acquisition during the growing season. Multitemporal data are ensured with SAR systems. In addition to the possibility to use the temporal behaviour of land cover and crop types, multi-temporal data are also used for speckle filtering. For agricultural regions with small field size, it is essential to have very efficient speckle reduction methods.

With ENVISAT ASAR dual polarisation and multi-incidence angle data, the backscatter behaviour of land cover and crop types as a function of polarisation and incidence angle can be used to enhance the data information content and can be used for speckle reduction. Effective use of these various data types may reduce the number of images needed during a growing season without degrading the classification performance.

Statistical, data driven methods based on training data sets are usually used for classification. As examples, the following physical properties are expected:
- small seasonal change in the backscatter of dense canopies (forest, fruit trees, sugarcane)
- large seasonal change of the backscatter of rice compared to that of other crops.
- canopy backscatter dominates at HV, large incidence angles (IS6 or IS7). This leads to two applications: discrimination of bare soils from vegetation and estimation of crop biomass.
- large value of the HH/VV polarisation ratio at low incidence angle (IS2) for cereals compared to other crop types, which can also lead to estimation of cereal biomass.
- high backscatter of broad leaf crops (potato, sweet potato) compared to cereals.
- An analysis of the backscatter data as a function of land cover and crop types, at different incidence angles polarisation and incidences will be used to define the classification rules.

The multi-channel filtering, developed by Quegan et al., 2000, will be applied to the multichannel data. Classification may be on a pixel basis or parcel based using field boundaries contained in a GIS.

From local to province scale

The possibility of using ASAR Narrow Swath, ASAR Wide Swath and GIS provides great potential to extend mapping from local to province or regional scales. The “upsampling” approach here refers to mapping of broad classes such as forests and fruit trees, rice and other crops at the WS (spatial resolution 150 m for a 400 km swath width). WS data have only one polarisation (HH or VV) but cover a large range of incidence angles (IS1 to IS7). A primary analysis of WS data, as compared to NS data and GIS will provide decision rules for large scale classification. It is expected to use mainly the temporal behaviour at polarisation VV (or HH) to map different cover types.

1. Vegetation monitoring

Vegetation monitoring consists of monitoring of biophysical properties of vegetation and soil during the growing season. MERIS data can be used to retrieved photosynthesis related properties such as Leaf Area Index and FPAR, ASAR data can be used to monitor changes in soil moisture, flooding status and vegetation biomass. The retrieved information is useful in a) agriculture management, and b) crop growth models to simulate the daily growth and development rates of the crop, using as other inputs meteorological parameters such as solar radiation, temperature, precipitation and humidity. Both detailed crop yield prediction models and more regional Net Primary Productivity models are possible.

II. Application Projects

Project 1: Land use change monitoring

China’s urban population continues to grow and the standard of living is rising. These two factors combine to exert increasing pressure on the agricultural land surrounding cities. As diet improves, shifting away from the national staple of rice, farmers are adapting by switching to more lucrative crops like fruit and vegetables. At the same time, the ever-advancing urban fringe is consuming these agricultural areas, placing greater demand on the remaining land. These changes need to be carefully monitored to ensure that future growth is sustainable.

A pilot project will be undertaken with users in a part of Fujian Province undergoing rapid urban development, with emphasis being placed on detecting the consequent expansion and contraction of land cultivated with rice, fruit, vegetables and other cash crops. The type and rate of land use change will be studied, and maps and statistics prepared for future development and planning purposes.

Project 2: Forest resources inventory and change monitoring

Careful management of forest resources is essential for maintaining the quality of our living environment. The last 15 years have seen large changes in the forested area of southern China and accurate monitoring of forest change is very important for management and planning purposes. Within Fujian Province there are already a number of different organisations using GIS and remote sensing for forest mapping and forest fire detection; and a test area will be selected for which detailed forest compartment maps are available. Attention will be focussed on the development of new techniques for detecting forest change using satellite data.

Project 3: Productivity monitoring

A test area will be selected for developing the use of SAR data for crop growth monitoring in the...
context of yield prediction and precision agriculture. Rice growth modelling using ORYZA-1 in the frame of Rice monitoring Dragon Project will be applied to the test area. More regional productivity using MERIS and ASAR WS mode data will be conducted in Fujian province. The Net Primary Productivity (NPP) will be estimated based on the "Light Use Efficiency" concept, where NPP will be derived from fAPAR retrieved from MERIS, and biomass, which impacts on the plant respiration, retrieved from ASAR.

III. Internet and Location Based Systems Development

A RS/GIS Internet server offers a cost-effective tool for sustainable development because of the way that data is centrally archived and shared amongst a large group of users. This also brings advantages in terms of continuity, consistency and compatibility. The Internet enables an effective, hi-tech solution to be delivered directly to user agencies and institutes of all sizes. Once established, a service can be improved and extended, both in content and coverage; and so make a meaningful contribution to the sustainable economic, social and scientific development of China as a whole.

The proposed research includes the development of a RS/GIS Internet server which provides a continuously evolving centralised source for downloading image and map data, together with capabilities for land use analysis and monitoring. Software tools for change detection and monitoring will be developed using time sequences of remote sensing imagery combined with map data. These will be customised operations working within existing image processing/GIS systems. Both server and client-based tools will be needed, and the design will also need to include a facility for showing the availability and coverage of remote sensing data.

Internet/GPS/GIS/Telecom technologies now offer many possibilities for location-based downloading of map and image data, used both for field data gathering, and for field-based change detection and map updating. It is planned to develop and use several different techniques in meeting the different objectives of the three pilot projects.

Non ESA Comment

Non ESA Data

File Upload

Upload file comment
Annex: Experience of the team

Upload Filename
Experience of the team.doc

Modification of the Submission

1) Please clarify how the work will be divided between European and Chinese teams.

The intention throughout this project is to transfer technological know-how about exploiting SAR data for agriculture to the Chinese partners. Although we have not had the chance to work this out in detail yet (although we hope that the trip to China in April will provide such an opportunity), the first part of the project has to involve a substantial component of sharing expertise and knowledge between the participants. Very important here will be the extent of knowledge amongst the Chinese partners and how they will structure their activities. There also has to be some software transfer and development, and possibly training, to the Chinese partners. This obviously is needed for the Internet and location based systems activity to be led by Mike Wooding, but it is expected that other specific tools for handling SAR data could be advantageously supplied to the Chinese partners. However, the extent of this still needs to be determined, and we need advice from the Chinese partners.

It is clear that the responsibility for ground data gathering, quality control and dissemination lies with the Chinese partners, although we expect that some of the experience of the European partners may be of value to them in devising their sampling schemes, as well as in the RS/GIS area. As made clear above, the intention is that the Chinese partners will be fully involved in both the ground and SAR data analysis, with the European partners acting principally as advisors (although, if resource is available, it is hoped that the Europeans will also be actively involved in this analysis, perhaps through a research assistant, PhD student or other worker at their home base).

2) Please clarify the coordination with the proposal nr. 2562, PI Dr. Le Toan, titled "Rice Monitoring in China".

The coordination with Dr Le Toan is straightforward. The emphasis of her project is very firmly on rice and methane emissions, whereas project 2563 is more concerned with technical issues of land cover mapping, classification, monitoring, etc. in a more general landscape context. However, rice is a very important crop in Fujian, and it is expected that the change detection techniques and growth cycle recovery for yield models in project 2562 will be wrapped into our image analysis techniques. In addition, we will take advantage of the rice yield methods developed for Chinese conditions in proj. 2562 and apply them in Proj. 2563, if they are directly transferable. Note again that this needs further discussion with the Chinese partners and clarity about the site conditions and associated information system. If a full-blown GIS approach is...
possible, then the automated pixel-based approach used by Le Toan for assessing rice yield may perhaps be much simplified. This type of knowledge will flow through from her project into Project 2563.

Chinese and European Partners

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Product of ENVISAT / ASAR Alternating Polarisation Mode

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Data Requirements

Details about archive acquisitions. Acquisition in the Zhangzhou District in the south of Fujian province, between 116°53'-118°09'E and 23°32'-25°13'N.
Details about new acquisitions. Acquisition in the Zhangzhou District in the south of Fujian province, between 116°53'-118°09'E and 23°32'-25°13'N.
Specific polarisation schemes required for ASAR yes
Specific swaths required for ASAR yes
Alternative bands set required for MERIS no
Simultaneous acquisition of different sensors required no
Comment specific modes ASAR APP, VV+VH between October and April and HH+VV between May and September, all possible passes from IS1 to IS7
NRT data required no