The Nansen Environmental and Remote Sensing Center

NERSC

a non-profit
research institute affiliated with
the University of Bergen

Edv. Griegsvei 3a,
N-5059 Bergen
Norway

NERSC Technical Report no. 165

under contract with

European Space Agency (ESA)

no. 12861/98/F/TB

esa

and

Russian Space Agency (RSA)

РК

SYNERGETIC USE OF ERS AND ENVISAT SYNTHETIC APERTURE RADAR (SAR) WITH OTHER EO DATA

—

A MARKET SURVEY FOR THE RUSSIAN TERRITORIES

by

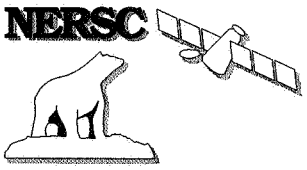
Lasse H. Pettersson and Ola M. Johannessen

in co-operation with

SPOT Image	NIERSC	NITs IPR	SRSC
Toulouse, France	St.Petersburg, Russia	Moscow, Russia	Novosibirsk, Russia

Bergen, August, 1999

Nansen Environmental and Remote Sensing Center
Edv. Griegsvei 3a
N-5059 Solheimsviken - Bergen
NORWAY
Phone: +47 55 29 72 88 Fax: +47 55 20 00 50
e-mail: ola.johannessen@nrsc.no
http://www.nrsc.no



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REPORT

TITLE	**REPORT No.**
Synergetic use of ERS and ENVISAT Synthetic Aperture Radar (SAR) with other Earth Observation (EO) data – A market survey for the Russian Territories.	Technical report no. 165
CLIENT	**CONTRACT No.**
European Space Agency (ESA), Paris	12861/98/F/TB
CONTACT PERSONS	**AVAILABILITY**
G. Duchossois, ESA HQ G. Kohlhammer, ESA/ESRIN	**OPEN**
AUTHORS	**DATE**
Lasse H. Pettersson [1], Ola M. Johannessen[1], Tor I. Olaussen[1], Louise- Francois Guerre[2], Alain Hirschfeld[2], Leonid P. Bobylev [3], Vladimir V. Melentyev[3] Oleg Eu. Korotkevich[3], Alexei V. Kouraev[3], Lola A. Kotova[3], Alexey M. Volkov[4], Vitaly I. Khizhnichenko[4], Larisa I. Permitina[4] and Gennady N. Erokhin[5]	August, 1999

PROJECT PARTNERS

1. Nansen Environmental and Remote Sensing Center, Bergen, Norway (co-ordinator)
2. SPOT Image, Toulouse, France
3. Nansen International Environmental and Remote Sensing Center (NIERSC), St. Petersburg
4. Scientific Research Centre for Exploration of Natural Resources (NITs IPR), Moscow Russia
5. Siberian Remote Sensing Center (SRSC) Novosibirsk, Russia

APPROVAL	
Lasse H. Pettersson	Ola M. Johannesssen, director

ESA STUDY CONTRACT REPORT

ESA CONTRACT NUMBER: 12861/98/F/TB	SUBJECT: Synergetic use of ERS and ENVISAT Synthetic Aperture Radar (SAR) with other earth observation (EO) data – A market survey for the Russian Territories.		CONTRACTOR: Nansen Environmental and Remote Sensing Center
ESA CR( )N(	STAR CODE:	NO. OF VOLUMES: 1 THIS VOLUME: 1	CONTRACTOR'S REFERENCE: Technical Report no. 165

ABSTRACT:

In 1995 the Russian (RSA) and European (ESA) Space Agencies initiated their first co-operation within earth observation - the "ICEWATCH" project, which aimed at demonstration of European ERS Synthetic Aperture Radar (SAR) for guidance of vessels and icebreakers along the coast and rivers of western Siberia. Over the last years the Nansen Centers in Bergen and St. Petersburg have conducted 12 demonstration campaigns for use of SAR in ice navigation of the Northern Sea Route using ERS SAR data. The SAR data acquired by the Norwegian satellite receiving station (Tromsø Satellite Station, TSS) in Tromsø, the ESA station in Kiruna, Sweden and the US station in Fairbanks, Alaska, covers major parts of the Northern Sea Route and the Siberian coast. However, large parts of the central Siberian mainland and the Laptev Sea are not covered. Therefore an acquisition station located within the Russian Federation is needed to provide SAR data from the entire northern Russian territory and the Arctic including the Northern Sea Route. The conclusions of the ICEWATCH project have so far been very positive with respect to the actual SAR applications within sea ice navigation.

The availability of ERS/ENVISAT SAR data will further stimulate and encourage a wider use of SAR data for the territories of the Russian Federation, both within the Russian EO user communities as well as at the international market operating within Russia.

A market survey to evaluate the potential use within Russia of ERS and ENVISAT SAR data in combination with other satellite EO data, including several Russian satellites and the French SPOT satellite, is being reported in the current document.

The project background is given in Section 1and the market survey approach in Section 2. In Section 3 and 4 an overview of the use of Russian EO data is given. In section 5 a review of the current market survey through interviews (questionnaires) and organisation of three regional workshops within Russia is given. Section 6 addresses the international use of EO data for the Russian Territories. In section 7 the project conclusions and recommendations are given.

NAMES OF AUTHORS:

Lasse H. Pettersson, Ola M. Johannessen, Tor I. Olaussen, Louise- Francois Guerre, Alain Hirschfeld, Leonid P. Bobylev, Vladimir V. Melentyev, Oleg Eu. Korotkevich, Alexei V. Kouraev, Lola A. Kotova, Alexey M. Volkov, Vitaly I. Khizhnichenko, Larisa I. Permitina and Gennady N. Erokhin

ESA STUDY MANAGERS:	ESA BUDGET HEADING:
G. Duchossois: ESA HQ, Paris, France G. Kohlhammer: ESA ESRIN, Frascati, Italy T. Beer, ESA HQ, Paris , France	

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0. Executive Summary

From the Soviet era extensive experience in design and applications of spaceborne radar systems have been established within the former Soviet states, in particular in the Russian Federation and the Ukraine. The year 1974 marked the beginning of the era of environmental and natural resources Earth Observation (EO) sensor satellites in the USSR. In this year the Meteor-18 satellite was launched and it was succeeded by a series of six other satellites, the last one - Meteor-31 - launched in 1981. This series of EO satellites has been followed by the launch of the Resurs-O1 satellites, which included the Kosmos-1689 in 1985, Kosmos-1939 in 1988, Resurs-O1 N 3 in 1994 and Resurs-O1 N 4 in 1998. The development of this EO program has mainly contributed to the development of terrestrial and coastal zone applications within the Russian Federation and data are currently distributed for use world–wide under international agreements. As a result, there exists today a diversified and structured system of EO data acquisition, distribution, processing and delivery, involving various organisations. The government of the Russian Federation approved a *Concept for State Space Policy* on 26. May, 1996, including EO data. This document determines the priorities of the Russian Space Agency in a broad range of application areas including EO development and applications. For the vast territories of the Russian Federation it is necessary to use satellite EO data for environmental monitoring as well as to obtain information about natural resources for their sustainable and cost-effective management. In 1997 a round table discussion - "*Russian space and remote sensing market*" - was organised. According to the survey conducted, the most frequently used EO data sources are aerial photography and data from the Resurs-O series. Then after come high-resolution photographic data (5 meter) from the KFA-1000 sensor and data from the NOAA AVHRR sensors, followed by information from MK-4 and SPOT sensors. The use of EO data from other space agencies was almost non-existing at among the participating organisations, although some Russian research institutions have used data from the ERS satellites.

The identified factors hampering development of the Russian EO data market includes; (i) complicated access to the information on availability, retrieval parameters and quality of EO data for a specified territory, (ii) difficulties to meet the users request for specific territorial data coverage by the Russian providers of EO data, and (iii) lack of knowledge on satellite remote sensing possibilities and poor popularisation of satellite retrieval methods for geo-information.

The most developed applications of Russian EO data are related to:

- monitoring inundation of river floodplains during spring floods,
- ecological monitoring of land surface pollution near large cities,
- monitoring of forest fires,
- estimation of crops status and harvest forecast,
- sea ice mapping and monitoring,
- mapping geological structures for assessment of mineral resources content and for detection of high risk zones related to mining activities, and
- monitoring coastal zones exposed to significant technogenic influence and pollution.

These main application areas are developed based on the use of high-resolution photographic image data, optical and infrared multi-spectral data, and passive and active microwave sensors, including real-aperture radar systems. The main Russian development of spaceborne radar satellite technology was carried out under the Almaz-program where civilian synthetic (SAR) and real-aperture radar systems have been developed and launched for both scientific and operational applications. Currently no Russian spaceborne SAR system is operational, although the real aperture Side-looking Radar on Okean was recently switched on again for operations. The planned launch of the Resurs-Arktika satellite with a SAR sensor is among the priorities of the Russian Space Agency.

To serve the EO data needs a national network of three main regional centres for satellite EO data acquisition is established - in Obninsk, Novosibirsk and Khabarovsk. In addition there are a number of personal ground stations (PGS) providing access to download images from the "Resurs-O1" satellite series, serving the local and regional needs for EO data.

In 1995 the Russian (RSA) and European (ESA) Space Agencies initiated their first co-operation within earth observation - the "ICEWATCH" project, which aimed at demonstration of European ERS Synthetic Aperture Radar (SAR) for ice navigation guidance of vessels and icebreakers along the coast and rivers of western Siberia. Through the use of SAR data acquired by the Norwegian satellite receiving station in Tromsø, the ESA station in Kiruna, Sweden and the US station in Fairbanks, Alaska, large parts of the Northern Sea Route and the Siberian coast are covered. However, major parts of the central Siberian mainland and the Laptev Sea are still not covered regularly by the current network of SAR acquisition stations.

An acquisition station located within the Russian Federation is needed to cover the entire northern Russian territory and the Arctic including the Northern Sea Route. The availability of such data will further stimulate and encourage a wider use of ERS and ENVISAT SAR data for the territories of the Russian Federation, both within the Russian EO user communities as well as within the international community and industry operating within the Russian Federation.

A market survey to evaluate the potential use of ERS and ENVISAT SAR data, in combination with Russian and other satellite EO data, for the territories of the Russian Federation, has been initiated by the European (ESA) and Russian (RSA) Space Agencies.

The objectives of this project was to perform a qualitative and quantitative assessment of the Russian market in the short-term (1-3 years) and mid-term (5 years) focusing on the user requirements for earth observation (EO) data and in particular ERS/ENVISAT SAR data.

The specific objectives included:

- Assess the market in the four main application areas: **sea ice monitoring, environmental and pollution monitoring, boreal forest mapping**, and **geological resource mapping** within such sectors as industry, government, international agencies and research organisations, excluding military and defence sectors.
- Assess the requirements of users and identify the role of integrated use of EO data to satisfy the users needs.
- Identify the geographical and seasonal demand for EO data.
- Identification of the required quantities of EO data and its market value, including assessment of the readiness and willingness to pay for EO data.

This market survey project is being co-ordinated by the *Nansen Environmental and Remote Sensing Center* (NERSC) in Bergen, Norway. In addition the project team consisted of *SPOT Image*, Toulouse, France, *Nansen International Environmental and Remote Sensing Center* (NIERSC), St. Petersburg, Russia, *Scientific Research Centre for Exploration of Natural Resources (NITs IPR)* in Moscow, and *Siberian Remote Sensing Center (SRCS)* in

Novosibirsk. The project has received important practical and technical support from both the *Russian Space Agency* (RSA) and *European Space Agency* (ESA).

The analysis of user requirements for EO data was performed after careful examination of earlier studies of the *market for Russian EO data*, by gathering user information through *personal interviews* and completion of a *questionnaire form*, as well as by organising three *thematic workshops* focusing on the key user groups. The Project team conducted the interviews in various regions of the Russian Federation and obtained responses from most parts of the Russian Federation (see Figure 4-1).

The Market Survey for SAR Applications

Information about state-of-the-art SAR applications within the four selected application areas and derived information products are essential for successful survey of the actual and potential use of this type of EO data. Although much information on EO applications are available to the Russian user community, linguistic and other reasons still significantly limit the awareness of both EO data and its applications. Hence, information material from ESA, RSA, and the project partners were gathered and distributed. The project team also produced a four-page brochure for each of the four main application areas in the Russian language, based on information material available from agency and other sources.

The questionnaire survey covered three main elements: the overall information needs and utilisation to meet the main mission objectives of the organisation, including the financial aspects of these current activities; the experience and possible use of EO data in this respect, including the requirements for, the availability of and access to SAR data for efficient use within these mission areas; management information on the organisation and respondents. The philosophy behind the questionnaire was to obtain very detailed information on the activities of each potential user contacted.

The completion of the questionnaires was done through personal interviews and to a lesser extent through mail distribution of the questionnaires to the identified potential users. In order to get higher level of confidence in the project responses the direct interview approach was preferred. The project team approached around 450 organisations and finally 189 of these organisations were included in the market survey. Around 60 of the contacted organisations found the use of satellite earth observation data of no relevance to their organisations and were therefore not included. Around 200 organisations were contacted by mail approach, from which the level of responses was very low. The direct interview approach was hence adopted

as the main method for information acquisition for the survey. The information from the questionnaires was stored in an appropriate relational database for statistical analysis and evaluation of the information.

Three thematic workshops were organised in respectively St. Petersburg, Moscow and Novosibirsk focused on the four selected SAR application areas. The aim of the workshops was to inform the users of the SAR applications and to assess in depth the users requirements. A preliminary analysis of the information obtained from the interviews aided in the selection of the workshop participants. The workshops included information about the availability and application areas of ERS SAR data as a basis for further discussion. The three workshops brought together respectively 35, 23 and 50 participants.

Assessment of Russian Users Requirements

Most of the territories of the Russian Federation were covered by the Project, with a focus on the European western and northern parts, central and southern Russia, west and central Siberia and only to minor extent the east Siberia and the Far East.

Organisation Types and Funding Sources: A wide range of funding agencies, authorities, industry, information providers and users, research and development groups, and educational institutions have been contacted. 82 % of the respondents were from organisations, which were wholly or predominantly state-owned. This reflects the fact that by tradition many Russian organisations are under public or semi-public administration. During the recent years a transition of organisations to private companies and organisations has occurred, leading to various joint-sector subsidiary organisations. The funding agencies and clients for EO related activities within the contacted organisations are to a very large extent supported from public budgets.

The private sector, including voluntary organisations and international organisations, accounted for only 18% of the survey responses. A large proportion of these organisations (71 %) obtained part funding from the oil and gas industry, indicating this as an important industrial application area. Several oil companies have established subsidiaries to serve their companies and to a large extent the EO relevant activities are allocated to this type of subsidiary organisations.

Mission areas: The responses on mission foci cover several application areas for EO data. For all institution categories more than half of the organisations have main mission goals related to "environmental monitoring" and "thematic mapping". Also, around 50% are engaged in

"data collection" and "research and design". Hence, to a large extent, the survey has been among organisations involved in the process of generating information used for environmental monitoring, i.e. the value-adding sectors of the EO data use. However, most categories of EO data users has been contacted through the Project, covering management use and decision making to actual processing and analysis of EO data.

EO Data Application Areas: The responses with respect to the EO applications cover all major areas. The application areas related to monitoring of "environmental pollution" are of concern to a large proportion of the contacted organisations. Related activities such as "risk management", "GIS" and "cartography" are also within the major application areas of many of the responding organisations. Also in the user categories such as sea ice navigation there is a high level of concern for these issues. The responses from basic and applied research institutions indicate that many of the respondents are involved in a wider range of EO relevant application areas. The application areas with greatest development potential seems to be within sea ice monitoring, where the users have identified a significant benefit in use of SAR data compared to the current observation methods. The fact that use of aerial surveys has practically almost vanished over the last years, encourage the use of alternative sea ice monitoring methods. "Risk management" is an application of general and high concern to all application areas and hence a field of potential development. The integrated use of EO data in "GIS" and "cartography" applications is also a field where SAR data will have a significant use and impact. Within mapping of natural resources various sectors of the exploration industry have identified their strong interest in using EO data provided that the application methods are well documented and are able to support their main mission and goals. In this respect the EO service providers have to document valid application methods in order to "convince" the market.

EO Data Coverage: The requirements on geographical SAR data coverage extends over all the main parts of the Russian Federation. For land areas the focus is in west Siberia and the northern and north-western regions of the Russian Federation. For "environmental monitoring" the geographical distribution of interest is quite homogeneous all over the RF, although with a stronger focus on western Siberia among the respondents. For forestry applications the northwest and central parts and Siberia are of prime interest. This is consistent with the location of the major forest resources within the RF. The geographical preferences of the private sector are slightly higher in northern regions, Ural, and Siberian parts of the RF, primarily due to the fact that these are the regions rich in major natural

resources.

For water areas the general focus in on the Arctic Seas and of the Baltic, Black, Caspian and Far East seas. For sea ice applications 88% are interested in the Arctic waters, about 50% in the Baltic sea, and in the Far East seas. A significant part of the respondents also indicated interest in use of SAR data for inland water bodies, although the geographical requirements for these were not investigated further.

In general, the areas of primary geographical interest are to a large extent covered by the existing ESA stations in Europe as well as through a new proposed station in the higher latitude regions of the central or eastern parts of the RF, e.g. Salekhard or Yakustsk.

Seasonal Coverage: Year round SAR data coverage are required by half of respondents, with variable seasonal interests for the different application areas. A clear requirement for SAR data coverage throughout the year is identified and a planned ESA ERS/Envisat SAR station in the Russian Federation should allow for year around operations.

Requirements on SAR Data Products: In general 33% of the respondents required the basic level image products (Level-1B types). For sea ice applications around 50% were able to use the basic image products and one-third the calibrated radar image product. This lower response to the calibrated products may be due to a lack of a complete understanding of the EO product differentiation. Most of the survey respondents had, however well defined requirements on the level of EO data and the derived data products, supporting the conclusion that the contacted institutions are quite well educated or experienced in the use of EO data. In the private sector and for industrial applications the thematic information products were of prime concern, implying that well documented processing methods should be applied to deliver the final information products. The international oil and gas industry expressed that their initiatives to a large extent will depend on the formal requirements imposed on their activities by the Russian authorities. Hence, they will not implement any oil spill monitoring service based on SAR data, unless it is required or agreed with the Russian authorities.

Based on the acquired information and impressions obtained during the interviews and workshops, the project team made an assessment of the potential for future "purchase" and /or "use (application)" of satellite SAR data as an information source for their activities. The evaluation of the respondents was, partly subjectively, ranked "high", "medium", "low" or "unable to evaluate" (see Figure 0-1). The conclusion of this assessment is that with an acceptable level of confidence around 1/3 of the contacted organisations will to some extent be purchasing SAR data in the future. Around the same number will also be using data in the

territories of the Russian Federation are identified. The eastern and northern stations locations are those providing maximum additional coverage compared to the existing network of ERS SAR stations.

Table 0-1: An assessment of the importance (ranked from 1 to 4) of the various ERS/ENVISAT SAR station locations for each application area. The coverage of the existing ESA stations is taken into consideration when ranking the station locations. N/A: not applicable compared to the higher priorities or other current stations.

Application area		Moscow	Novosibirsk	Salekhard	Yakutsk	Tiksi
Ice Monitoring		4 [1)]	N/A	3	1	2
Env. Monitoring & Hazards	marine	2	N/A	1	3	3
	land	1	2	3	3	N/A
Forest management		1	2	3	3	N/A
Natural Resources (Geology)		3	1	3	2	N/A
Agriculture		1	2	3	(3)	N/A

1) area covered entirely by the Tromsø & Kiruna stations.

The International Market Segments

The most significant interest in the possible use of EO data for the Russian territories is identified within the sector of exploration of hydrocarbon resources. Related to these activities is also the support of shipping and off-shore operations in ice covered waters as well as planning of pipeline structures. Within international research programs for monitoring of the forest resource there is also a pronounced interest for EO data coverage of the forested parts of the RF. Most of the relevant international activities within the RF are depending on non-Russian funding of its activities, however many companies regards their presence to day as were important for a more active future activity in the Russian market. The general conclusion through the limited number of contacts is that the non-Russian market for EO data over the Russian territory seems low, even if the potential needs for information are very large. The market will firstly be developed when the economic situation and infrastructure will significantly improve and stabilise, and when western companies or organisation will start to invest significantly in the use of the resources available within the Russian Federation.

The ERS Announcement of Opportunity (AO) Call is the prime mechanisms to stimulate development of applications and scientific research using the ESA satellite EO data. In the first four ESA ERS AO calls Russian Principal Investigators have been completely absent, although, some Russian Co-PI´s were involved. Direct experience and use of ERS SAR data

among Russian institutions was for various reasons very limited. Through the first ERS AO calls around 69 non-Russian PI's have requested ERS SAR data from locations within the Russian Federation, although only a few (<10 projects) were focused on issues that specifically required SAR data for the territories of the Russian Federation, including the ICEWATCH project. After the ERS AO-3 Call the situation has changed drastically and 16 Russian scientists have become ERS PI's requesting ERS sensor data over NIS countries as well as other geographical areas. The increased number of Russian ERS PI's is due to increased awareness of the AO possibilities for data requests as well as an increased international scientific co-operation with Russia over the last couple of years.

Conclusions and Recommendations

The study concludes that a wide range of SAR applications has been developed for use within the Russian Federation. The Market segments needs to SAR data are well defined within several sectors, however the commercial applications are limited due to the current financial situation in the RF. The scientific sector has a large potential to contribute to development of SAR applications and their request for data has been increasing over the last years. Hence a data demand is well defined, however with limited commercial ability to purchase SAR data. The international market for SAR applications for the territories of the RF are in situation of awaiting changes in the Russian economy before implementing new initiatives in this respect. The need for one or more SAR receiving station within the Russian Federation are documented to serve the users needs with respect to both SAR data coverage and facilitate the user access to actual data. The necessary infrastructure and local initiatives to meet the operational needs of such stations are identified, however this was outside the main scope of this project to investigate.

State-of-the–art

- Optical and infrared EO data have for many years been operationally used within areas such as:
  - Sea ice monitoring;
  - forest fire detection and damage assessment;
  - weather forecasts;
  - pollution monitoring and assessment;

- river flooding monitoring;
- ecological mapping;
- crop status monitoring;
- coastal zone monitoring;
- geology and natural resources mapping, and others.

- A national network of EO acquisition stations has been established in order to serve the regional needs for data and information from the Russian and earlier Soviet Union EO satellites.
- Russian experience with spaceborne radar systems has been established by various Russian institutions under the Almaz SAR program.
- Use of Russian EO data has declined over the last decade, but an increase is again observed over the last years, despite the current financial problems in Russian economy.
- Lack of information on state-of-the-art SAR application areas limits the actual use to be considered by "non-expert" EO users.
- Regional authorities (environment, natural resources and industry) of the Russian Federation are currently using EO information sources.
- Regional Authorities have shown willingness to further explore EO data as major source of information.
- Regional environmental authorities cover part of their budgets through local taxes from the industry involved in exploration of natural resources.
- The use and awareness of EO data are more limited in the private sector, than in the public sector.
- No respondent to the market survey has provided information on the financial aspects of their activities (current budget, costs of services etc.). Accordingly the expected future outlook for development has been impossible to assess from their responses to the survey.

Awareness and Requirements

- A high level of awareness for use of EO data is established in a wide range of public and semi-public organisations – in particular at scientific research institutions.
- Despite a general high level of awareness most user groups need information and routines for generation of value added products. In particular the knowledge of non-Russian EO data and sensor systems are very limited.

- The forest authorities and industry, as well as the oil companies and mining industry, are in general sceptical about the benefit of SAR until their direct applications are better validated and demonstrated within their own fields of operation.
- Tailored and dedicated information on state-of-the–art applications for SAR data are very much needed in order to develop new application areas and to stimulate the increased use and further development of EO data.
- User training and documentation of application algorithms and methods are needed in order to increase the awareness in a large section of the Russian user community.
- Near real-time applications and year around operations are identified within all the user categories.
- An increased demand for ERS SAR data for the territories of the Russian Federation is identified among Russian scientific users, regional authorities and partly among the international user community involved in activities in the RF.
- In order to meet the identified user requirements for SAR coverage of the RF, a combination of three station locations are required - in Moscow, Novosibirsk and in Yakutsk.
- One or more ground station located within the Russian Federation will significantly facilitate the access to and promotion of use of SAR data for the Russian user community.
- To serve the data needs of the Russian and international PI's under the Third ERS Announcement of Opportunity (AO3) a station located in Novosibirsk is required.
- The Yakutsk station location will *uniquely* cover the eastern part of the Northern Sea Route (Laptev Sea) as well as land areas of the Far East of RF. The Far East seas will also be covered in partly overlap with other existing station locations.
- The SAR data costs are a significant and limiting factor for application development within all application areas.
- The market survey has contributed to an increased awareness of Russian SAR application forming a basis for future market and application development.

Application Areas

- SAR data has its particular benefit among EO information sources in the high latitude regions of the Russian Federation, due to the frequent occurrence of cloud, haze and winter darkness.

- The basic industrial use and exploration of natural resources are located mainly in the northern regions of the Russian Federation.
- Regional authorities have indicated significant benefit in the use of EO data, including SAR, within environmental mapping for planning of new activities and installations (roads, railroads, pipe lines etc.) and environmental monitoring and assessment of impact from existing installations.
- Regional authorities envisage EO data to become a prime source of information within mapping and monitoring of natural phenomena such as sea ice, flooding including ice blocking in rivers, forest state and damage as well as forest fires.
- SAR applications in support of ship navigation in ice covered areas is the most developed application area, although, wide spread commercial use is currently limited by the data costs, due to limited geographical coverage of the current ERS SAR sensor (100 km swath) and the current financial situation in Russia. Despite the technical limitations SAR data has proven significant value when available.
- Ship detection is of interest to local authorities in order to monitor illegal fisheries particular in the Far East seas.
- The oil exploration industry operates often through intermediate companies, providing environmental assessment and other services in which EO data can be used as an integrated source of information. These end-users do not regard EO data alone as a source of information, but require integrated retrieval of the information content as essential to increase the use of EO data.
- Previous forest monitoring was mainly done using aerial surveys. However this has declined significantly over the recent years due to the budget situation. A cost-efficient substitute or complement could be obtained through use of satellite SAR data in combination with other information sources.

Future Development

- An increasing interest in the Russian and international scientific community for SAR data from the territories of the Russian Federation is observed through the increased number of projects in response to the later ERS AO calls.
- The Russian scientific community has expertise in existing and future thematic application areas of SAR data, which will be of benefit to the Russian and international user communities.

- Within mapping and monitoring of terrestrial pollution, forestry and natural resources (geology) exploration, SAR data have a significant national potential of development provided that the application methods well demonstrated and validated.
- Within the oil exploration industry, partly shipping industry, forestry (industry and authorities) and mining companies there are financial resources and willingness to invest in use of *documented and beneficial applications* of EO data.
- Increased availability and access to ERS SAR data within the RF will foster research and application development. Furthermore this will stimulate the development of future operational applications and the market for ENVISAT SAR data from year 2001.

1. Introduction

1.1 Project Background

From the Soviet era extensive experience in design and applications of spaceborne radar systems have been established within the former Soviet states, in particular in the Russian Federation and the Ukraine. The first Soviet spaceborne real aperture side-looking radar (SLR) was launched by Cosmos-1500 in September 1983. This led to the development of the Russian Satellite Oceanographic Program - "Okean", under which the first operational satellite Okean-0-1 was launched in 1988. The main development of spaceborne radar satellite technology was carried out under the Almaz-program where civilian synthetic (SAR) and real-aperture (RAR) radar systems have been launched for both scientific and operational applications. The Almaz prototype SAR mission was launched in 1987 on Cosmos-1870. The Almaz-1 launched in March 1991, proved its direct applications in essential support for rescue of the R/V Michael Somov, which was captured in the Antarctic winter sea ice in July 1991. Russian EO scientists and application users have put considerable efforts in the development of satellite radar applications ranging from terrestrial mapping to near real-time sea ice monitoring. Development of the planned follow-on satellite radar systems on Almaz-1B and Almaz-2 satellites have been started in Russia. The launch dates of these satellites are uncertain, despite the willingness of both national and international interests to participate in and partly fund the program. At present Program Almaz has been closed down due to financial priorities of the Russian EO program. Currently no Russian spaceborne synthetic aperture radar (SAR) system is operational, although the real aperture Side-looking Radar on Okean was recently switched on again for operations. The planned launch of the Resurs-Arktika satellite with a SAR sensor is among the priorities of the Russian Space Agency. Considerable knowledge on spaceborne SAR applications is established within the Russian Federation and there exists a high level experience in the use of satellite radar data for the Russian territories.

In 1995 the Russian (RSA) and European (ESA) Space Agencies initiated their first co-operation within earth observation - the "ICEWATCH" project [Johannessen et al, 1997 a,b and 1998], which aimed at demonstration of European ERS Synthetic Aperture Radar (SAR) for guidance of vessels and icebreakers along the coast and rivers of western Siberia. Over the last years the Nansen Centers in Bergen and St. Petersburg have conducted 12 demonstration campaigns for use of SAR in ice navigation of the Northern Sea Route, starting with the French "L´Astrolabe" expedition in 1991 two weeks after the launch of ERS-1 [Pettersson et al., 1992]. These campaigns have been executed with the aim both to apply and to validate the use of ERS SAR data for ice navigation. Through the use of SAR data acquired by the Norwegian satellite receiving station (Tromsø Satellite Station, TSS) in Tromsø, the ESA station in Kiruna, Sweden and the US station in Fairbanks, Alaska, large parts of the Northern Sea Route and the Siberian coast are covered. However, major parts of the central Siberian mainland and the Laptev Sea are not covered regularly by the current network of ESA and other national ERS SAR ground acquisition stations. Therefore an acquisition station located within the Russian Federation is needed to cover the entire northern Russian territory and the Arctic including the Northern Sea Route (see map Figure 1-1).

The conclusions of the ICEWATCH project have so far been very positive with respect to the actual SAR applications within sea ice navigation. There is a specific demand from the Murmansk Shipping Company for use of these data by their icebreaker fleet as well as from

the oil companies due to the increased exploration and exploitation activities both on land and off-shore in Siberia. In order to obtain full coverage of the Siberian coast and the central Russian mainland, direct negotiations for establishment of an ERS/ENVISAT SAR receiving station at the territories of the Russian Federation have been initiated between the two space agencies. Such a station would be implemented as a joint ESA and RSA co-operation within earth observation. However, location and market opportunities for such a SAR station have not been fully investigated.

Several other applications of spaceborne radar sensors have also been developed both in Russia and other countries within fields such as e.g. boreal forest mapping, thematic vegetation mapping, ocean circulation studies (e.g. the Kara Sea), as well as use of interferrometric analysis for determination of land and glacier topography.

The justification for the establishment of an ESA/RSA SAR satellite data receiving station in Russia is hence two-fold. A SAR satellite receiving station at the Russian territories will provide a unique data coverage, which will become available for several application areas, also under the ERS AO3 announcement. The availability of such data will further stimulate and encourage a wider use of ERS and ENVISAT SAR data for the territories of the Russian Federation, both within the Russian EO user communities as well as at the international market operating within Russia.

A market survey to evaluate the potential use within Russia of ERS and ENVISAT SAR data in combination with other satellite EO data, including the French SPOT satellite, has been initiated, under the present project.

The market survey project is being co-ordinated by the *Nansen Environmental and Remote Sensing Center* (NERSC) in Bergen, Norway. In addition the Project Team consist of *SPOT Image*, Toulouse, France, *Nansen International Environmental and Remote Sensing Center* (NIERSC), St. Petersburg, Russia, *Scientific Research Centre for Exploration of Natural Resources* (NITs IPR) in Moscow, and *Siberian Remote Sensing Center* (SRSC) in Novosibirsk. The project has received important practical and technical support from both the *Russian Space Agency* (RSA) and *European Space Agencies* (ESA).

1.2 Project Objectives

The overall objective is to set up a qualitative and quantitative assessment of the Russian market in the short-term (1-3 years) and mid-term (5 years) focusing on the user requirements for earth observation (EO) data and in particular ERS/ENVISAT sensor data.

1.3 Specific Objectives:

- The market survey will a priori address the following four application areas; sea ice monitoring, environmental and pollution monitoring, boreal forest mapping, and geological resource mapping; in the industry, government, international agencies and research sectors (private and public) at the local, regional, and national level.
- The survey will focus on the users requirements and identify the role of integrated use of EO data to satisfy the users needs.
- Identify the geographical and seasonal demand for EO data.
- Identify the required data volume and its market value, including assessment of the readiness and willingness to pay for EO data.

Figure 1-1: Map of the Russian Federation with names used in the report on major regions and ocean areas.

2. The Market Survey Study Approach

The market study approach is based on some constraints in order to obtain an overview of the potential market for use of SAR data over the territories of the Russian Federation. The main focus is to investigate the potential market for use of SAR data among the Russian users. The potential international market comprising non-Russian institutions operating over Russian territories has been limited to a selection of some institutions involved in applications areas for SAR.

The application areas for use of SAR data have been limited to four, which have been selected under certain criteria. The applications have also been selected with respect to suitability for development of synergetic use of EO data from European and Russian satellite sensors. The survey does *not* include EO applications dedicated to military or defence operations.

2.1 Selected Application Areas

In order to perform a survey of the market for EO data, the application areas and final information products need to be clearly defined. Limited project resources and logistical problems in acquisition of information from various user categories necessitated a selection of the actual application areas and users categories to be investigated in further depth. In the base line for the project, 10 relevant application areas for SAR data were investigated. These application areas covered:

- Agricultural Mapping
- Boreal Forest Mapping
- Cartography
- Climate Application Studies
- Environmental Monitoring
- Fisheries applications
- Mapping of Natural Resources
- Risk Management
- Sea Ice Monitoring
- Urban Planning

In the selection procedure, to limit the final number of application areas to be investigated in depth, the following criteria were used as a basis for selection:

- the maturity of each of the EO data application areas;
- the number of potential customers, both within and outside Russia;
- the willingness of users to pay for the EO data/services;
- the frequency of EO data requests and
- match with priorities of the Russian EO program.

In reality it was difficult to evaluate all these aspects without having performed an initial survey of the market and its demands. Hence the major focus was given to the first and last items, which implies that the maturity of the EO application products from both a Russian and European point of view was investigated. Also, the strategic focus and priorities of the two Space Agencies in the development of the application market for SAR data was taken into

account in the evaluation.

Since the ICEWATCH project formed the basis for the initiation of this market survey it was natural to take advantage of this application area with integrated Russian and European data products. Sea ice monitoring by SAR in support of ship navigation is also one application area with potential for growth, particularly as replacement for traditional observation methods. Such observational schemes (e.g. use of airborne survey, coastal and ice station observation network) have become too expensive to be used operationally on a regular basis and parts of this infrastructure now seem to have vanished.

Sea ice: Based on the experiences from the ICEWATCH project, the application of spaceborne SAR data for use in operational sea ice navigation has reached a high level of maturity within the relevant Russian and international user community with operations in ice-covered Russian waters. The task of preparing ice information is a national Russian activity, which has to be used by those operating in ice-covered waters of the Russian Federation.

Environmental Monitoring: The Russian Federation is very rich in natural resources including oil, gas and a wide range of minerals. Detection, use, production and protection of these resources are hence of great importance to both industry as well as the national and local authorities. Environmental monitoring to support sustainable and environmentally safe management of oil and gas resources is of great concern to Russian authorities at regional and national level. Monitoring efforts are initiated and maintained through regional authorities and funded through taxation of the industrial enterprises. The use of satellite EO data in this respect is well developed, based on a number of Russian and international satellite sensor systems, although SAR data are currently not well-exploited in this respect.

Natural Resources: The vast and remote areas of the Russian Federation contain a wide range of natural mineral and other resources. Several efforts, some quite successful, have been made in the Russian Federation to detect various mineral resources of significant value and use. The methodologies used are mainly based on optical EO data, although the large areas in winter darkness and frequent cloud cover and haze, stimulates investigation on the use of active microwave EO sensors such as the SAR.

Boreal Forests: The Boreal forests in Russia are one of the major resources of both regional and national concern with important impact for both the public and private sectors. A national network, based on regional monitoring nodes and extensive use of optical EO data, has been built up for monitoring the available resources, their condition and state, including health conditions and external threats such as forest fires, as well as the use and exploration of the forest resources. The applications of SAR data from the view of the resource management industrial exploration as well as with respect to the role of the Boreal forests in the context of global change emphasise the potential of this application area for development of SAR applications within the Russian Federation.

For all the above EO application areas, with possible the exception of mapping of the natural resources, the applications require repeated data coverage in order to detect the changes in the environment as well as to meet the monitoring requirements of each of the different application areas. Developments within these application areas are also among the foci of the RSA priorities (see Ch. 0) and the use of SAR data are complementary to the currently available Russian optical and microwave EO sensors.

In conclusion the project adopted the following four major application areas to focus on within the market survey:

1. Sea Ice Monitoring
2. Monitoring of Terrestrial and Marine Oil Pollution, including Environmental

Monitoring of the Northern Territories (regional authorities)

3. Boreal Forest Mapping
4. Mapping of Natural Resources (geology)

2.2 Information Material - Application products

Information about state-of-the-art applications and information products based on SAR data are essential for successful survey of the actual and potential use of this type of EO, within the four selected application areas. Although much information is available to the Russian user community, linguistic and other reasons still cause a limitation in the awareness of both EO data and the applications thereof.

In order to increase the awareness and on this basis to become better suited for performing a more realistic survey of the potential use of SAR data among users in the Russian Federation, information material was regarded as essential. In this respect information material from ESA, RSA, and the project partners were distributed and used. The project team also produced four-page brochures for each of the four main application areas. These brochures were produced in the Russian language for extensive use and distribution throughout the project, including to all participants at the three workshops in St. Petersburg, Moscow and Novosibirsk.

Through ESA ESRIN EO Help Desk ESA information materials were requested, including:

- "ERS & Marine Applications" (BR-128/I)
- "ERS & Land Applications" (BR-128/II) and
- some other brochures (SP-1185, SP-1221, SP-1176/I-II, BR-134, etc.).

The material was shipped directly to the ESA Office in Moscow for use at the workshops and in the survey. In addition both SPOT Image and the Nansen Center provided information material on various EO applications available from the institutions. Information material on the Russian EO data, satellite systems and their applications were provided by NITs IPR for distribution through the project.

A dedicated Web site for the Project was designed and installed at a server in Moscow (http:\\www.ocean.geogr.msu.su\eoma.htm). The site contains information in Russian language about the Project aims, application areas, project team, as well as examples of application of satellite imagery for the four areas - sea ice monitoring, oil pollution monitoring, boreal forest mapping and natural resources mapping. The content of the project web-page is similar to the information given in the technical material presented in Ch. 2.2.1 and Appendices A.2 - A.5.

2.2.1 Technical Information Material in the Russian Language

Based on information collected from various sources ESA promotion material and other information sources available among the project partners, NIERSC have produced four information brochures in the Russian language (four pages each, included in external Appendices A.2 to A.5). The topics of these brochures are on the main application areas, which were the selected foci of this market survey:

1. Sea Ice Monitoring
2. Oil Pollution Monitoring
3. Forest Monitoring, Inventory and Mapping
4. Natural Resources Exploration and Mapping

The folders are based on information collected from various ESA material, such as "ERS and its Applications: Marine", "Applications Achievements of ERS-1 - New Views of the Earth", "Earth Watching. Anthology", "Use of ERS-1 SAR data for Agricultural, Forestry and Environmental Applications in Central-Eastern Europe". Other information sources available to the project partners (SPOT IMAGE, Nansen Center) were also used in those brochures.

The information content of brochures reflects the Earth Observation data applications for environmental monitoring and research activity within the four application areas.

Particular focus on near real-time use of EO data for sea ice ship navigation is given in the brochure "*Sea Ice Monitoring*". The main principles of sea ice monitoring and ERS/SAR data advantages for the Arctic Seas ice survey are presented. The joint project activities between NERSC, NIERSC and Murmansk Shipping Company is illustrated by combined use of European (ERS-2) and Russian (OKEAN) satellite data within the ICEWATCH project. An example of the sea ice classification procedure is given. Future satellite systems, such as ENVISAT and RESURS-ARCTICA are suggested for future follow-on sensor systems.

The main steps of oil spill surveillance are presented in the brochure - "*Oil Pollution Monitoring*". The key information concerning oil spill monitoring with focus on the use of SAR data is given. The main elements of image analysis for oil detection are outlined. The experience of Norwegian Oil Spill Monitoring Service based on combined use of satellite and ground-based data is illustrated.

The state-of-art applications of ERS SAR data for mapping of natural resources are presented in the brochure "*Natural Resources Exploration and Mapping*". Some ERS/SAR data applications for mineral exploration are listed and illustrated. Integrated use of satellite and in-situ data for image analysis is shown. The two main ERS instruments (SAR and Radar Altimeter) application for oil exploration are illustrated.

The applications of ERS/SAR data for forest monitoring are presented in the brochure - "*Forest Monitoring, Inventory and Mapping*". Earth Observation data applications for localisation of forest fires, forest inventory and mapping are illustrated. The benefits of techniques based on the combined use of different satellites (ERS/SAR, LANDSAT/MSS) are demonstrated through an example for the St. Petersburg Region.

2.2.2 Dedicated ERS-2 SAR Data Requests

Prior to and during the completion of the actual survey it became clear that a range of experienced EO data users also would like to get relevant ERS SAR data examples from their own investigation areas. Through the survey a list of such relevant investigation areas within the Russian Federation were made and an order for these SAR data to the ESRIN ERS data service were made. The data request covers around 20 sites within Russia (see Table 2-1 and Figure 2-1). For demonstration purposes the Nansen Center has performed geo-location and some pre-processing of the data and made hard copies for distribution to the relevant users within each area. Distribution of digital PRI data has been done to some of the user institutions who have their own, or through NIERSC, capabilities to perform dedicated analysis of the data. During the workshops several participants had additional requests to obtain ERS SAR data coverage for areas of their specific interest. These SAR data were distributed to the contacted institutions and authorities, located in different regions of Russia: Kola Peninsula, Arkhangel'sk region, Polar Ural region, Yamal Peninsula, Western Siberia, Eastern Siberia, Altay, Khakassiya and Sakhalin island.

For these SAR data the main applications and investigation areas are:

- mineral resources deposits of Apatity and environmental monitoring (Kola Peninsula);
- Lomonosov Diamond Deposit, Onega Peninsula National Park, forestry and environmental monitoring (Arkhangel'sk region);
- mineral deposits and environmental monitoring (Polar Ural region),
- Cape Kharasavey and Bovanenkovo oil/gas fields and environmental monitoring (Yamal Peninsula);
- oil/gas deposits, forestry, water and soil pollution and environmental monitoring (Western Siberia: Khanty-Mansiysk, Surgut, Tomsk, Tumen - Priobskoye oil/gas deposit);
- forestry, quality of waters and environmental monitoring (Eastern and Central Siberia: Tunguska, Novosibirsk, Chany saline lakes),
- cities, mountains and steppes monitoring, agricultural and environmental monitoring (Altay, Khakassiya, Krasnoyarsk);
- Oil/gas deposits of shelf zone and sea ice navigation (Sakhalin island).

Some publications are under preparation based on integrated use of the SAR data with the regional expertise and data provided by the contacted institutions.

Figure 2-1: Location map of the sites of SAR data for demonstration purposes used in the market survey study (see Table 2-1 for site names and locations).

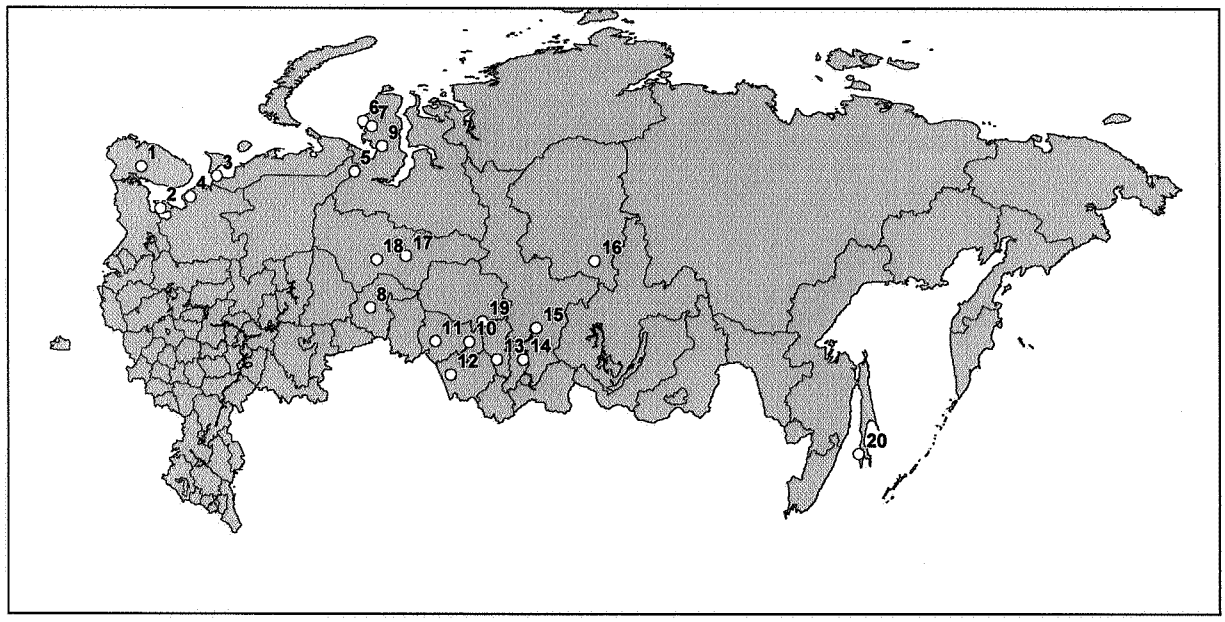


Table 2-1: Summary of the requested ERS SAR data from various locations in Russia. The data has been distributed for demonstration purposes to various users within the Russian Federation.

no	Date	Orbit	Frame	Lat.(N)	Min	Long.(E)	Min	LOCATION
1.	010897	11928	2223 2241	67	40	33	40	Kola Peninsula
	101097	12930	2223 2241					
2.	140695	0777	2295	64	40	36	30	Onega Peninsula
	230797	11799	2295					
3.	070796	06345	2241	67	00	45	00	Kanin Peninsula
	270896	07075	2241					
4.	090697	11169	2277	65	30	41	00	Arkhangel'sk region
5.	170797	11712	2241	67	20	65	40	Polarny Ural
6.	040896	6745	2169	70	58	67	00	Kharasavey
7.	170797	11712	2169 2187	70	36	68	17	Bovanenkovo
8.	240898	17487	1143 1161	57	30	68	00	Tumen
9.	041096	7618	2187 2205	69	10	69	50	Yamal
10.	050798	16764	2475 2493 2511	55	02	82	57	Novosibirsk
	090798	16828	1089 1107					Novosibirsk
11.	020898	17165	2475 2493 2511	55	05	77	50	Chany
12.	060798	16807	2529 2547	52	39	80	09	Altay
13.	140698	16470	1053 1071 1089	53	45	87	07	Novokuznetsk
14.	100798	16842	1071 1089	53	45	91	05	Khakassiya
15.	300598	16255	1107 1125	56	02	93	04	Krasnoyarsk
16.	180698	16520	2367 2385	60	53	101	54	Tunguska
17.	170898	17380	2367 2385	61	15	73	24	Surgut
18.	220798	17008	2367 2385	60	59	69	01	KhantyMansiysk
19.	020798	16721	2457 2475	56	29	84	58	Tomsk
20.	150196	3857	0927 0945	46	57	141	44	Yuzhno Sakhalinsk
	180498	15645	2655 2673					Yuzhno Sakhalinsk

2.3 The User Survey Questionnaire

The philosophy behind the questionnaire development was to obtain very detailed information on the activities of each potential user to be contacted. The reason for demanding such a high level of information from the respondents to the questionnaire was the fact that one expected that most of the information would be obtained through direct interviews with the various potential users. These types of personal interviews would require a significant effort from the project team and hence the information acquisition through the personal interviews could be more extensive than in other types of market surveys, where the contact with the client is more indirect. The final version of the questionnaire (Annex A.2) was developed through an iterative process of the forms in respectively Russian and English versions.

The expected a priori knowledge of the application areas for SAR data in general was expected to be limited among a large part of the potential Russian EO user community. Based on this assumption it was planned that the customer contacts also would contain a significant element of information dissemination on the potential application areas of SAR prior to assembly of the actual information from the users.

The level of information requested from the users through the questionnaire was acquired at three levels;

- the organisation type and its role, included its activity areas, clients, and funding sources
- detailed description of the main information requirements to meet the tasks of the organisation
  - type and sources of information, geographical coverage, frequency and scales of information
  - financial resources and expected development of the activity during the coming years
- assessment of the role of EO data in current as well as future activities of the organisation.
  - use of other types satellite EO data and for what applications,
  - requirements on processing level of EO data and the limiting factors for their use in the organisation.

  In addition the information on the correct address etc. of the organisation and contact persons was included.

Based on the acquired information and impressions obtained during the interview, the project team made an assessment of the potential for respectively future "purchase" and /or "use (application)" of satellite SAR data as an information source for their activities. The evaluation of the respondents was, partly subjectively, ranked "high", "medium", "low" and "unable to evaluate".

The questionnaire is made in an appropriate relational data-base version based on Claris FileMaker Pro 4.0 for the statistical analysis of the information.

In order to obtain a representative survey of the potential Russian clients for synergetic use of ERS and ENVISAT SAR in combination with other EO data, the information retrieval from the users was done subsequently according to the following scheme;

- identification of key organisations - potential EO-data users - using various information sources available: personal contacts and experience of the project partners, various on-going scientific and technical conferences, evaluation of workshop materials, reference-books, etc.;
- a preliminary lists of the potential EO-data users – respondents to be contacted;
- selecting the actual channel/means to get the first contact with the potential EO-data

users: either personal (visits, presentations, interviewing, discussions, workshops, etc.) or indirectly through information distribution via fax, e-mail, mail, etc.;

- distribution of information packages concerning the key application areas for the survey, as well as a cover letter and the questionnaires to be completed;
- acquiring, implementing, organising and processing the information obtained from the users; and
- creation, maintenance and statistical analysis of the acquired information in a central relational data base for the project.

The selection of user organisations has been done on the following principles: (i) relevance; (ii) representativity; (iii) whether organisation is an existing or potential user of satellite data; (iv) possibility to get in contact and to receive an adequate reply.

The completion of the questionnaires was done through both personal interviews and to a minor extent through distribution of the questionnaires and project information to the identified users. The latter approach was evaluated though a group of around 80 organisations in the St. Petersburg region as well as to 112 oil companies and forestry agencies. For this non-personal approach the feedback ratio was very modest, with only responses from those also directly contacted by other means. Personal contacts require much more time, efforts and competence by the interviewer, but at the same time this approach proves to be fruitful and the received information is more relevant, objective and complete. The most efficient way to conduct an interview turned out to be when the responding person fills in the questionnaire and the interviewer make clarifications if necessary. Also additional information was obtained during the interviews, which was taken into account in the evaluation of the information obtained.

2.4 The Regional Survey Activities

The questionnaire survey was conducted by the Project Team in various part of Russia. All information obtained was assembled in a common data. The geographical regions covered are;

- the north and north-western part of Russia
- the St. Petersburg region
- the Moscow region
- the Siberian region
- remaining parts of the Russian Federation

2.4.1 North and North-Western parts of Russia

Prof. V.V. Melentyev (NIESRC) completed a trip to Murmansk, Apatity and Arkhangel'sk (north-western part of Russia) from 6. - 16.10.98, during which interviews were arranged and questionnaires distributed among potential users of EO data. The total number of organisations visited was 47. Through participation in a technical fisheries conference – "Century of the Industrial Fisheries in Russia"- in Murmansk, a large number of organisations involved in fisheries from all over the Russian Federation were informed about SAR applications and interviewed for the market survey.

The northern parts of Russia were covered during Prof. V.V. Melentyev's business trip to Salekhard and Khanty-Mansyisk (28.10. - 11.11.1998). The Committee on Environmental Protection of Yamalo-Nenets Autonomous District (YaNAD) provided efficient assistance and an official letter signed by the Head of YaNAD Environmental Committee (Mr. Ershov)

accompanued the project information sent to 18 oil/gas companies in the region. Interviews and consultations with representatives of 7 large YaNAD companies of various types of field of activities were carried out. In co-operation with YaNAD Committee on Environmental Protection, meetings with regional executive officials were arranged. The total number of visited organisations in Salekhard was 42.

A visit to Khanty-Mansyisk was also arranged with the support of the Regional Committee on Environmental Protection. A number of organisations (mostly oil and gas and mining companies) were visited. Totally 17 organisations were involved in the market survey in the region.

2.4.2 The St. Petersburg region

Dr. O.Eu. Korotkevich, NIERSC, was responsible for the regional survey. After an initial survey by post among 83 organisations in the region, personal meetings and detailed discussions were arranged with leading and business executives of the 31 most relevant organisations. Among these, 23 institutions were identified as having specific interest and requirements for EO data within the four identified and other application areas. The information about the EO-data market survey in the St. Petersburg region is summarised in Table 2-2.

Table 2-2: The market survey of potential EO-data users for different application areas.

Ways of getting information	**Application areas**					
	Ice cover	Forest cover	Env. monitoring	Nature resources	Others	**Total**
Questionnaires sent	10	27	26	8	12	**83**
Organisations visited	6	6	10	5	4	**31**
Replies received	6	2	8	4	3	**23**

2.4.3 The Moscow Region

Dr. A.V. Kouraev (NIERSC) completed during the project period questionnaires for 43 organisations of various types operating in the four specified application areas. Of these 18 questionnaires were completed through direct interviews. Through project participation at a technical seminar on use of satellite data within forestry (in Moscow, 18. November, 1998) additional 13 replies were obtained, from about 30 relevant participants. At the project user demonstration workshop at ESA Office in Moscow, information from additional two participants were obtained. Through personally agreed mail and faxes additional three were reached and by on-ward distribution of questionnaires through prime contact additionally seven replied.

In addition, a direct mail survey was initiated and 112 letters were sent to Russian oil companies and to 12 state forest management bodies all over the Russia. The positive success rate of this survey was as low as around 10%, although the visibility and marketing effect of the project has later turned out to be more significant than the actual number of replies indicates.

2.4.4 The Siberian Region

Prof. G.V. Erokhin (SRCS) performed an in-depth analysis of the state of the EO data market and user requirements within Siberia, which was done through completion of the questionnaire by identified potential users of EO data. More than 50 questionnaires were distributed among the organisations and enterprises of Siberia. About 30 organisations and enterprises from all Siberian regions replied and returned the filled questionnaires (some in duplication with the NIERSC survey).

2.4.5 The Moscow Region and other parts of the Russian Federation

NITs IPR, as a main distributor of Russian EO data, used its current network of around 40 clients as a baseline for completion of the questionnaires. These organisations covered mainly governmental organisations funded through the state budget and some commercial joint-stock companies partly owned by governmental shareholders.

The qualitative and quantitative and analysis of the information content of the questionnaire survey is presented in Ch. 4.1.

2.5 The Regional Thematic Workshops

Based on an initial analysis of the questionnaire survey three locations were selected for the project workshops – St. Petersburg, Moscow and Novosibirsk. In order to obtain the user specific information of relevance for the market survey, it was necessary to include a major part of information about the availability and potential applications of ERS SAR data in the context of the program of the workshops.

For the workshops, all project partners have prepared contributions and shared information material among each other for use in the preparation of the oral presentations. The viewgraphs for the overview presentations given by the Nansen Center in English were partly translated to Russian. The viewgraphs for all the technical presentations, to be given in the Russian language, were made in or translated to the Russian language. Linguistic issues did not introduce any problems in the completion of the workshops and in the information exchange process associated with the workshop completion.

The technical presentation program for the workshops included:

1. *Workshop Background, Objectives and Tasks – NERSC*

   The project organising the workshops is based on the RSA & ESA co-operation in the ICEWATCH project. The history of using ERS SAR in the Northern Sea Route (NSR) for ice navigation since August 1991 was described through major highlights. The combined use of Russian and European satellite data was emphasised, for both navigation, offshore industry and environmental and climate studies in the NSR. The user workshops are a part of a market survey and the objectives and methods for these investigations were presented. An overview of the thematic focus of the workshops, the four main EO application areas, and the expected outcome of the project were given. The aim of ESA to establish an ERS/ENVISAT SAR receiving station in Russia, to stimulate integrated use of both Russian and European EO data as well as definition of the requirements to an EO data supply mechanism concluded the presentation.

2. *The ESA Earth Observation program – NERSC*

   A review of the ESA ERS program, its sensors with focus on the SAR instrument and the global SAR acquisition station network including the current lack of coverage of major

parts of Russia were presented. A review of the three major purposes of the ERS mission; the scientific achievements and applications; the human quality of life and its direct applications; and the competitive industry development from the ERS mission, with focus on the two first were presented. The way forward with ENVISAT was described including the mission overview. Concluding with the METOP and Living Planet (Earth Watch and Earth Explorer) programs was the planned way for the future.

3. *The Russian Earth Observation program – RSA and NITs IPR*

   The main objects of RSA and NITs IPR activity were presented, with respect to the launch history and schedule of the main meteorological, natural resources and environmental monitoring earth observation satellites and sensor systems. The technical parameters of Russian satellites "RESURS-O1" and "OCEAN-O1" were shown for earth observation. The benefits of different data archives were described. Among future RSA plans are the launch of the radar satellite "RESURS-ARKTICA" for Earth observations and improving the availability of archive EO data in standard format via Internet.

4. *Ice navigation applications – NIERSC*

   A technical presentation on the development of use of sea ice information in support for ship navigation in the Northern Sea Route (NSR). Particular focus was given to the opportunities in applications of microwave EO data, particular from SAR, for near real-time use in ship navigation in sea ice. The presentation used the experience of the ICEWATCH project to describe the various elements involved in this type of operational application. A technical description of the key elements from data acquisition and processing to data transmission and onboard applications and analysis was given. The application was demonstrated through analysis of various images from the NSR for navigation and mapping purposes (e.g. pipeline planning). The presentation was completed with the CEC project Arctic Demonstration and Exploratory Voyage (ARCDEV) during which a Finnish tanker was escorted from Murmansk to the Ob estuary in April 1998.

5. *Environmental Mapping and Monitoring – NIERSC*

   The use of satellite data (SPOT and ERS-1, 2) for oil spill monitoring was presented. Main steps of image analysis for water oil spill were presented. The ERS-SAR data application for marine oil pollution monitoring in Norway was presented. Combined use of satellite and ground-based data was shown in the example of the Usinsk (Komi Republic, Russia) pipeline accident. The advantages of ERS-SAR and SPOT data for monitoring of technological (marine pollution) disasters and natural (flood) disasters were presented.

6. *Forest Mapping and Monitoring – NIERSC & International Forest Institute (IFI), Moscow*

   The forest mapping and inventory is one of the main fields for satellite data applications in Russia. The techniques of using different satellites (NOAA, SPOT, RESURS and LANDSAT) for localisation of forest fires, forest clear cutting and forest insects damage detection were presented. GIS applications for forest fire protection were shown on the example of Far East forest fire in 1997-1998 years. The benefits of ERS-SAR data applications for forest monitoring and mapping were shown. Combined use of satellite and ground-based techniques for forest state assessment was presented for test areas in the St. Petersburg and Moscow regions.

7. *Natural Resources – NIERSC*

   The application of ERS data for natural resources monitoring were presented. The benefits of ERS SAR data for studies of lineaments and tectonic structure were shown. The

advantages of combined use of satellite and ground-based data for mineral explorations were discussed. The EO data applications were shown in an example of detection of oil deposits in the coastal areas. The Earth surface deformation measurements were presented by using SAR differential interferometry. The examples of EO data applications for ground displacement monitoring related to extensive coal mining were described.

8. *Practical use of satellite data in Russia – SPOT Image*

   State-of-the-art of the SPOT program was presented. The technical parameters of SPOT-4 were shown. The advantages of SPOT image data access were described. Examples of SPOT images applications for monitoring of Russian territories were presented.

9. *Applications of Russian remote sensing data – NITs IPR*

   The Russian systems for satellite data processing were presented. The benefits of NITs IPR satellite data archives were described. Examples of data from "RESURS" for monitoring of pipelines, river run-off and snow pollution were shown.

10. *Siberian Accord, SRSC (Novosibirsk only)*

    Siberian Accord is an interregional association ("non-governmental amalgamation") of economic cooperation between the 19 territories (states, republics, krais, oblasts, autonomous districts) of the Russian Federation within Siberia. The Siberian region covers 38% of the Russian territory (10.000.000 km^2) with a population of 24.4 mill people. The region is rich in natural resources, such as wood, coal, oil, gas, iron and other minerals. The Siberian Accord has a defined policy to utilise EO data for environmental and resource monitoring due to its geographic structure and large areas. Due to winter darkness and frequent haze and cloud cover the high latitude regions can significantly benefit from use of microwave EO data.

    EO data have been used in the different Siberian Research Institutes and administrative institutions. The scientists from the Ecological Monitoring Institute (Barnaul, Aliay Krai) have been working 12 years in remote sensing.

    The Siberian Space Monitoring Center (Novosibirsk) was established with the main objective to develop regional applications of EO data (RESURS) for ecological monitoring of oil spills in the soil, forest fires, etc.

11. *Workshop discussion and participant contributions – NERSC/NIERSC*

    The discussion deals with the satellite data accessible to users, the applications of satellite data for ship navigation (Arctic Region of Russia); pollution and vegetation monitoring in oil-gas exploration regions, the applications of satellite data for forest management and monitoring. The participants discussed the aspects of image processing and image format standardisation for users and new satellite stations locations.

The three workshops were completed on 9. December in St. Petersburg, 11. December in Moscow and 15. December in Novosibirsk. Invited organisations 44 of 35 participated in St. Petersburg, 31 of 23 in Moscow, and 70 of 50 in Novosibirsk.

Project Staff Participation with presentations at the Workshops:

NERSC:	Mr. Lasse H. Pettersson
NIERSC:	Dr. Leonid P. Bobylev, Prof. Vladimir V. Melentyev, Dr. Lola A. Kotova, Dr. Victoria V. Donchenko, Dr. Oleg Eu. Korotkevich (St.P), Dr. Sergey A. Bartalev, IFI (Moscow), 5 administrative staff in St.P., and Dr. Alexei Kouraev (adm. in Moscow)
SPOT Image:	Mr. Evgéne I. Krivtchenko, (Russia representative) (all)
ESA:	Mr. Alain Fournier-Sicre (Moscow)
NITs IPR:	Dr. Alexey M. Volkov (St.P. and Moscow), Dr. Vitaly I. Khizhinitchenko (all)
SRCS:	Dr. Gennady N. Erockhin (Novosibirsk) and 9 administrative staff.

3. The National Market for Applications of Russian EO Data

This section gives an overview of the existing Russian market for EO data. It contains elements of the official policies, the actual satellite data acquisition and distribution as well as the applications of EO data for various environmental purposes. The information is mainly based on sub-reports from the Russian project partners (see Annexes A.6 to A.8).

3.1 Russian Remote Sensing Data Market - An Overview

The vastness of the territories of the Russian Federation, their frequent remoteness in accessibility, the need for the development of various regions of Russia, have all led to the widespread use of satellite earth observation data for industrial, agricultural and environmental mapping and monitoring. As a result, there exists today a diversified and structured system of Earth Observation (EO) data acquisition, distribution, processing and delivery, including various organisations.

The general Russian EO policy is defined by the following governmental bodies:

- Russian Space Agency (RSA),
- Federal Service for Hydrometeorological and Environmental Monitoring (Roshydromet),
- Federal Service of Geodesy and Cartography (RosKartografia),
- Ministry of Defence and
- State Committee on Ecology.

These organisations and others, including the Russian Academy of Sciences (RAS) have developed a "*Federal Space program up to the year 2000*", in which the current remote sensing policy is reflected. The policy includes EO systems that will:

- provide information to the weather forecasting services,
- improve meteorological and ice monitoring information for the Northern Sea Route,
- reduce costs of geological and agricultural activities,
- provide necessary information for forestry and water resource management,
- give information for harvest forecasting,
- determine and forecast productivity of fishing areas and
- enable pollution monitoring and improve mitigation efforts.

The government of the Russian Federation approved a *Concept for State Space Policy* on 26. May, 1996. This document determines the priorities of the Russian Space Agency in a broad range of areas such as [Efimov and Miller, 1997]:

- creation, modernisation and application of space systems and complexes of social-economic importance,
- provide operational/regular spaceborne EO data to federal agencies, ministries, organisations, regional services and other users,
- appoint the main operator of the "Resurs-O" satellite, and provide regularly the users with data from MSU-E and MSU-SK sensors,
- provide calibrated satellite EO data and derived thematic information products and interpretation,

- provide services for manufacturing and delivery of ground acquisition stations and
- perform pilot demonstration projects for applications of satellite EO data for use in environmental studies.

According to the adaptation of the EO policy and the implementation of necessary technological infrastructure, data are acquired and distributed to the Russian user community. Based on the new knowledge obtained using EO data in support of the decision process a feedback process is adopted to implement relevant changes to the EO policy (Figure 3-1).

The Russian organisations operating within the Earth Observation and Geo-information market can be divided in the following categories [Miller, 1997, Miller, 1998]:

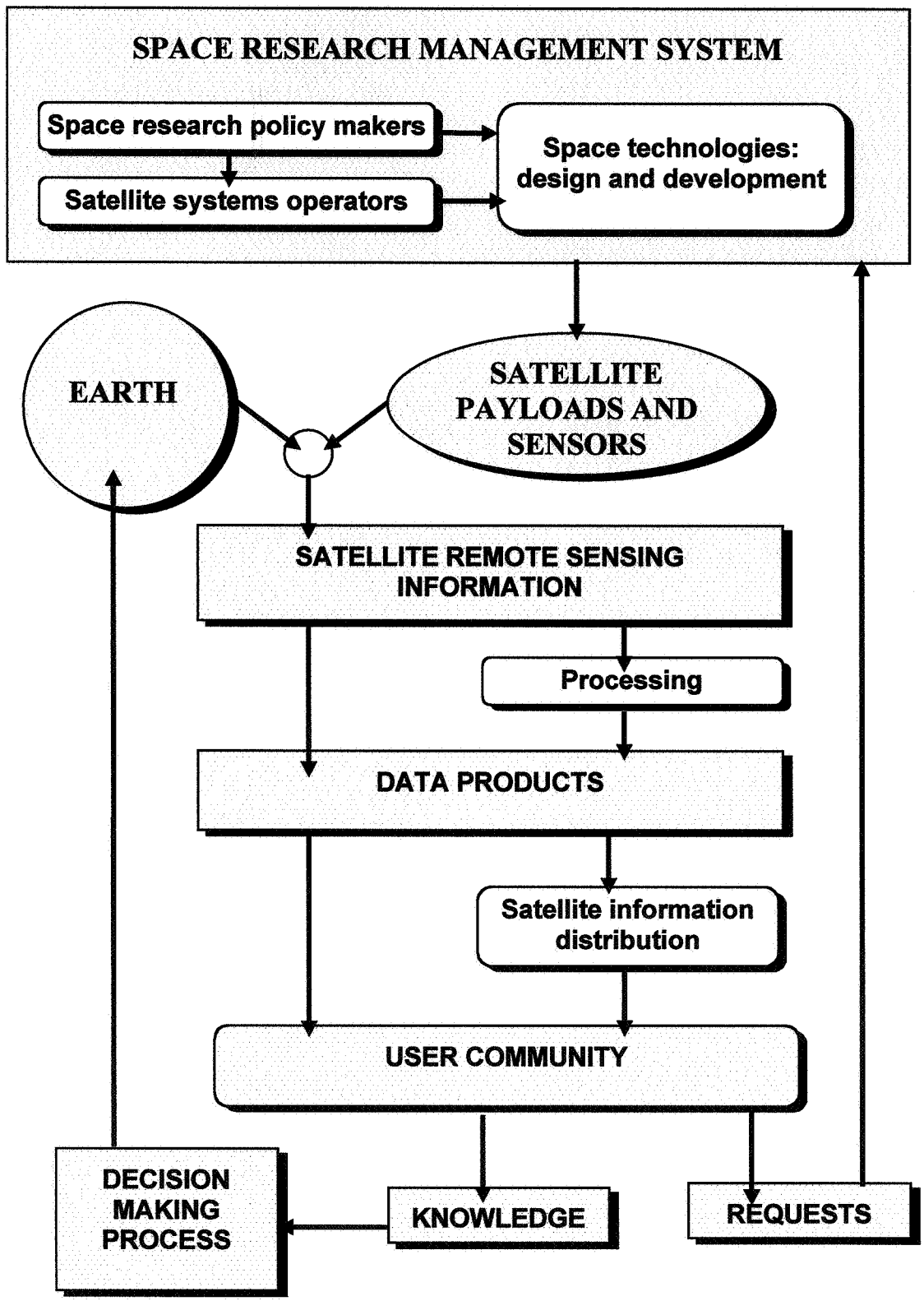
- State management structures
- Remote sensing data providers (acquisition and archiving institutions)
- End-user organisations
- Providers of software for data handling and thematic processing
- Providers of specialised hardware (computer peripherals, ground stations etc.)
- Educational and consulting organisations
- Organisations and companies providing value-added EO based services and products.

At the Federal level the following key organisations are identified as the main users of Earth Observation data:

- Russian Space Agency
- Federal Service for Hydrometeorological and Environmental Monitoring (Roshydromet)
- Federal Service of Geodesy and Cartography (RosKartografia)
- Ministry of Defence
- Ministry of Emergency Situations (MChS / EMERCOM)
- Ministry of Agriculture
- Ministry of Natural Resources (MPR)
- Ministry of Internal Affairs (MVD)
- Federal Security Service (FSB)
- Ministry of Combustible Fuel and Energy (Mintopenergo)
- Ministry of Education
- Ministry of Fisheries
- Gosstroy (Ministry of Construction)
- State Committee of Ecology (Goskomecologiya)
- Federal Forest Service
- State Committee for Land Use (Goskomzem)

A new rapidly growing EO market segment is represented by the regional and local authorities of various regional entities of the Russian Federation (e.g. republics, krais, oblasts, autonomous districts, cities). The traditional market segment exists among commercial companies (value-adding services, shipping companies, users of natural resources, etc.), scientific and scientific-production organisations.

Figure 3-1: The general structure of Russian Earth Observation data system.



3.1.1 An Assessment of the Market for Russian EO data

For the vast territories of the Russian Federation it is necessary to use remote sensing data for environmental monitoring as well as to obtain information about natural resources for their sustainable and cost-effective utilisation. Since the end of the seventies, the use of remote sensing data in Russia has been developed under a free of charge distribution policy. A dedicated implementation policy by the Russian Space Agency has led to a gradual manifestation of the role of remote sensing data as a state-of-the-art source of information for various Russian organisations, as well as the development of new EO information technologies. In general, corresponding expenditures were included in space system costs. In the end of the eighties, GosNITs IPR, as a major national distributor satellite EO data for mapping of natural resources and oceanographic applications, provided data to more than 200 users.

From the beginning of the nineties Russian economy was oriented toward free market development causing a change in the satellite data distribution policy. In spite of the fact that the public budget funds most satellite launches and their use, satellite EO data are now mainly distributed on a commercial basis. During last ten years the Russian economy has been through periods of significant transition. For the development of an EO data market the resources allocated by different departments for purchase of satellite EO data has also decreased.

As a result, during the years from 1996 to 1998, the number of clients of the EO data service of NITs IPR has degraded to only 40. It should be noted that in the previous years users were satisfied, in general, by receiving lower level processed EO data in the form of photo products and applied the data for analyses and interpretation. The current clients demand higher level pre-processed digital data of varying thematic information content. A rather moderate price policy and increased availability of Russian satellite EO data as well as the development of the computer and commercial software market, both contribute to the increase in the number of the new EO data user organisations. For example, some new joint-stock companies were founded with involvement of the ministries, state departments and other public organisations, for carrying out environmental monitoring activities in the public sector for environmental protection, mineral resources exploration, etc. Such establishments are evaluating several options for cost-efficient completion of their tasks, including evaluation of the use of EO data sources.

In 1997 a round table discussion - "*Russian space and remote sensing market*" - was organised [Efimov, 1997]. Around 40 organisations participated in the round table conference, where various issues concerning Russian EO data market were discussed. The conference covered issues related to the main types of EO data, their advantages and limitations for use, user requirements for information and delivery, demands on processing level as well as supportive software tools etc..

According to the survey conducted at the round table, the frequency of use of various EO data were investigated (summarised in Figure 3-2). The most frequently used EO data sources are aerial photography and data from the Resurs-O series, which were used by 22% of the participants. High resolution photographic data (5 meter) from the KFA-1000 sensor and data from the NOAA AVHRR sensors were used by 19%, followed by information from MK-4 and SPOT sensors (16%). The Almaz SAR data are used only by 3 organisations or 9% of the participants, and the KATE-200 images by the same number of users. Other types of remote sensing data were only used only by two organisations, while data from the MIR space station were only used by the Centre for the Preparation of the Astronauts. The use of EO data from

other space agencies were almost absent among the participating organisations, although 6 % of the participants have used data from the ERS satellites.

A ranking of the hampering factors for development of the Russian EO data market identified the following issues [Efimova and Miller, 1997]:

80% - Complicated access to the information on availability, retrieval parameters and quality of EO data for a specified territory;

70% - difficulties to meet the users request for specific territorial data coverage by the Russian providers of EO data;

60% - lack of knowledge on satellite remote sensing possibilities and weak popularisation of satellite retrieval methods for geo-information;

60% - low data quality and consistency of Russian EO data as a commercial product (missing format standardisation, accompanying metadata, full information on survey conditions and sensor characteristics);

60% - lack of widely accessible information on digital thematic and topographic products (GIS products) that can be used in conjunction with the satellite EO data;

50% - lack of consumers demand (open discussions, marketing research) for surveys from Russian satellites and direction of research and design efforts;

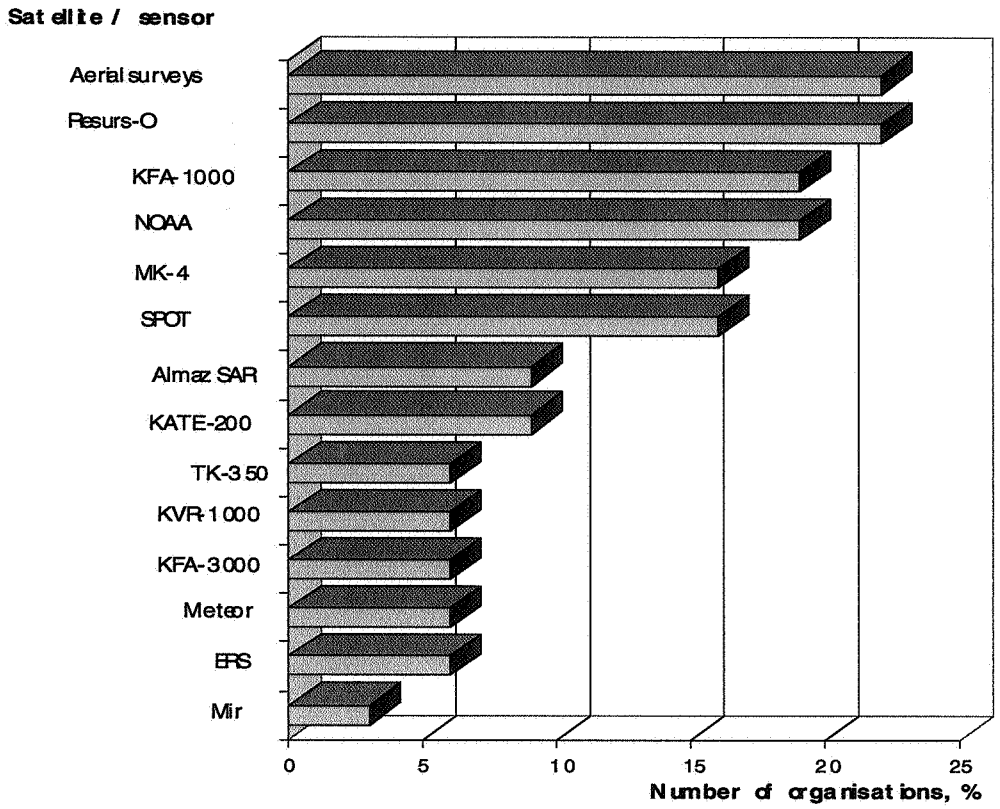
40% - unreasonable strict regime of secrecy concerning use of satellite and cartographic data;

30% - high prices for Russian satellite data;

The majority of the Russian user organisations (94%) use the EO data mainly in the digital format, while a similarly high percent of the users applies data in either raw format (Level-1) or as higher level processed information (81% of respondents). The most frequently used types of data processing routines includes according to Efimov [1997]:

- geometric correction and transformation - 81%
- radiometric correction - 68%
- filtering - 68%
- image quality enhancements- 68%
- original algorithms and methods - 65%
- automatic classification and pattern recognition - 58%
- image mosaicking, production of photographic plans and orthoplans - 45%
- atmospheric correction - 42%
- use of data after thematic processing - 32%
- digital terrain models - 26%
- production of high-quality photographic hard copies - 26%

Figure 3-2: The most frequently used EO data among Russian users [after Efimov, 1997].



The most frequently used image processing software packages in Russia for remote sensing data processing are [Efimov, 1997]:

- Erdas Imagine (19 %);
- ER-Mapper (12 %);
- Original own developed software (9 %);
- XV-HRPT - software developed by Space Research Institute (IKI) of RAS (6 %);
- ScanViewer - software from Engineering and Technological Centre "ScanEx" (3 %);
- Photomod (3 %); and
- IDRISI (3 %)

In general, a limited availability of commercial international image processing and GIS software also hampered the actual use of EO data among these users.

3.2 Overview of the RESURS and OKEAN Satellite Programs

The year 1974 marked the beginning of the era of environmental and natural resources Earth observation sensor satellites in the USSR. In this year the Meteor-18 satellite was launched and it was succeeded by a series of six other satellites, the last one - Meteor-31 - launched in 1981. The payload of these satellites comprised the multi-spectral optical sensors with low (MSU-M) or medium (MSU-S) spatial resolution. This series of EO satellites has been

followed by the launch of the Resurs-O1 satellite, which included the Kosmos-1689 in 1985, Kosmos-1939 in 1988, Resurs-O1 N 3 in 1994 and Resurs-O1 N 4 in 1998. The Resource-O1 series carried already the next generation multi-spectral opto-electronic scanning sensors of higher spatial resolution – the MSU-E - and the multi-spectral opto-mechanical conical scanning sensor of medium spatial resolution – the MSU-SK. At present Resurs-O1 N 3 is operational and Resurs-O1 N 4 satellite undergoes flight tests. Since April 1999 it has not been in operation due to serious technical problems with the data transmission from the satellite. The development of this EO program has mainly contributed to the development of terrestrial and coastal zone application within the Russian Federation and data are currently distributed for use world–wide under international agreements.

During the same period of time also the oceanographic earth observation satellite systems were developed in the Russian Federation. Earliest oceanographic EO satellite was the "Kosmos-1500" (launched in 1983), followed by "Kosmos-1602" (in 1984), "Kosmos-1766" (in 1986), "Kosmos-1869" (in 1987), "Okean-01" (in 1988), "Okean-02" (in 1990), "Okean-03" (in 1991). At present the Okean-O1 No. 7 satellite has been in orbit since 1994. The principal application fields for Okean-O1 satellite series are:

- operational sea-ice status study and estimation in the Polar regions for shipping along the Northern Sea Route and in the Antarctic, and for the Northern Seas offshore operations;
- study and estimation of structure and dynamics of sea ice and ice on large rivers and lakes;
- estimation of the flood-affected areas;
- support of emergency tasks;
- regional and global climate change studies and
- studies of sea surface macro- and meso-scale variability.

The main sensor on board Okean-O1 is the side-looking radar (SLR or RLSBO), which for the first time in the world made it possible to systematically make all-weather observations of land and oceans surface in the microwave range (3.2 cm, VV-polarisation) covering a swath width of 450-480 km. In particular, this sensor made it possible to provide monitoring of the meso-scale sea ice conditions for the entire Arctic seas at a frequency of at least twice per week.

During May 1999, the Okean-O N1 satellite is scheduled to be launched following the series of the Okean-O1 oceanographic satellites. The sensor payload has been considerably extended as compared to the Okean-O1 N7, and the data will be downloaded through a digital link at a rate of 61.44 Mbit/s to dedicated acquisition stations. In particular, the MSU-S optical sensor will be replaced by the more modern scanners MSU-SK and MSU-V. The latter sensor has high ground resolution (50 meter) in the visible and near-infrared (IR) ranges and medium resolution in the middle and far IR ranges. The spectral band locations for the MSU-V sensor is the same as for the Landsat Thematic Mapper (TM), and hence will mainly improve the land surface and coastal zone monitoring applications. Okean-O N1 will also carry another new sensor - the scanning multiband microwave radiometer Delta-2 designed for atmospheric studies. In contrast to earlier Okean satellites, the Okean-O N1 satellite will operate in a sun synchronous orbit and becomes a multi-sensor platform for studies of the atmosphere, natural land resources, as well as the coastal, ocean and ice covered water regions .

During 1999 the Meteor-3M N1 satellite is also due to be launched. The payload is more developed than in the previous Meteor series. The orbit will be sun-synchronous and new

digital data down link will give significant improvements for data distribution. The new sensor payload includes a limb atmosphere sensing sensor - SAGE III, a contribution from USA - designed for the estimation of atmospheric gases content, including ozone, other trace gases, as well as aerosol content.

In a more distant prospect it is planned to launch the radar satellite - Resurs–Arktika. This satellite will follow the Resurs-O1 satellite series, and the sensor payload will include the MSU-SK and MSU-E scanners (the latter with a ground resolution of 22-26 m). Besides, this satellite will carry the MSU-S2 scanner for the mapping of the global vegetation index as well as land surface temperature. The synthetic aperture radar (SAR) "Severyanin" will be operated in several modes providing radar images of medium resolution (130 m) at a swath width of 450-550 km and of high resolution images (30-50 m) at a swath width of 60-80 km. In this respect the characteristics of "Severyanin" are similar to those of the Canadian Radarsat. "Severyanin" also will provide onboard processing of the wide swath (450-500 km) SAR images with a resolution of 300 meter. These images will be downloaded in a HRPT mode (similar to AVHRR) as well as in an APT mode at a one thousand-meter spatial resolution, for direct down-link to small user acquisition stations. The Resurs-Arktika satellite will hence provide high quality EO data in the visible, infrared and microwave spectral ranges that may be used for different applications.

Table 3-1 gives a brief summary of some of the main characteristics of the current Russian EO sensors. For more detailed technical specifications on these and other Russian satellite systems please refer to the Annexes A.6 and A.7 of this report).

Table 3-1: Some main characteristics of current Russian EO satellite sensors.

Sensor	Type	No. of Bands/ Spectral range	Spatial resolution (m)
	Resurs-O1 #3		
MSU-E	Multispectral high resolution scanning sensor	3 * VIS and NIR	45
MSU-SK	Multispectral medium resolution scanning sensor with conical scanning	5 * VIS/NIR/TIR	160 to 600 (TIR)
	Resurs-O1 #4		
MSU-E	Multispectral high resolution scanning sensor	3 * VIS and NIR	30
MSU-SK	Multispectral medium resolution scanning sensor with conical scanning	6 * VIS / NIR / TIR	160 to 700
SRRB	Scanning radiometer for radiation budget	4 * VIS / NIR / TIR	60 km
	Okean-O1 #7		
MSU-S	Multispectral medium resolution scanning sensor	2 * VIS and NIR	500
MSU-M	Multispectral low resolution scanning sensor	4 * VIS and NIR	1200
RLSBO	Side-looking real-aperture radar	3.2 cm (VV)	1300/2500
RM-08	Scanning microwave radiometer	0.8 cm (HH)	15 km

VIS = visible, NIR = near infrared; TIR= thermal infrared spectral range.

The information from the various types of Russian EO satellite data presented above may be used for environmental and natural resources mapping and management. The Russian Federation has launched several EO satellites providing significant flow of remote sensing data, while the number of users capable of adequately using these data are still limited. In some organisations, success has been achieved in using remote sensing data for separate application projects, while in general the situation cannot be considered as very satisfactory.

An evaluation of Russian EO data applications 10 years after the launch of the Resurs-O1 N2 satellite in 1994 one can conclude the following [project report by NITs IPR, Appendix 7];

- the main applications of digital satellite data are within hydrometeorology, geology, ecology and forestry,
- the annual volume of digital data delivered to users peaked at its maximum in 1989 (11.92 Gigabytes), at a time where the data were distributed free of charge to the users,
- a sharp decrease of the data volume occurred with minimum in 1993 (487 Mbytes), which was related to the introduction of cost-recovery for the data,
- a gradual increase of the volume of EO data has occurred since 1993 and
- in 1997 the archives reached a level of 7.65 Gigabytes, of which the purchase of data were only 7.7 % of the total volume acquired.

The most significant achievements of EO data has been made in application areas related to:

- monitoring inundation of river floodplains during spring floods,
- ecological monitoring of land surface pollution near large cities,
- monitoring of forest fires,
- estimation of crops status and harvest forecast,
- sea ice mapping and monitoring,
- mapping geological structures for assessment of mineral resources content and for detection of high risk zones related to mining activities, and
- monitoring coastal zones exposed to significant technogenic influence and pollution.

The Resurs-O1 and Okean-O1 are operational spaceborne EO systems and their data can be used for regular environmental monitoring tasks. The actual monitoring applications can be grouped into some classes differing in their importance, such as:

- forecast, operational control and damage assessment for disasters which originate from natural and anthropogenic phenomena (forest and steppe fires, floods, avalanches, mud flows, oil spills),
- ice monitoring on the seas and inner water bodies of Russia and, in the first place, on the Northern Sea Route and the Arctic shelf region,
- pollution monitoring for coastal waters (e.g. mapping of blue-green algae), of atmospheric pollution (by observing snow cover changes) etc., and
- studies of long term global and regional processes in the environment and their influence on vital human habitat conditions. These processes involve desertification of previously fertile areas, soil erosion, deforestation etc..

3.3 The Infrastructures for EO Data Acquisition and Distribution

The description of the Russian providers and distributors of satellite data is based on the information given in the report in Annex A.6.

3.3.1 Photographic Image Data

From 1974 satellite photographs (except for the materials from military intelligence satellites) obtained from "Kosmos" and "Resurs-F" satellites, manned spacecraft and other space vehicles are stored at and distributed by the State Scientific Research and Production Centre "Priroda".

Up to the middle of 1980-ies the State Centre "Priroda" provided space imagery free of charge for its clients (the number of users of such data in USSR amounted to more than 1000). However, later on acquisition and use of photographic EO materials has changed due to various factors. In 1986 State Centre "Priroda" together with the associations Aerogeodesiya, Kosmokarta and Geodezpribor established the All-Union foreign trade association "Soyuzkarta". "Soyuzkarta" offers commercial photographic satellite images for various parts of the Earth with spatial resolution of down to 5-10 meter. Soyuzkarta has a series of long-term agreements with western companies for distribution of their satellite imagery world-wide.

Commercial distribution of satellite photographic imagery from environmental and earlier military intelligence satellites is being done through the joint-stock company Interbranch association (MA) "Sovinformsputnik" in Moscow. Images of foreign territories with spatial resolution up to 2 m. (for Russian territories up to 4 m.) were unclassified by decree of Russian government dating August 18, 1992, after which "Sovinformsputnik" offered these photographic EO images to the world-wide user community. Significant amounts of aerial photographs and satellite photographic maps are also archived by the Production Geological Union (PGO) "Aerogeologiya".

The following is a brief summary of each of the key Russian organisations involved in distribution of satellite image photographs.

State Scientific Research and Production Centre "Priroda"

State Scientific Research and Production Centre "Priroda" (State Centre "Priroda") was established in 1973 and is a part of the Federal Service of Geodesy and Cartography of Russia. "Priroda" provides EO information from "Resurs-F" and "Kometa" systems ("Priroda" is the main official distributor of KFA-1000 and MK-4 images), as well as photographs from the "Mir" space station module, including EO data from the KFA-3000, KFA-1000, MK-4 and KFA-200 cameras.

Interbranch Association "Sovinformsputnik"

Interbranch Association (MA) "Sovinformsputnik" was created in 1991 by a group of enterprises that were involved in design, development, manufacturing and operation of military-oriented remote sensing systems. "Sovinformsputnik" has exclusive rights for distribution of images from TK-350, KVR-1000 ("Kometa" system); it is also an official distributor of images from KFA-1000 and MK-4 ("Resurs-F1 and -F2 systems) cameras. Its archive contains high-resolution imagery from selected parts of the Earth since 1981.

Production Geological Union "Aerogeologiya"

Production Geological Union for Regional Study of Geological Structure "Aerogeologiya" is a leading organisation in the system of Ministry of Geology for implementation of aerial and satellite geological methods. All-Union Scientific Research Institute of Space and Aerial Geological Methods (VNIIKAM) is a part of the Union.

3.3.2 Multi-spectral EO Data

The information from the first Soviet meteorological satellites of the "Kosmos" and "Meteor-1" series have been received and processed by the Hydrometeorological Centre of the USSR. In 1974 State Scientific-Research Centre of Natural Resources Study (GosNITSIPR) of Hydrometeorological service of the USSR was established in order to design and develop hydrometeorological, environmental and oceanographic space systems. GosNITSIPR was responsible for acquisition, processing and distribution of EO data. The acquisition of multi-spectral sensor data was made by the *Main* Centre of Acquisition and Processing of Satellite Data (GCPOD) in Obninsk (Kaluga region) and at the *Regional* Centres of Acquisition and Processing of Satellite Data (RCPOD) in Tashkent, Novosibirsk and Khabarovsk, respectively. These centres handeled acquisition, processing and distribution of EO data to the users such as organisations of State Hydrometeorological Committee as well as other public organisations such as various Ministries and departments. They also carried out study of user requirements for EO data, studies of the implementation of new data types as well as new methods and technologies of satellite data acquisition, processing and applications.

Up to the middle of 1980's satellite EO information was distributed free-of-charge to the user community, according to the orders of State Hydrometeorological committee of USSR and later on Goskomhydromet. Since January 1, 1985 provision of space based EO information to the users is done on a commercial fee basis, with the exception of use in organisations of the Goskomhydromet and educational institutions under the Ministry of Education of USSR and later the Russian Federation. The users could receive data from central (GCPOD) or the regional (RCPODs) centres of satellite EO data acquisition and distribution. EO data of high and medium resolution were distributed as photo negatives or prints, hydrometeorological information as separate photo images, maps of sea surface temperature and radiation temperature of terrestrial surface, as well as various types of information in the digital form on magnetic media.

The association "Sovzond" was created for commercial distribution of "Resurs-O1" data. It was established as a joint effort of the Russian scientific and research institutes - Electrical Engineering ("Elektromechaniki"), Space Device Engineering, and NPO "Planeta". Until recently data from "Resurs-O1" were transmitted un-encrypted and could be acquired by any organisation in possession of a personal ground station (see also external Appendix A.6, section dedicated to the "Resurs" satellite).

Exclusive rights for distribution of radar imagery from Almaz satellite in Europe and USA were given to the Space Commerce Corp (Houston, Texas, US) and Almaz Corp was created for commercial distribution of these images. Besides, a special trading department was established within NPO "Mashinostroyeniye" for sale of Almaz-1A images. Later an agreement was signed between NPO "Mashinostroyeniye" and Hughes STX (Lanham, Maryland, US) for thematic processing and distribution of radar images. In Russia, data from the Almaz satellite (1991-1992) can be obtained at NITs "Almaz" of NPO "Mashinostroyeniye".

The market survey project has identified the following key distribution organisations for EO data within the Russian Federation;

Scientific and Research Centre for the Study of Natural Resources (NITs IPR)

The State Scientific and Research Centre for the study of natural resources (Gos NITs IPR) was established in 1974 under the auspices of RosHydromet. In 1990 it was transformed into scientific and production association (NPO) "Planeta". In 1997 NPO "Planeta" was divided into NITs IPR and NITs "Planeta". NITs IPR is located in Dolgoprudny (Moscow region), while acquisition of satellite information is being

done in Obninsk (Kaluga region) by NITs "Planeta". The acquired digital satellite EO data are transmitted via radio relay link to the NITs IPR in Dolgoprudny, where main EO data archive is maintained. In a Board decision of April 23. 1999, RosHydromet re-merged NITs IPR under the organisation of NITs Planeta.

Scientific Research Centre of Satellite Hydrometeorology - NITs Planeta

Scientific Research Centre of Satellite Hydrometeorology "NITs Planeta" was founded in 1997 separated from the former NPO "Planeta", founded in 1974. "Planeta" is a leading Russian organisation for the exploitation and development of national Earth observation satellite systems for hydrometeorological ("Meteor", GOMS), oceanographic ("Okean") and environmental ("Resurs") purposes, as well as operational acquisition of data from the western satellites (NOAA, METEOSAT, GMS, SPOT etc.).

Engineering and Technological Centre (ITTs) "ScanEx"

Engineering and Technological Centre "ScanEx" was formed in 1989 in order to develop and implement innovative technologies for access to environmental, ecological and meteorological information. In August 1996 "ScanEx" started acquisition of data from "Resurs-O1" satellite on a personal ground station (PGS), that was designed and developed by orders from the Russian Space Agency. Currently 12 PGSs "ScanEr" staions for receiving "Resurs-O1" data within the radio frequency are in operation (Table 3-3 and Figure 3-3).

Siberian Remote Sensing Centre (SRSC)

Siberian Remote Sensing Centre was created in 1997 as a non-profit non-governmental scientific organisation, by the integration of efforts of the three state organisations. These were (i) The Regional Data Acquisition Centre (RCPOD) of Western Siberia, (ii) The Regional Association "Siberian Agreement" and (iii) the Institute of Computational Mathematics and Mathematical Geophysics of the Siberian Branch of the Russian Academy of Sciences. The purpose of SRSC is to provide interested departments and organisations in Siberia with satellite data for various purposes of environmental monitoring and management (further information is given in Ch. 3.4 and Annex A.8).

3.3.3 Regional Russian EO Acquisition Infrastructure

The three main Russian regional EO data acquisition centres are located in Obninsk, Novosibirsk and Khabarovsk. In addition there are a number of personal ground stations (PGS) providing access to download satellite images from the "Resurs-O1" satellite series. Currently 12 such "ScanER" PGS stations, delivered by the Engineering and Technological Centre "ScanEx", are in operation (see Table 3-2, Table 3-3 and Figure 3-3). These PC-based stations are well suited for use at research and education institutions and regional environmental monitoring centres etc. to provide real-time access to satellite EO data.

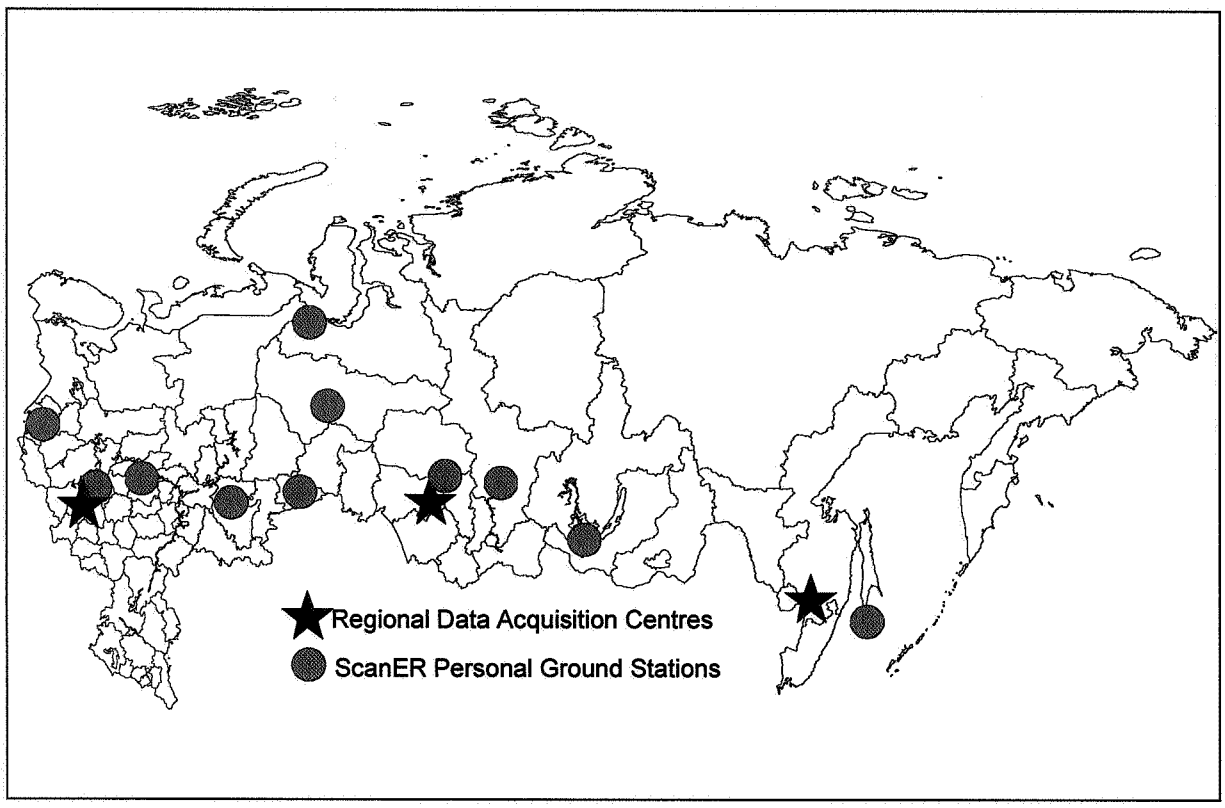
Table 3-2: The technical specifications of the ScanER station [Source: ScanEx Web site].

Antenna type	parabolic dish
Dish diameter	1.6 m.
Polarisation	circular, right-hand
RF input frequency	8175-8225 MHz
LNA noise temperature	55 K
Data rate	7.68 Mbps
Positioning accuracy	0.1º
Operational (survival) wind speed	15 (40) mps
Working temperature range	-50ºC - 50ºC
Antenna system weight	70 kg

Table 3-3: List of current ScanER PGS users [Source: ScanEx Web site].

ORGANISATION	**Location**
Engineering and Technological Centre ScanEx	Moscow
Regional Committee for ecology	Kurgan
Nature Protection Committee of Yamal-Nenets Autonomous District	Salekhard
Krasnoyarsk Scientific Centre	Krasnoyarsk
Ministry of environmental protection and natural resources of Khanty-Mansiysky Autonomous district	Khanty-Mansiysk
Tomsk State University in cooperation with NPO "Sibgeoinformatika"	Tomsk
Tomsk physics and technical institute	Tomsk
Architecture academy, cadaster faculty	Nizhniy Novgorod
Ecological problems institute	Ufa
Scientific and Research Institute of Space and Aerial Geology Methods (VNIIKAM)	Saint Petersburg
Dal'geoinform	Yuzhno-Sakhalinsk
Baikal RIKTs	Irkutsk

Figure 3-3: Location of some satellite EO acquisition stations in the Russian Federation



3.4 An Example of Regional Co-ordination

3.4.1 The "Siberian Accord"

The interregional association of economic co-operation SIBERIAN ACCORD is a non-governmental co-ordination of the 19 territories of Siberia. These are the republics - Altai, Buryatia, Khakasia, Tyva; the krais - Altai, Krasnoyarsk; the oblasts - Irkutsk, Chita, Kemerovo, Novosibirsk, Omsk, Tomsk and Tyumen; and the autonomous districts - Aginsk Buryat, Evenk, Khanty-Mansi, Taimyr, Ust-Ordynsk Buryat and Yamalo-Nenetsk.

Siberia, with its territory of 10,000,000 sq. km (i.e. 38 % of the territory of Russia) and a population of 24.4 million people. The territory of Siberia is similar in size to Canada. 25 % of the global wood deposits and 27 % (161 billion tons) of its coal are located in Siberia. 32 % of the world's gas deposits is to be found here. The deposits of iron ore amount to 7.1 billion tons and there are 98.5 million tons deposits of manganese ore. 82 % of Russia's aluminium, and 61 % of its refined copper is produced in Siberia. 60 % of the world's peat supplies are also found here.

According to the latest estimate, the value of the main natural resources of Russia amounts to US$ 30 trillion. Siberia is one of the richest parts of Russia with respect to natural resources and almost half of these natural resources of the Russian Federation are located in Siberia.

The Siberian industry is represented by 9,000 industrial enterprises. The Siberian Branch of Russian Academy of Science and its headquarter in Novosibirsk - Akademgorodok (Academic township) are known all over the world.

The supreme representative body of the association is the Council, which consists of Heads of the 19 territories of Siberia, as well as leaders of legislative bodies of these territories. The 19 Leaders of these territories are also members (senators) of the Federal Council – the highest chamber of the Russian Parliament. The Chairman of the Council is Mr. Vitaly Mukha, the Governor of Novosibirsk Oblast. The Director General of the Executive Board is Vladimir Ivankov, who is also Deputy Chairman of the Association Council.

The Council examines the most urgent regional problems. As a rule, the representatives of the President, the Government and the Parliament take part in the work of the Council, which indicates the significance of problems of Siberia to the whole of Russia and offers the possibility of solving regional and state problems quickly and efficiently.

The association considers important questions of economic policy, which affects one third of Russia's territory. It is therefore directly concerned with investment, effective and sensible use of natural resources (tenders, rental payments etc.), foreign economic relations, science and technology policies, agricultural machinery, conversion and industrial policies, construction transport development, crime prevention policies and the public health service. Economic and social programmes are developed by special committees called Co-ordinating Councils.

Co-ordinating Councils are working structures of the SIBERIAN ACCORD, which include the representatives of local authorities, the Government of Russia, scientists and experts. The ideas, proposals and documents are worked out by the working groups of the Co-ordinating Councils.

Ministers of the Russian Federation, heads of Siberian Republics, governors of Siberian territories, directors of major companies, scientists, bankers and financiers, sociologists and politicians, all take part in the work of the Co-ordinating Councils. As a rule the Co-ordinating Councils are headed by the governor or chairman of the legislative body of one of the Siberian territories.

Co-ordinating Councils are established according to economic and social programmes of the SIBERIAN ACCORD. The leaders of Co-ordinating Councils are members of Federal Ministries Collegium and represent the interests of Siberia in the Russian Government.

The Executive Board is responsible for creating new systems of interregional business contacts, contacts with other regions of Russia, with the Government, the Parliament and the President of the Russian Federation, as well as with the world community, international economic organisations and companies. It provides all the members of the SIBERIAN ACCORD with current economic data and details of problems to be solved, as well as helping to implement the adopted decisions.

Together with the federal authorities, the association is working out new methods of management of Russia´s and Siberia´s economy in conditions of decentralisation and market relations and is making a contribution to overcome the economic crisis.

The SIBERIAN ACCORD is concerned with legislation and with establishing and developing new external economic trade and business relations. The association actively collaborates with foreign embassies in Russia, with representatives of companies and international economic organisations and takes part in the work of these organisations in Russia and abroad.

SIBERIAN ACCORD is working out new forms of economic management: it creates corporations, which include industrial plants, trading companies and research institutes.

Substantial results have already been achieved. The first of these is the agricultural corporation "Agrosib" aimed at solving one of the main challenges facing Russia - efficient utilisation of agricultural products. With the assistance of the corporation the achievements of latest technology and global experience are introduced into the creation of new agricultural complexes. The corporation is also engaged in manufacturing of agricultural machinery, in the building and maintenance of miniplants and automated lines for agricultural processing.

3.4.2 The EO Activities under the Siberian Accord

The Siberian Remote Sensing Centre (SRSC) was formed in 1997 by a decision of the Executive Board of the SIBERIAN ACCORD with the purpose of providing satellite data to organisations and departments in Siberia. The founders of the centre are the Institute of Computational Mathematics and Mathematical Geophysics of RAS, the Regional Centre for Acquisition and Processing of Satellite Data of RosGidroMet (RCPOD) and the Regional Association Siberian Accord (represented by the Information Centre EcolMASS). The Novosibirsk ground station for EO data acquisition has been receiving satellite data from the Russian Resurs-O1 satellite since 1989. Professor Gennady Erokhin is the General Director of the Siberian Remote Sensing Centre.

Realizing the imporatnce of joining forces to implement up-to-date space technologies, the Russian Space Agency (RSA) and Interregional Association SIBERIAN ACCORD (IASA) have concluded an agreement on scientific and technical co-operation in the field of outer space investigation and use. The agreement was signed on December 9, 1998 in Moscow. This agreement focuses on the development and realisation of co-operative and regional programs (projects), considering priority directions for science and technology development. The intention is to provide all interested authorities and institutions of Siberia with satellite EO data, which would allow them to meet the social and economic needs in their organisation for environmental monitoring and creation of a space network of telecommunication, television, radio and navigation.

In the framework of the present Agreement between RSA and IASA the following activities are included:

- work out and co-ordinate regional programs and projects on the development of telecommunication systems and natural resources and ecological monitoring of Siberia;
- take joint decisions on finding ways and means to initiate co-operative programs and projects;
- carry out joint meetings to settle the problems in providing the Siberian region as a whole and parts of the Russian Federation, belonging to the IASA, with space information;
- exchange regularly scientific and technical information on the problems of mutual interest; and
- develope expertise through scientific and technological projects relating to the launching of modern space information technologies in the Siberian region and parts of RF belonging to IASA.

To realise the program on space monitoring of Siberia on the basis of modern space information technologies IASA established the Co-ordination Council on Space Monitoring of Siberia (CC SMS). Its first meeting was held on April 8, 1999 in Khanty-Mansijsk. At this meeting the Council panel as well as CC SMS work-plan for 1999 were approved.

The Council panel consists of 45 expert members and includes the head of Khanty-Mansijsk Autonomous Region Administration, Mr. A.V. Filipenko as its chairman, the head of the Earth Remote Sensing Department of RSA (Dr. G.M. Polischuk) and the General Director of Siberian Remote Sensing Center (Prof. G.H. Erokhin) as vice-chairmen. In addition leading officials from state and regional committees, administrative departments and scientific centres from all of Siberia and RF are members of the Council. Among non-Siberian scientific organisations which are members of the Council panel, are the Nansen International Environmental and Remote Sensing Center in St. Petersburg and International Forest Institute in Moscow.

CC SMS strategy covers tracing the state-of-the-art on environmental monitoring in Siberia and fulfilment of the Council tasks; organisation of regional space monitoring centres working together with Siberian GIS centres on remote sensing data application; working out a concept for development of a Siberian space monitoring system.

3.4.3 Siberian Infra-structures for EO Data Acquisition

Regional Data Acquisition Center in Novosibirsk

During the market survey the location of a receiving station near Novosibirsk at the premises of the Regional Data Acquisition Center (RCPOD) was suggested. Without further evaluation the proposal is based on the following facts:

- RCPOD has in operation the basic antenna equipment, to be used in support of the ESA acquisition station for ERS SAR data;
- Competent scientific and operational personnel area available in Novosibirsk to support acquisition of the ERS SAR data and regional use of the data through thematic interpretation and dissemination;
- Communication and data distribution can be made through high-speed external Internet-relay channels linking Novosibirsk with the rest of the world (space link 1 Mbit/s Novosibirsk - Germany, dedicated line 2 Mbit/s Novosibirsk- Moscow -Finland).
- In the framework of the Regional Association SIBERIAN ACCORD a broad co-operation between all interested users of satellite information from various regions of Siberia was established. The co-ordination of space monitoring activities is being done through the Co-ordination Council on Space Monitoring of Siberia, organised by the SIBERIAN ACCORD.
- There is political resolution by the administrative leaders of the regions and the Regional Association SIBERIAN ACCORD, including 19 regions of the Russian Federation, to implement a program for space monitoring of Siberia.

YaNAD State Committee on Environmental Protection - Salekhard.

Yamal-Nenets Autonomous District (YaNAD) covers 750,3 thousands sq.km. More than 50% of its territory is north of the Arctic Circle. Salekhard, the district administrative center, founded in 1595, has a population of 30.400 people. Since 1993 under the new Constitution of the Russian Federation Yamal-Nenets Autonomous District has been related to as the subject of the Russian Federation. The region is an important node in the regional communication network, involving the Northern Sea Route, road and rail road communication and an international airport.

The natural gas deposits of the region are unique and have reserves sufficient to satisfy both

the national needs, and for export. Actually up to 90 % of all the recoverable natural gas reserves in Russia is concentrated in Yamalo-Nenets Autonomous District. Approximately 35 % of the potential oil reserves of Western Siberian oil-and-gas province are located in Yamalo-Nenets district, 174 natural gas, oil and oil-and-gas-condensed deposits have been explored. The region is also rich on wide range of other minerals and natural resources. Due to the extensive exploration of the natural resources a high level of regional concern and efforts are mate within environmental monitoring of the extent and effects of these activities.

In order to perform such monitoring activities the State Committee on Environmental Protection of the Yamal-Nenetz Autonomous District in Salekhard, has since 1996 operated a regional service for acquisition and processing of EO data from the satellites NOAA, METEOR and Resurs-O. At present the service is equipped with two satellite data receiving stations.

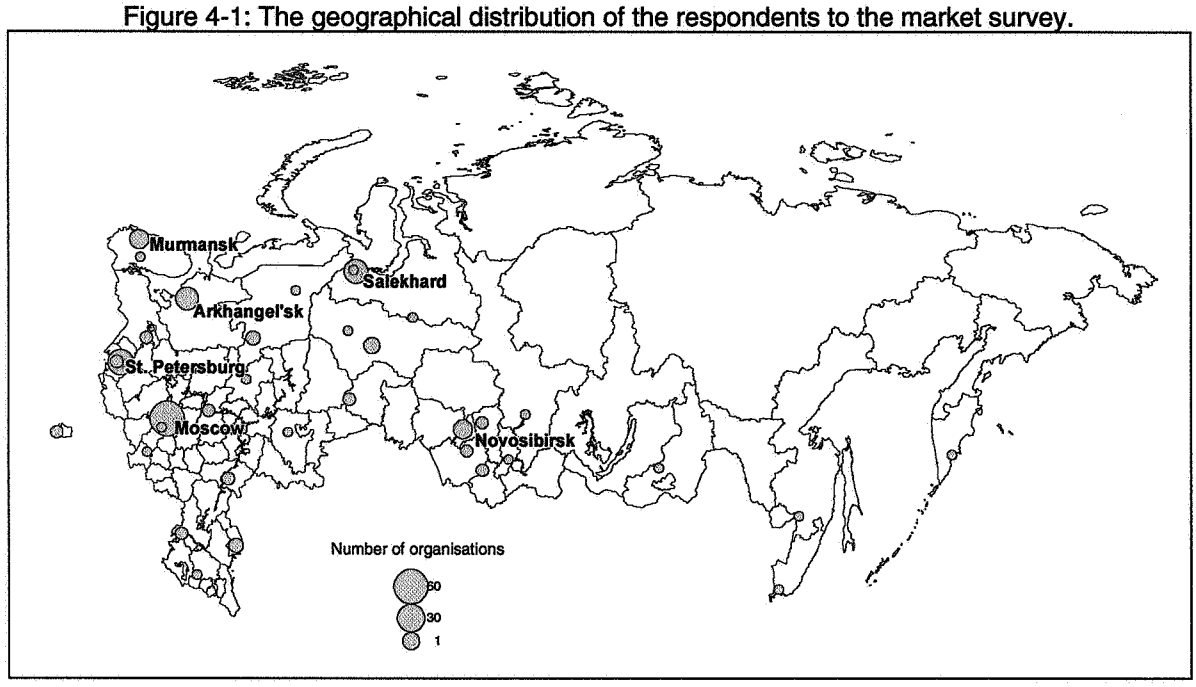
A strong regional interest has been expressed in order to accommodate an ERS SAR receiving station in Salekhard. The local applications will be multiple among other maintain the control of the oil transportation and other shipping activities in the Kara Sea and through the Northern Sea Route. Local and regional use of SAR data for planning and environmental monitoring related to the oil and gas exploration activities, planning of infrastructures such as roads and rail-roads, and flood monitoring. The center is also linked to high speed data communication networks which allows to disseminate data and processed information products to a wide range of users within Siberia, the rest of the RF and abroad. In this respect it is suggested to use the antenna and infrastructure of the existing "Orbita" receiving station near Salekhard. For digital data transmission from Salekhard to Nametkinskaya station (Moscow), the use high-speed channels of the communications satellite "Yamal-100" is suggested.

4. Assessment of the Russian EO Market

4.1 The User Survey

Totally 189 Russian public organisations, institutes and private enterprises responded with adequate information to be included in the market survey database. The geographical distributions of respondents covered most of the territories of the Russian Federation, although with a focus on the European western and northern parts, central and southern Russia, west and central Siberia and only to minor extent the east Siberia and the Far East (Figure 4-1). Some overlap occurred between information obtained from the various organisations in the project team. The gathered information concerned the needs to meet their main mission including their requirements for possible use of EO data in this connection. Requirements for EO data and their delivery, information content, coverage, frequency etc. for potential application of SAR data from the ERS and ENVISAT satellites, in combination with information from other satellite sensor systems, were gathered. Further details on the survey approach are given in Ch. 2.3 and Questionnaire forms in report Annex A.2.

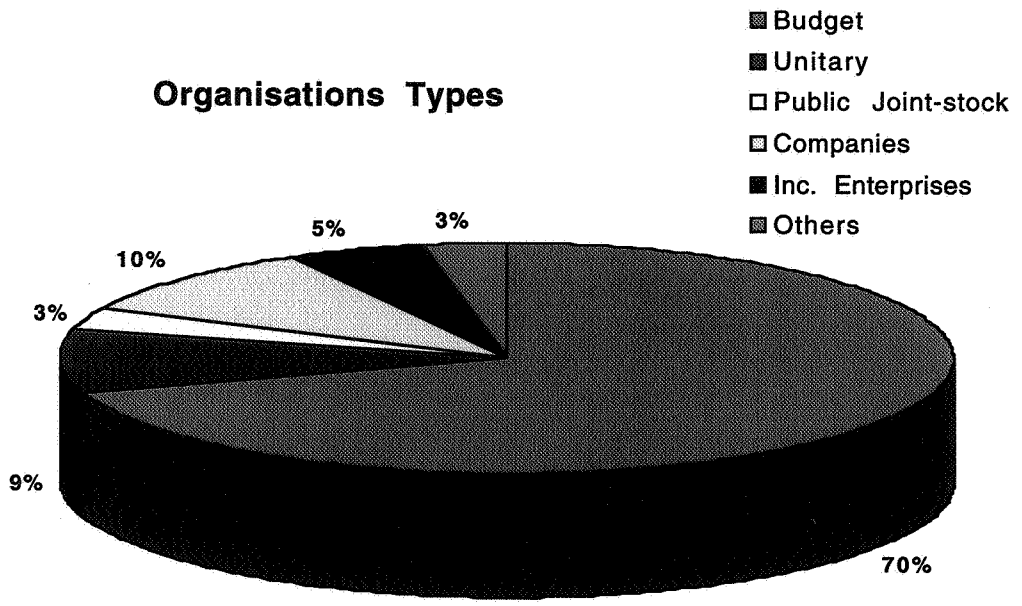
Figure 4-1: The geographical distribution of the respondents to the market survey.



Organisations Types and Funding Sources: 82 % of the respondents were from organisations, which were wholly or predominantly state-owned (see Figure 4-2). This proportion is very large, although it reflects the fact that by tradition many Russian organisations are under public or semi-public administration. During the recent years a transition of organisations to private companies and organisations has occurred, leading to various joint-sector subsidiary organisations. The funding agencies and clients for EO related activities within the contacted organisations are to a very large extent supported from public budgets. In general the survey shows that most of the organisations obtain some kind of public funds, from regional authorities (65%), federal agencies (40%) and from international organisations (24%). In addition 43 % of the public organisations indicated commercial

clients within the oil and gas industry, from other organisations – large industries (22%), smaller industries (24%), consulting companies (16%), Universities (45 %) and educational institutions (19%). In general, the funding sources for each organisation are quite diverse and complex, involving several source types and client categories. It was impossible to obtain any quantitative information on the actual volume or significance of the different funding sources for the institutions. Lack of this type of information makes it difficult to perform a quantitative assessment of the importance of the various funding sources initiating the EO relevant activities. However, this reflects also the fact that the public sector in Russia today depends (considerably) on commercial and other non-public sources to fund its activities.

Figure 4-2: The distribution of the main Russian organisation types covered by the market survey. The Budget, Unitary and Public Joint-Stock is under the public sector and the latter in the joint sector, while the private commercial sector is covered by Companies, Incorporated enterprises and others.



The private sector, including voluntary organisations and international organisations, accounted for only 18% of the survey responses. A large proportion of these organisations (71 %) obtained funding from the oil and gas industry, 47% from minor industry, 24% from private organisations and 35% from other sources. For the incorporated enterprises these figures were even higher, among which e.g. 83 % received funding from the oil and gas industry. This shows that such companies are established in order to serve their parent companies and that to a large extent the EO relevant activities are contracted to this type of subsidiary organisations. Such companies are usually established in order to undertake specific tasks related to the overall consortium activities. Also among the private sector the public funds from regional, national and international authorities are indicated as relevant sources by respectively 53%, 24% and 18% of the responding organisations. This indicates that public sources are also of importance for the private industry. The lack of quantification of budget proportions for each sector makes it difficult to assess the quantitative importance of the various sources relative to the total activity of the organisations. The private market is in general also quite mixed involving various sources of funds for the activities related to exploration and use of EO data and derived information.

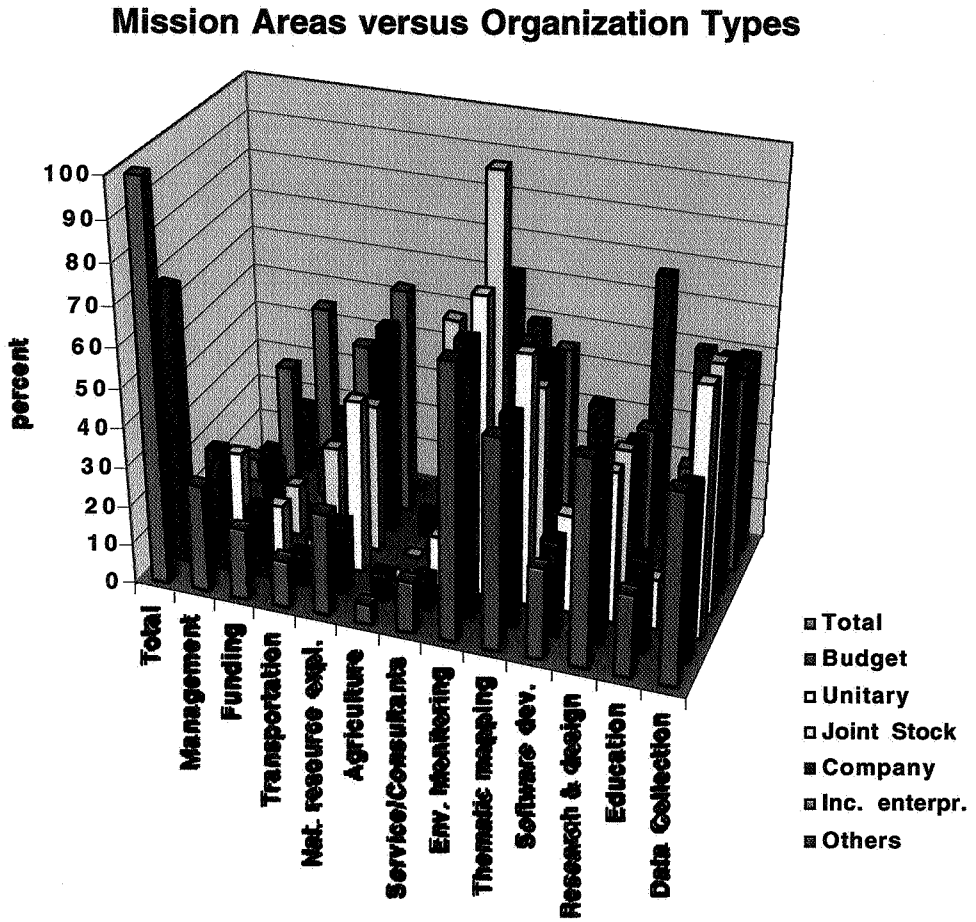
Mission areas: The responses on mission foci cover several application areas for EO data. A wide range of funding agencies, authorities, industry, information providers and users, research and development groups, and educational institutions have been contacted (see Table 4-1 and Figure 4-3). In summary, the mission areas covered all *a priori* indicated areas except for fields such as manufacturing, energy (except oil and gas) and infrastructure maintenance, which are neglected due to the low number of responses. EO applications are relevant within these categories, e.g. hydro-electric power plants, and users could have been identified, although these mission areas were not covered by the survey.

For all institution categories more than 50 % (up to 69%) of the organisations have main mission goals related to "environmental monitoring" and "thematic mapping". Also, around 50% are engaged in "data collection" and "research and design". The survey has, to a large extent, been among organisations involved in the process of generating information used for environmental monitoring, i.e. the value-adding sectors of the EO data use. Organisations responsible for public administration (31%) and direct funding agencies (18%) have been contacted, which are among the end-user categories of EO-based information products. Within the private sector the focus is also mainly on "environmental monitoring", although the exploration of "natural resources" is among the mission goals for over 50% in this category. The so called end-users of the information within management (27%) and funding agencies (18%) have also been contacted through the survey. The survey information is hence adequate and include all major *a priori* defined mission areas within the EO related activities.

Table 4-1: A summary of the responses (in %) to each of the main mission foci, shown for the entire survey, as well as for the various types of organisations contacted. The numbers discussed in the report are high lighted.

		Public			Private		
Main Mission Area	Total	Budget	Unitary	Joint Stock	Company	Inc. enter-prices	Others
No of respondents	189	131	15	8	17	12	6
in %	100	70	8	4	9	6	3
Management	27	31	25	0	12	33	17
Funding	18	18	13	13	0	50	17
Transportation	12	8	6	25	12	42	33
Nat. resource expl.	26	18	44	38	53	58	0
Agriculture	5	7	0	0	6	0	0
Service/Consultants	13	8	13	63	12	42	17
Envir. Monitoring	69	69	75	100	71	50	50
Thematic mapping	53	53	63	50	53	50	17
Software developm.	23	24	25	13	29	25	17
Research & design	52	59	38	38	35	33	67
Education	21	24	13	0	12	25	50
Data Collection	48	44	63	63	59	50	50

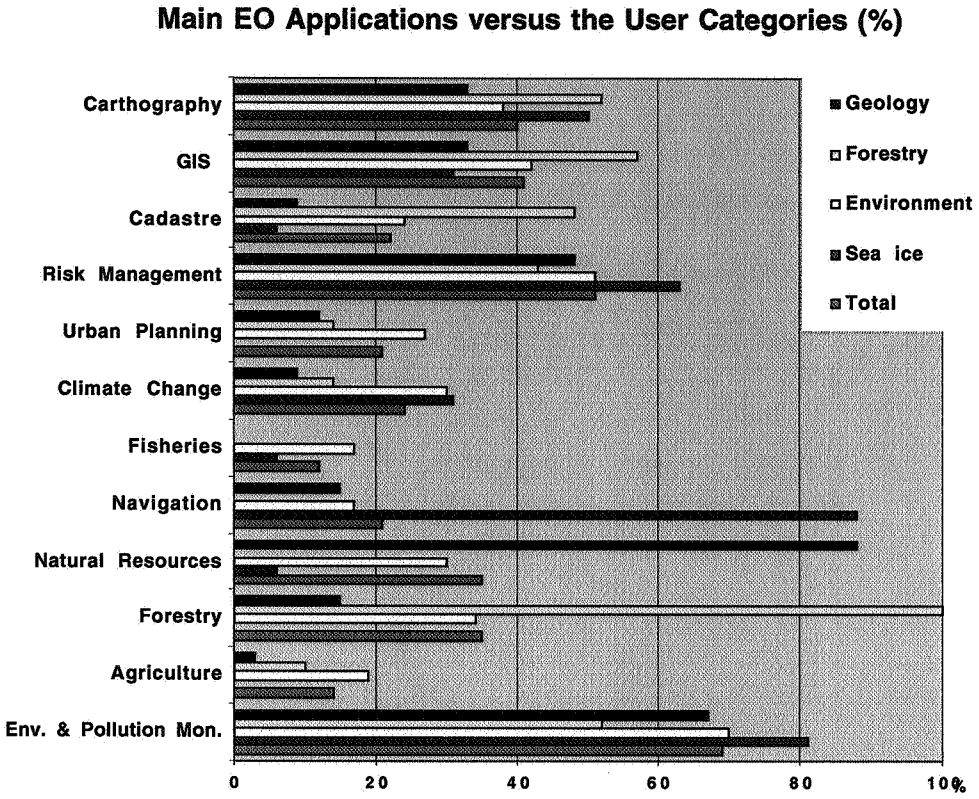
Figure 4-3: A summary of the responses (in %) to each of the main mission foci, shown for the entire survey, as well as for the various types of organisations contacted. The information content is similar as shown in Table 4-1.



EO Application Areas: The responses with respect to the EO applications cover all major areas (Figure 4-4). The application areas related to monitoring of "environmental pollution" (69%) are of concern to a large proportion of the contacted organisations. Related activities such as "risk management", "GIS" and "cartography" are hence also within the application areas of many of the responding organisations. Also in the user categories such as sea ice navigation there is a high level of concern for these issues. This implies that a particular user may have several application areas of SAR data in case these are being used within the organisation. The responses from basic and applied research institutions indicate that each of them covers a wide range of EO relevant application areas and hence they respond to several application areas. Taking into consideration the fact that 77% of the respondents have had experience in use of EO data, the role and use of EO data seems important for a large proportion of the contacted organisations. Except for agriculture and fisheries all application areas have been indicated by over 20 % of respondents. The application areas with greatest development potential seems to be within sea ice monitoring, where the users have identified a significant benefit in use of SAR data compared to the current observation methods. As mentioned above, "environmental monitoring" is among the tasks for many of the users and particularly at high latitudes SAR data has advantages compared to other EO based information sources. "Risk management" is an application of general and high concern to all application areas and hence a field of potential development. The integrated use of EO data in "GIS" and "cartography" applications is also a field where SAR data will have a significant

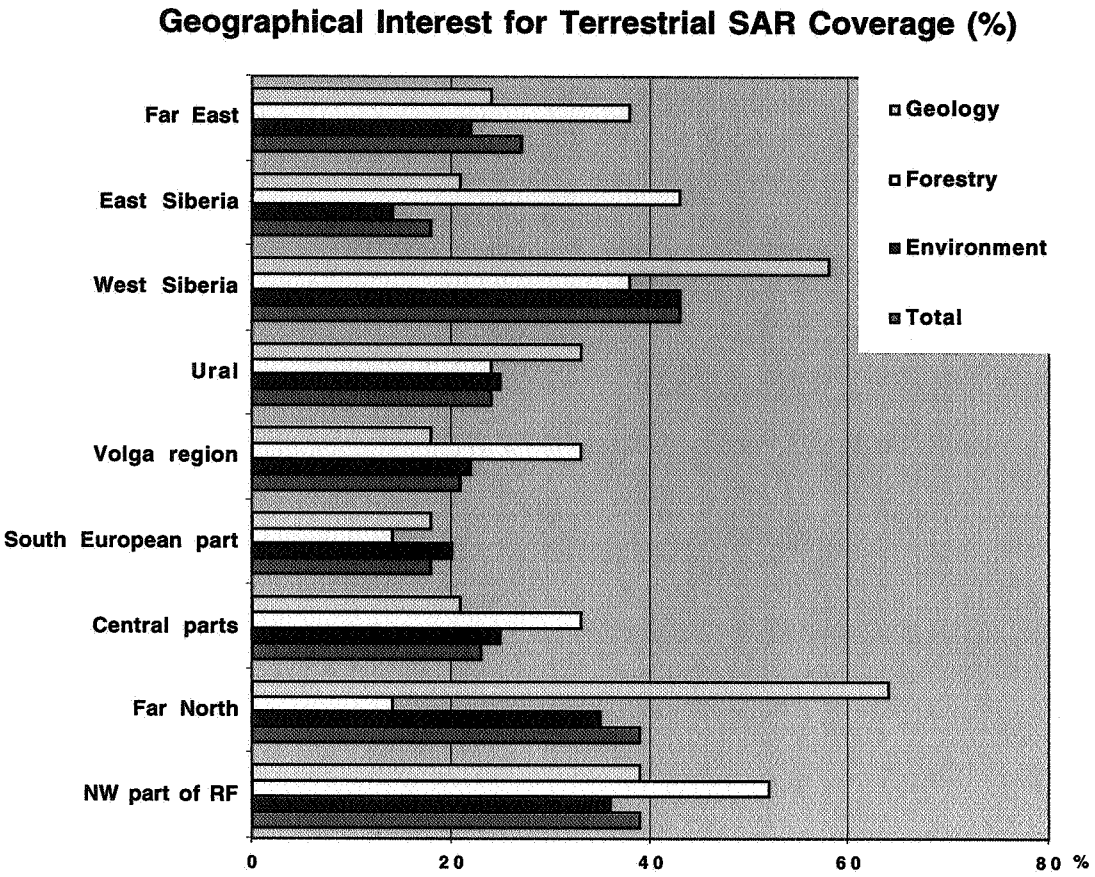
impact. Within mapping of natural resources various parts of the exploration industry has identified their strong interest in using EO data provided that the application methods are well documented and are able to support their main mission and goals.

Figure 4-4: The distribution of responses for various EO applications shown for the total survey and for each category of the main user groups – Sea ice navigation, Environmental monitoring, Forest mapping and Natural resources (geology).



EO Data Coverage: The requirements on geographical SAR data coverage extends over all the main parts of the Russian Federation. For land areas the focus is in west Siberia (43%) and the northern and north-western regions (39%) of the Russian Federation (see Figure 4-5). Also the Far East is of interest to 27%, although very few of the contacted institutions are located in this part of the RF. For "environmental monitoring" the geographical distribution of interest is quite homogeneous all over the RF, although with a stronger focus on western Siberia. For "forestry applications" the NW and central parts and Siberia are of the prime interest. Geographical interest of the private sector is slightly higher in the far northern region, Ural, and Siberian parts of the RF, which is primarily due to the fact that these are the regions containing major natural resources.
In general, the areas of primary geographical interest are to a large extent covered by the existing ESA stations in Europe as well as through a new proposed station in the northern areas of the central or eastern parts of the RF, e.g. Salekhard or Yakustsk.

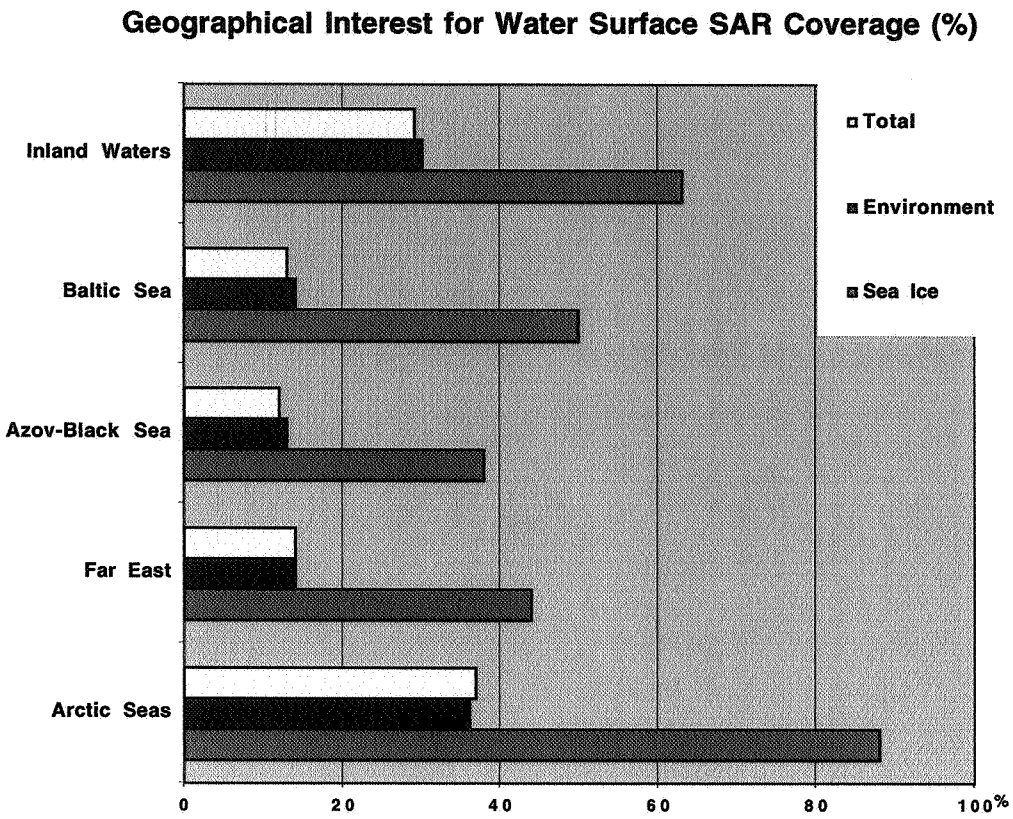
Figure 4-5 The geographical distribution for desired terrestrial SAR data coverage for the total survey and the land application areas.



For water areas the general focus in on the Arctic Seas (37%), and roughly equal (≈14%) on the water regions of the Baltic, Black, Caspian and Far East seas (Figure 4-6). For sea ice applications 88% are interested in the Arctic waters, 50 % in the Baltic sea, and 44% in the far east seas. 63% of the respondents also indicated interest in use of SAR data for inland water bodies, although the geographical requirements for these were not investigated further. From the workshop responses, the great lakes such as Baikal, Aral sea, Ladoga and Onega as well as the river/channel water way systems (including Volga) are of prime interest.

In order to cover the data demand for the major parts of the Arctic and Far East seas a station located in the Yakutsk region is desired in combination with the existing ERS stations. A station located in the Moscow region will cover the Caspian Sea, Black and Baltic Seas as well as some of the major inland water bodies (see also further discussion in Ch. 4.4).

Figure 4-6: The geographical distribution of water coverage for the total and the relevant application areas.



Seasonal Coverage: Year round SAR data coverage are required by 53% (Figure 4-7), with increased interest for sea ice applications during the winter season (44%) and for forestry applications during growth season (43%). This clearly states that there is a requirement for SAR data coverage throughout the year, although with some seasonal preferences for the various applications. One concludes that an ESA ERS/Envisat SAR station in the Russian Federation should allow for year around operations.

In general the observation frequency for SAR data coverage are requests on an "event" (55%) or "one-off" (31%) basis, although on average 19% will prefer a daily data coverage (Figure 4-8). The same level of respondents will also like to have SAR data coverage on a weekly, monthly and annual basis, although with some discrepancies between the various application areas. The main deviation from this general SAR data coverage requirements is that 50% of the sea ice monitoring users would like to have a daily coverage of SAR data in order to meet their mission requirements. In general one may expect that most users of SAR data will order data on an event to event basis connected to particular environmental situations or monitoring tasks undertaken by the organisations.

Figure 4-7: The seasonal distribution of SAR data request.

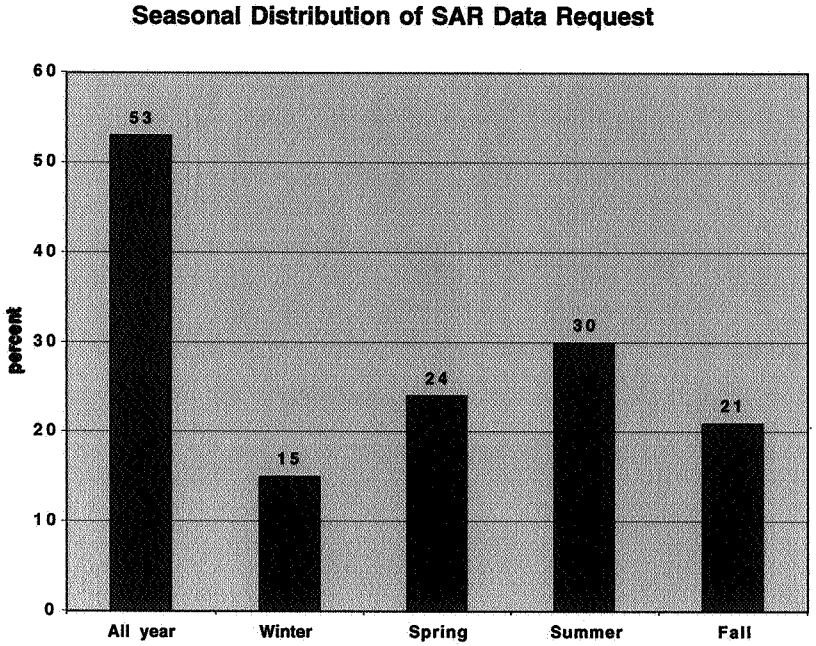
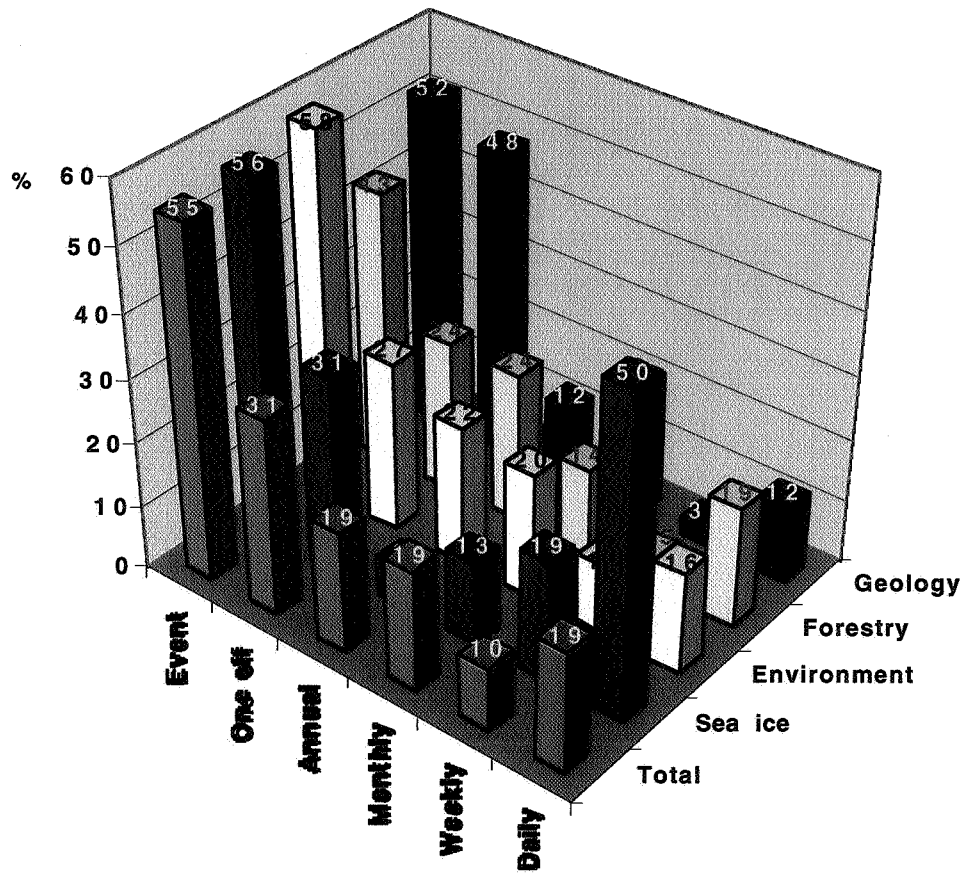


Figure 4-8: The observation frequency distribution for SAR data coverage within the overall and four application areas.

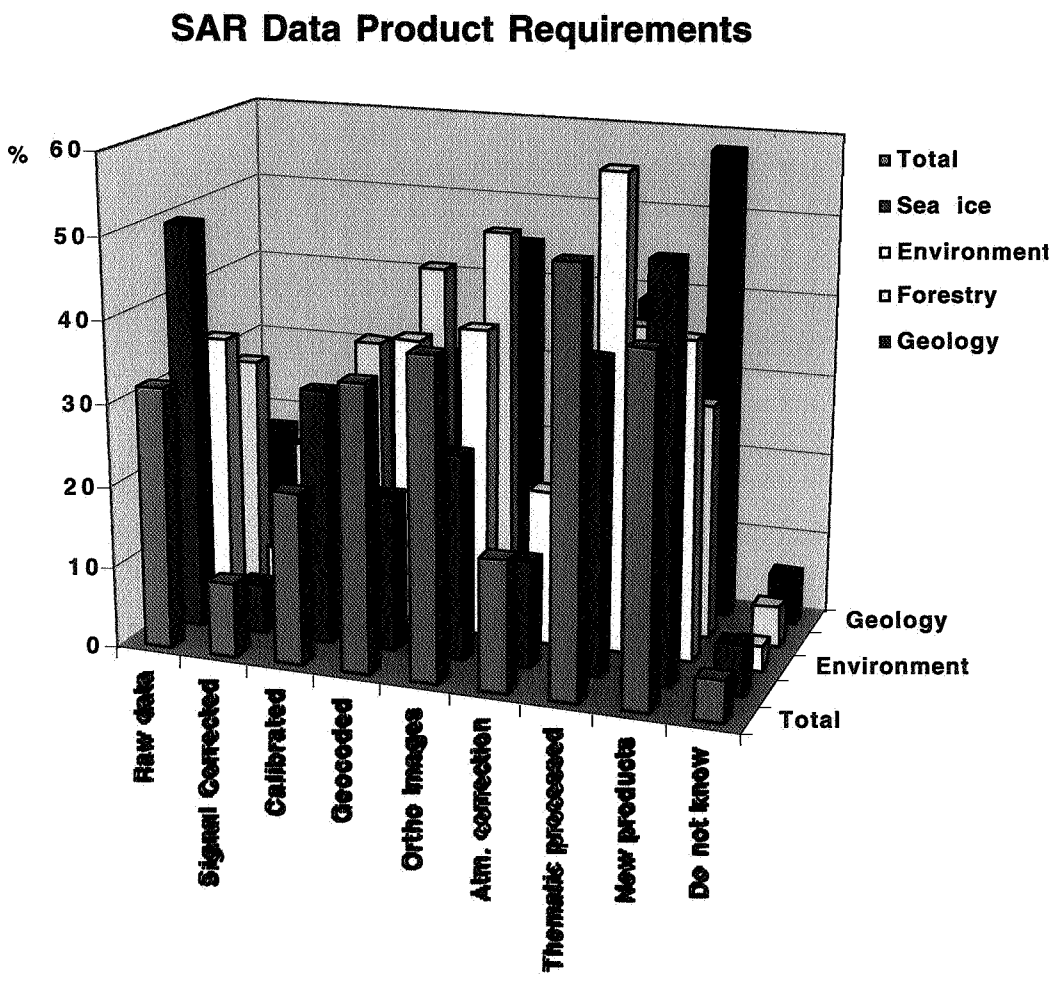


Requirements on SAR Data Products: In general 32% of the respondents would require the basic level image products (Level-1B types) (Figure 4-9). For the sea ice applications as many as 50% are able to use the basic image products or a calibrated product (31%). The lower response may be due to a lack of understanding of the product differentiation causing a lower response to these categories.

The fact that most of the Russian users are acquainted with optical EO data from e.g. the Resurs satellites is also reflected in their responses on SAR data product requirements. Geo-coded and Ortho images were requested by 35% and 39% of the respondents, respectively. For a large part (51%) thematic products are also requested, which implies that there is a need for a value –adding service provider between the data provided by the space agency and the end user of the EO information. As much as 42% also indicated a need for "New Products", which indicates that the many of the users have a prime interest in the derived information products and not necessarily the EO data itself. This fact is more marked in the geology application area (58%) and for sea ice applications (50%). From the workshops one can conclude that within these categories particularly, but also in the other categories, there is a profound need for documented value-added information products in order to stimulate a wider use of EO data sources for information retrieval.

Most of the survey responded had well defined requirements to EO data and the derived data products, supporting the conclusion that the contacted institutions are quite well educated or experienced in the use of EO data.

Figure 4-9: The distribution of the required level of data processing for SAR products required by the users in total, and for each of the four categories of application.



EO Data Experiences: The respondents to the survey were in general very well acquainted with the use of EO data within their field of expertise (see Figure 4-10). 77% of the respondents were already acquainted with the use of EO data within their organisation, the remaining (23%) had never used EO data or did not respond to the question (6%). The main EO data sources used among the respondents were optical sensor data, mainly from Russian satellites and primarily the Resurs satellite series (58%). Among non-Russian satellites the NOAA AVHRR data was the most commonly used data source (22%). With respect to use of microwave satellite radar data, Almaz data had been used by 11%, ERS SAR data by 14% and Radarsat data by 5%. The survey also indicates that the respondents expect future use of SAR data to increase significantly from current level. However, this may not be representative due to the thematic bias/focus of the survey, e.g. for ERS SAR an increase from 14% to 73 % (for future use), as well as for SPOT data (from 12 to 49%). Based on an integrated evaluation of the responses from each contact the project team has performed its own (subjective) assessment of the probability that they will purchase or use EO data in the future. Figure 4-11 summarises the overall assessment for future use and purchase of EO data and the probability for purchase (Figure 4-12) and for future use (Figure 4-13) in the four prime application areas.

Figure 4-10: The frequency of respectively current and future use of satellite EO data among the participating Russian organisation in the market survey.

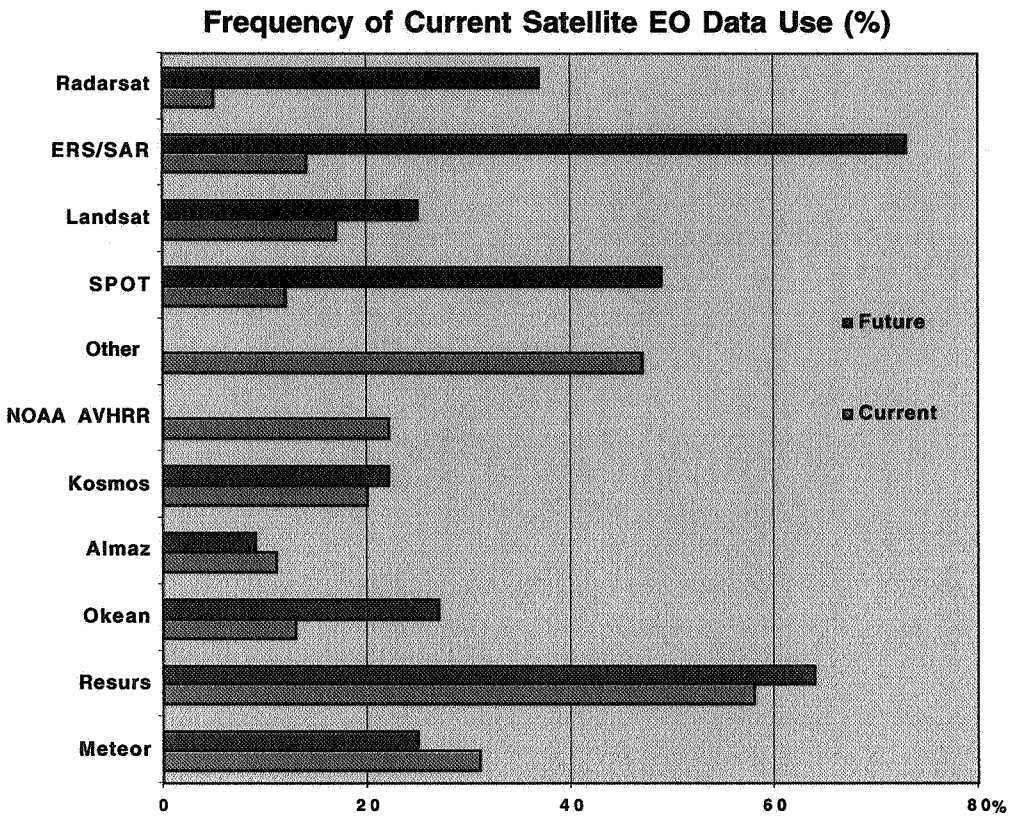


Figure 4-11: The project overall assessment of the probability that the contacted organisation will purchase or use ERS/Envisat SAR data in the future, ranked in High, Medium probability, Unlikely and unable to evaluate.

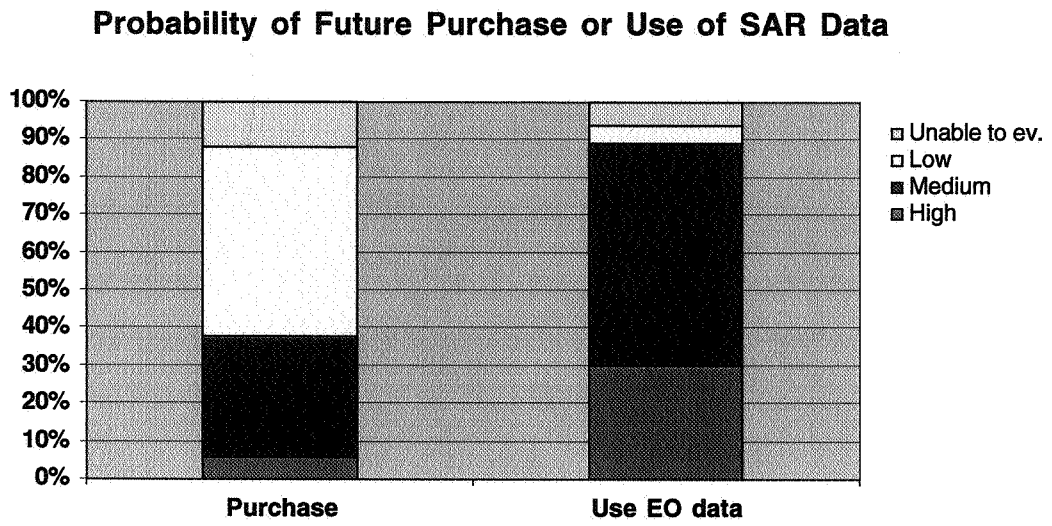


Figure 4-12: The project assessment of the probability that the contacted organisation will purchase ERS/Envisat SAR data in the future, ranked in High, Medium probability, Unlikely and unable to evaluate. The total assessment (same as in Figure 4-11) and for each user category are shown.

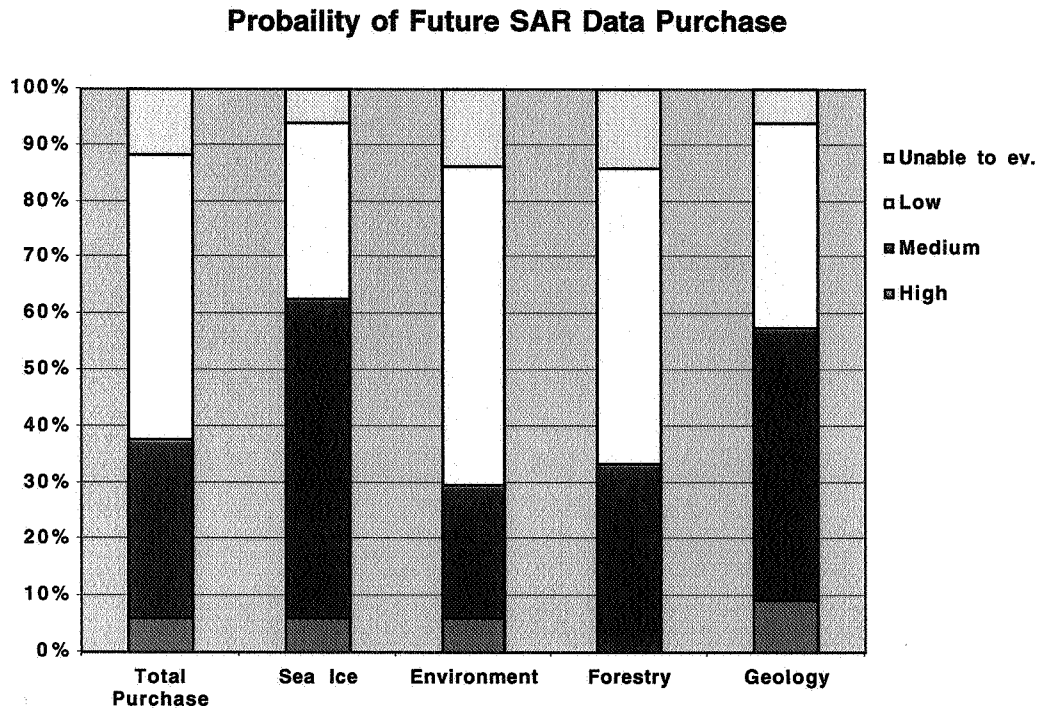
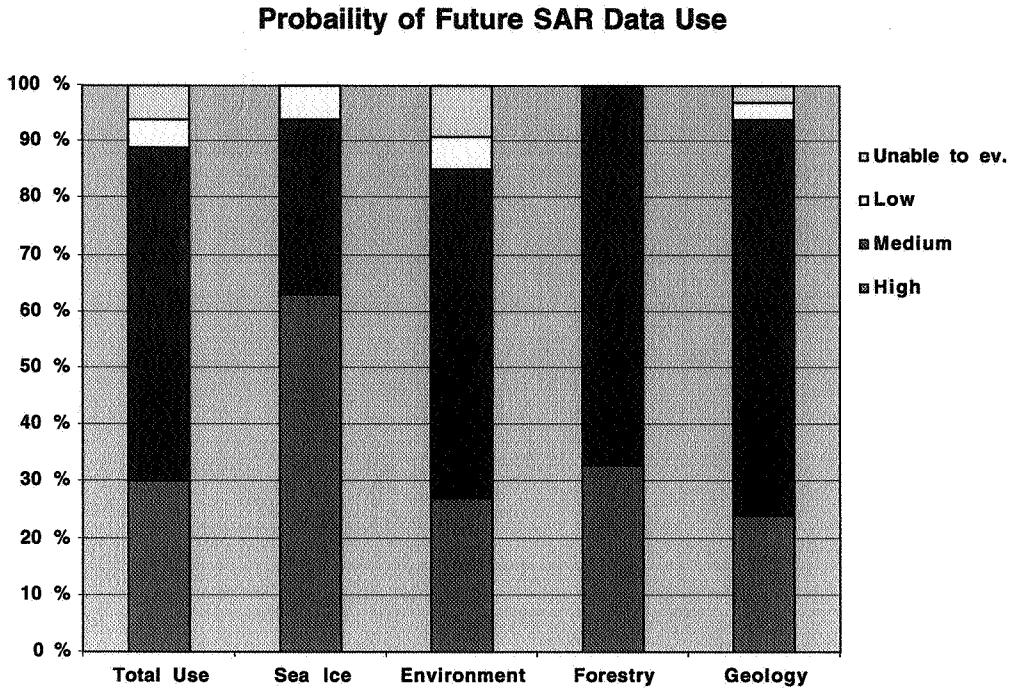


Figure 4-13: The project assessment of the probability that the contacted organisation will use ERS/Envisat SAR data in the future, ranked in High, Medium probability, Unlikely and unable to evaluate. The total assessment (same as in Figure 4-11) and for each user category are shown.



4.1.1 The Regional Workshops

The technical program for the three workshops included the following topics (see also Ch. 2.5) that were presented by the Project team:

- Workshop Background, Objectives and Tasks – NERSC
- The ESA Earth Observation program – NERSC
- The Russian Earth Observation program – RSA and NITs IPR
- Ice navigation applications – NIERSC
- Environmental Monitoring – NIERSC
- Forest Mapping and Monitoring – NIERSC and Int. Forest Institute, Moscow
- Natural Resources – NIERSC
- Practical use of satellite data in Russia – SPOT Image
- Applications of Russian remote sensing data – NITs IPR
- Interregional Association "Siberian Accord", SRSC *(Novosibirsk only)*
- Workshop discussion and participant contributions – NERSC/NIERSC

The discussions and user responses obtained during the three workshops are summarised below.

Saint Petersburg

Leading managers, technical staff and experts in the fields of geology, forestry, cartography,

ice navigation and oil exploration from different organisations, institutes and companies took part in the workshop. The participants noted that Earth Observation (EO) data applications were well established among them and other Russian user organisations. The main experiences of EO applications were with optical EO sensor system and their usefulness for different applications areas were highly acknowledged. It was emphasised that active microwave data were regarded as very relevant for ice navigation and pollution monitoring in the dark winter season as well as under the frequent cloud and haze conditions at the high northern latitudes.

In order to stimulate the use of EO data within the oil exploration industry it is necessary to define in detail the end information product that will be of use for their activity, which must be developed in co-operation between the industry and the EO expert providers. Sea ice mapping is one such field since the Arctic offshore oil exploration and transportation activity is increasing in Russia. The fact that Murmansk Shipping Company now is 51% owned by Lukoil indicates the increased interest in this direction.

It was also pointed out that synergetic use of aerial photography and EO data could be useful for forest mapping and monitoring in the north-western Russia. Planning of aerial surveys were difficult due to the changing weather conditions and satellite SAR data could be complementary information source. Participants emphasised the advantages of SAR data for production of digital bathymetry maps in shallow waters. The combined use of EO information (image information) in vessel traffic control systems (VTS) for both on-board and land based centres for marine traffic monitoring, was of significant interest to one participant.

The lack of basic information on the ESA EO program and sensors, lead to some questions on the satellite sensors technical specifications and how to obtain EO data from European and Russian Space Agencies.

The representative from the Yamal-Nenetz Ecological Committee presented their operational use of Resurs-O data in monitoring areas of their oil exploration fields. The activities included applications on terrestrial oil pollution, vegetation cover and snow pollution mapping.

In summary, the participants expressed a significant need for more information on ESA sensors and their potential applications. More imagery, faster data delivery, easier data ordering and access, validation and thematic image analysis, and integration of EO data in "one" system for users would be desirable.

Moscow

The specialists in emergency and hazard management from EMERCOM, forestry, gas/oil exploration industry and radar technology, different organisations and institutes, Russian (GazProm) and international (Statoil) oil companies took part in the workshop.

The participants emphasised that EO data had its most prospective applications within or monitoring of natural and technogenic disasters and hazards. EMERCOM gave examples of the international exchange of EO data under the STREAM program. In hazard monitoring the emergency authorities are in need of frequent and near real-time access to EO data, which put particular operational constraints on the EO data delivery chain. The participant from GAZPROM was interested in using EO data for monitoring of gas released during pipeline accidents, vegetation cover of oil/gas exploration regions and non-petroleum oil on the water surface, as well as in support of the increased activities in the Arctic shelf region. A concern of international oil companies was related to the actual regulations and demands put on their exploration activities by the Russian authorities, which will be a main guideline for their initiatives. Documented benfits of EO data sources could be included in their offers of supporting initiatives - i.e. improved sea ice monitoring and marine oil spill pollution using

SAR, the latter after a system used in Norway.

The forest inventory specialists asked questions concerning the EO data applications for forest fire monitoring, clear cutting and forest insects detection. It was especially noted that satellite images could be relevant for production of forest digital maps – thematic and topographic. The discussion became quite detailed on specific technical issues of EO technology and data processing for forest applications.

Participants also discussed the issues concerning the location of a new Russian Satellite Receiving Station, image processing techniques, as well as the techniques for validation of satellite retrieval and ground-based data sources. In the higher level educational system gaps were identified in the general training of students, and it was hence suggested that the specialists in Earth Observation data processing and image interpretation should be more active in providing lectures for students within various fields of the higher educational system.

Novosibirsk

The discussion focused on the accessibility of satellite EO data for Siberian users. The participants addressed the aspects of an ERS/SAR receiving satellite station located in the Novosibirsk region. It was noted that EO data were extremely important for the Siberian region, which was difficult to monitor by other means. In particular in the northern regions, where lack of daylight, clouds and haze are frequent, the use of microwave radar technology is particularly favourable for monitoring applications. The applications of satellite EO data for pollution and vegetation monitoring in oil-gas exploration regions were discussed. The degradation of the areas under influence of permafrost due to the greenhouse warming is of significant concern. The issue has both technical impacts on man-made constructions (buildings, roads, railway, pipelines etc.) in the areas, but is also of general environmental concern due to the increased release of methane gas. The use of high resolution EO data to detect hits of meteors was presented. The "SIBNET" (developed in Novosibirsk) a structure for the distribution of EO data within Siberia was presented.

During the discussion, the Ecological Monitoring Institute in Barnaul and Sun and Earth Physics Institute in Irkutsk presented various projects, involving use of EO data sources. The specialists from Ecological Monitoring Institute extensively used RESURS images and aerial photography data as well as in-situ measurements for soil studies. They developed the models that connected the soil moisture and brightness temperatures in themicrowave band as well as spectral reflectivity of soils with their type and humus content in optical band. The specialists from Sun and Earth Physics Institute presented the application of NOAA/AHVRR image applications for forest fire detection for Sakhalin and Khabarovsk regions in Autumn 1998. The results of using NOAA/AHVRR data for monitoring the Lake Baikal ice conditions and water temperature were also reported. These issues are of significant local concern, and future use of EO data that can improve the use of the lake were discussed (determination of circulation pattern, pollution, algae blooming, ice freezing and melting period, water level etc.).

At the end of the workshop a resolution was formulated by the regional participants, in which among other things they decided to address the Russian Federation Government for granting a financial support for the development of Siberian Space Monitoring Centre in Novosibirsk.

4.2 Assessment of the Total Russian User Potential

An assessment of the total number of organisations in the RF operating within the four main

application areas has been done. This assessment does not evaluate the probability that that the organisations directly will use satellite based EO information. An extensive list of most of the organisations included is given in Annex A.5.

4.2.1 Sea Ice Navigation

The major interest for sea ice mapping applications using SAR data in the Russian Federation is related to the shipping activities in the Northern Sea Route (NSR) and the major Siberian rivers. Under the Northern Sea Route Administration the following governmental bodies participate: RosHydromet (Arctic, Antarctic and Marine Administration), Ministry of Transport, Ministry of Natural Resources (Sea and Inland water administrations), Ministry of Fisheries, and the Hydrography Committee of the Navy. A total of 166 major entities are identified.

SAR-based ice information for ship navigation on inland lakes and rivers, the White, Caspian, Bering as well as the Okhotsk Seas, are also of relevance to the authorities and shipping industry. For the NSR the Northern Sea Route Administration is responsible for the management of all civilian ship operations in the region. The State Commission for Arctic Affairs consists of six Ministries and State Committees. In addition sea ice information is of use for sectors such as fisheries, natural resource exploration, mapping authorities, environmental agencies, educational institutions, as well as the HydroMeteorological Services. The key end users in this respect will ultimately be the ship captains and/or ice pilots on board the ship in operation or the escorting ice breaker service and their on shore management. Other active users are the authorities at various levels to monitor and enforce regulations for the shipping activity, at federal level to the local port authorities responsible for the local activity in their area. Along the NSR and in the main Siberian rivers around 16 ports are in operation for major parts of the year (see Figure 4-14).

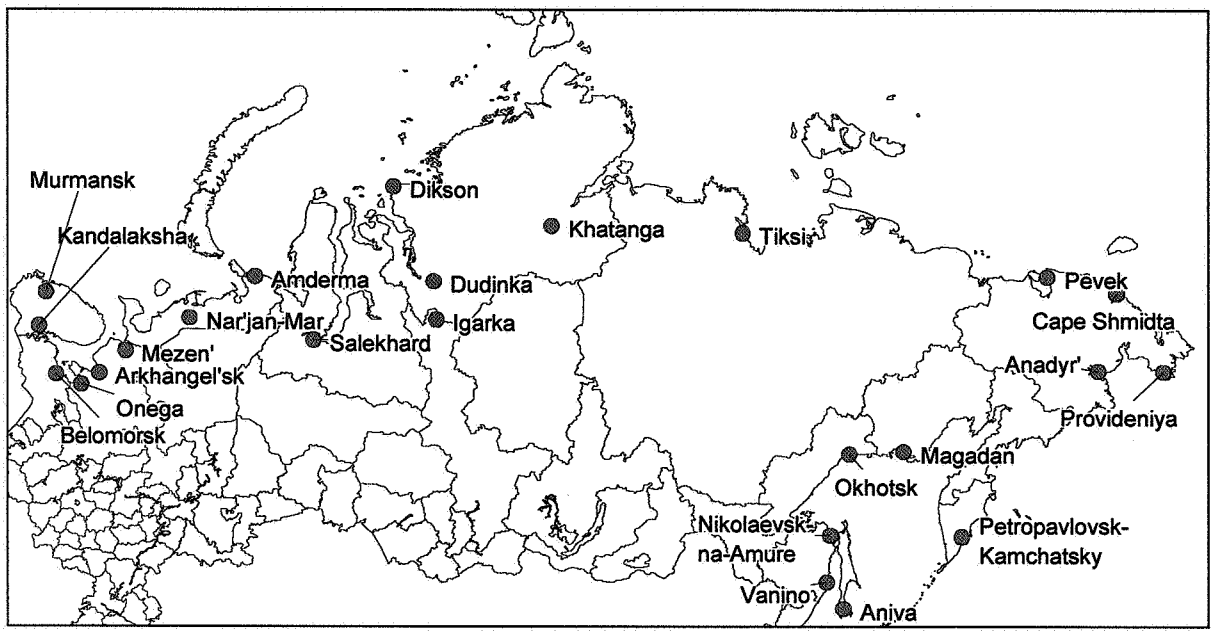
MANAGEMENT BODIES OF FEDERAL LEVEL	
Ministries and State Committees	11
Committees and Management Bodies at Regional and Republic level	71
Industrial and Scientific - Industrial Enterprises	21
Scientific and Research Institutions	15
Federal Training and Educational Institutions	6
ORGANISATIONS OF REGIONAL SUBORDINATION:	
Shipping Companies – operating in ice covered waters	13
Arctic Port Administrations (with ice cover 23)	16
Regional Training and Educational Institutions	3
Shelf Oil and Gas Companies	7
Scientific and Consulting Companies	3

4.2.2 Regional Environmental Monitoring

Environmental monitoring in Russian Federation is managed under the State Committee for Ecology and its subsidiary regional committees for ecology (89, one for each of the

constituent entities of Russian Federation), thus adding up to 90 organisations at the federal level. These regional environmental monitoring bodies operate under a high level of regional independence, since several obtain their sources of funding through direct local taxation of the industry using the natural resources in the region. A significant number of organisations and bodies deal with ecological monitoring and nature protection at the local levels (level of city, sub-region, town, village, etc.), but this number is difficult to determine.

Figure 4-14: The main ports in the Russian Arctic and Far East, in which the shipping activities are hampered by the ice conditions.



4.2.3 Forestry

Total number of various types of organisations within the system of Federal Forest Service of Russian Federation (RF) is 213, of which there are 86 forest management bodies at a federal level and 127 subsidiary organisations locally.

Source: Directory of office phones of workers of federal forestry service of Russia (on state at 1 January 1998) /Federal forestry service of Russia, Moscow, 1998, 66 pp.

MANAGEMENT BODIES OF FEDERAL LEVEL	
Federal Forest Service of Russia	1
Forestry management bodies in the republics of the RF	21
Forestry management bodies in Krai, Oblast and autonomous formations of the RF	64
ORGANISATIONS OF DIRECT SUBORDINATION:	
National parks	4
National parks subordinated to forestry management bodies in constituent entities of the RF	29
State Forest Management Enterprises	12
Scientific and Research Organisations	14
Institutes for qualification improvement	2
Other organisations of direct subordination (including 26 airbases and forest museum, forest information services etc.)	32
Special education organisations of the federal forestry service	21
Forest technical schools	4
Other organisations (such as magazines, banks, joint stock companies etc)	9

4.2.4 Natural Resources

Among organisations dealing with management, exploration, transportation etc. of natural resources, information was obtained for several systems or types of organisations: Russian Geological Service (1132), Russian Service for Water Management (159), and Russian oil and gas companies (259).

A) Within the Russian Geological Service total number of 1132 organisation was identified, of which:

FEDERAL LEVEL OF SUBORDINATION	
Ministries and State Committees	76
Industrial and Scientific-industrial enterprises	24
Scientific and Research Institutions	47
REGIONAL LEVEL OF SUBORDINATION:	
Institution and enterprises	948

Source: Directory of enterprises and organisations (on 1 July 1997). Book 1. Geological service of Russia (Federal level of management). /Ministry of natural resources of Russia, 1997

B) The system of Russian Service for Water Resource Management comprises the following 159 organisations:

Regional basin water management services	23
Directions of water reserves under constructions	7
Scientific organisations	13
Various organisations subordinating to the regional water management services	116

Source: Directory of enterprises and organisations (on 1 July 1997). Book 3. Water industry management service of Russia /Ministry of natural resources of Russia, 1997.

C) Total number of Russian oil and gas companies operating within the Russian Federation is 259. No distinction between federal/regional levels can be made from the data available.

Source: Golden fund of oil business, 1998. Section: Oil and gas extraction enterprises. Russian federation.

4.3 Key EO Application Areas of Concern for Russia

Analysis of the information acquired during the project implementation shows that satellite EO data coverage are requested for large parts of all over the Russian Federation. Both high spatial resolution and frequent coverage is necessary for many industrial organisations and authorities within various application areas. Various issues in application of EO information are described below for each of the main application areas.

4.3.1 Sea Ice and Marine Applications

Sea ice information for Navigation support

Of relevance to all marine activities is information on the ice edge and distribution, ice type (age), thickness, concentration and ice kinematics. Satellite data on ice cover, sea ice features and thickness obtained in the near-real time mode are necessary for safe and efficient ship routing during winter conditions. In addition, sea ice information is essential for off-shore oil and gas exploration activities, pipeline constructions in land and water areas, marine insurance companies etc.

Studies of marine resources

Of direct importance for fishery operations are hydrological conditions, such as location of ocean fronts, boundaries of cold and warm water masses, eddies and rings, internal waves and up-welling zones. Other important issues are operational mapping of sea surface temperature and the spatial distribution of phytoplankton, organic matter and marine pollutants including oil contamination. Sea bottom relief and assessment of coast line changes will be useful for coastal management and analysis of marine pollution effects.

4.3.2 Environmental Monitoring Applications

Oil and gas contamination

One of the most important issues for ecological monitoring is related to the intensive oil and gas production activity, mainly in the northern territories of the Russian Federation. The pollution issue is related to both monitoring of the terrestrial and marine contamination of the

environment. Pollution sources are associated with drill sites, the extensive network of oil and gas pipelines, and land and waterway transportation of oil and gas. For instance over two thousands cases of oil pipeline leakages occur annually in Siberia. In assessing hazardous situations along the oil pipelines and at oil and gas exploration sites, remote sensing will be very useful in determining the risk factors based on remoteness and natural condition of the territory. Until recently damage assessment from terrestrial oil pollution has been based on the use of EO data from the Landsat and SPOT satellite sensors, and only to a minor degree on the use of SAR data. Due to the frequent haze and cloud cover over large areas of Russian territory, the use of active microwave EO imagery is very promising.

Extent of the Permafrost area

Mapping of climatic changes in the geographical extent of permafrost conditions is essential. The information is related to the general issues of the release of methane gas to the atmosphere as well as to the significant change it will have on man-made constructions and activity in the area of changing frost conditions (movements of pipelines, roads, railway lines, dams, buildings etc.).

Floods

River flooding is an important problem of concern in various parts of Russia. Information related to the water equivalent in the snow cover, the melting process, critical ice barriers in rivers and lakes is of significant importance for forecasting spring-floods.

Erosion, landslides and avalanches

Both riverbed and ravine erosion caused by floods due to snow melting or extremely high precipitation activity, are important issues for many regional authorities. Estimates of the excessive soil moisture content, localisation of landslides or mudflows, snow avalanches, and risk assessment for these factors are also of paramount importance for many regions of Russia.

Other natural hazards

The detection of areas with changes of surface relief as a result of earthquakes can be used in seismic zoning and earthquakes prediction. In order to acquire multi-year data set for land use, such factors as albedo and reflective properties of Earth surface should also be studied.

In addition the survey also identified interests in use of EO data for monitoring of storms, drought, avalanches, mudflows, industrial risks and volcanoes.

4.3.3 Forest Application Areas

The control of the water protection boundaries during forest logging

Monitoring of the boundaries of the water protection zones along the rivers (typically 100-150 m extension) is a critical issue with respect to the actual logging activity. Areas of forest logging currently often severely affect areas of the water protection.

Forest management activities

There is a lack of thematic classification of both type and condition of forest areas for vast areas. A combined use of medium (40 m resolution) and high (10 m) resolution EO data for forest management activities in forest-abundant and unexplored areas may improve the management and exploitation efficiency. It will result in saving of significant financial and human resources as compared to traditional field mapping, and will significantly increase knowledge base in areas where it is difficult to organise operational aerial surveys.

Evaluation of forest restoration quality

EO images of high- and medium resolution allow evaluation of the actual state of forests that by its age should be classified as exploitable areas. Forests are classified in 3 groups. Usually for forests classified in the 3rd group (without economic importance) and sometimes in forests classified in the 1st and 2nd groups (better quality forests) are reclassified based on their age and not on an actual examination of areas and their development. As a result, significant areas that exist only on paper are classified into forested area and from that point are considered as valuable forest of the relevant age. For many forest enterprises it results in distortion of the baseline data on available forest resource structure, perhaps hiding unfavourable tendencies, which hence may contribute to incorrect decisions in the management of forest resources.

Assessment of surfaces and location of areas with natural ecosystems in the regions damaged from previous clear cutting

In many forest regions of Russia logging was previously done by clearing huge areas of several hundreds hectares. Boundaries of such clear cut areas, preserved natural areas or significantly deteriorated secondary vegetation is clearly visible on images even at 150-meter resolution. EO-based information could be used for planning of nature protection and for correction boundaries of planned protected territories, their protected zones as well as water-protection zones. The application of EO data for environmental purposes, by providing information on the spatial distribution and structures, is sometimes more informative than use of common types of land- and forest management information.

Evaluation of the actual boundaries and state of areas of near-tundra forests

Discrimination of the regions of near-tundra forests, where logging is prohibited, was conducted long time ago and currently available information does not correspond to the actual situation. The Federal authorities have particular interest in use of EO data to effectively control logging activities in the forest region near the tundra and improve the management of the current operating regulations.

Forest fire detection, combat and loss assessment

Satellite imagery may be very efficiently applied for monitoring of forest fires, particularly for assessment of forest fire danger (forecasting) and early warning and localisation of actual forest fires, assessment of their dynamics and potential development under various meteorological conditions. Damage assessment and mitigation is essential also for the possible use of the remaining timber resources in areas of previous forest fires.

4.3.4 Geologic Applications

Satellite images with resolution better than 100 m may provide relevant information for:

- Detection of regional geological structures such as lineaments, ruptures, jointing, zones of the newest activation, faults;
- Revealing of structural-tectonic elements;
- Discrimination of age and genetic types of newest sediments, elements of geomorphology, local class tectonics.

This information can be used for the study of tectonic beds and detection of regions of geological activity. In this case additional remote sensing information on surface temperature and Earth surface albedo is necessary.

The vastness and remoteness of the Russian Federation also stimulates the application of EO-based methods for assessment of possible location of various natural resources deposits.

4.3.5 Agriculture Application Areas

Inventory of cultivated land areas

Discrimination and identification of areas occupied by various crop types. Crop types, classified by satellite data, have to be validated by field observations and merged with the other public data bases and information on the structure of the cultivated areas. The need for information is both identified by public management and commercial agricultural enterprises.

Agricultural hydrology

The following main application areas are of importance: (i) analysis of precipitation rate and frequency, (ii) studies of soil moisture capacity and (iii) studies of water and watering regimes of arable lands.

Land use

In several regions there is a need for the detection of the changes in landscape topography and the detection of changes in terrestrial land cover type and condition due to natural and anthropogenic impact. Of specific concern are such issues as harvest forecasting as well as assessment of insect pests and protection measures against them.

4.3.6 Hydrology Applications

Control of water resources entails monitoring of snow and ice cover, assessment of sources of ground water, and monitoring of floods.

Monitoring of snow and ice cover is aimed at:

- Monitoring of fresh water reservoirs,
- Assessment of area and thickness of snow cover,
- Warning of possible floods resulting from intense snow melting.

4.3.7 Cadastre and Mapping Applications

Topographic mapping provides scientific research and applied programs that study environmental changes with topographic data and data on Earth surface characteristics, such as:

- Vegetation;
- Open ground
- Snow or ice covers
- Construction
- Infrastructure
- Agricultural areas
- Water bodies

It is also expedient to use high-resolution radar imagery for the studies of geomorphological phenomena such as:

- Landslides
- Deluvial and proluvial cones
- River valleys
- River deltas
- Changes in coastal line
- Mud flows
- Volcanic forms

The information acquired is used for land planning, detection of water flow channels and areas of potential flooding and for the study of soil erosion. In coastal areas topographical information is necessary for the detection of changes in slope of coastal morphology and forecasting of floods.

4.3.8 Urban applications

For the urban territories of Russia, especially for large cities, specific concerns are related to mapping, monitoring and management of urban territories, assessment of the state of transport networks, study of industrial and domestic heat losses etc.

4.4 An Assessment of Geographical Location of a ERS/Envisat SAR Acquisition Station

Recommendations for the possible location of an ERS/ENVISAT SAR data acquisition station within the Russian Federation is done on the basis of the user requirements for geographic data coverage. A baseline for the assessment is a requirement for complete SAR data coverage of the territories of the Russian Federation. The technical and practical implications, or the installations and operations of such a SAR acquisition station are considered to be outside the scope of this project. The current official ESA stations partly covering the RF are located in Kiruna (Sweden) and Fucino (Italy). In addition several national stations are covering various parts of the RF. For consideration of a station location within the RF three sites are considered i.e. Moscow region, Novosibirsk in Siberia and Yakutsk in the central eastern part. Figure 4-15 shows the approximate geographical coverage (the radio-visibility zones) for the three locations.

In addition to the Yakutsk location the city of Tiksi located at approximately the same longitude along the Arctic coastline is an other option. In comparing these two locations the Tiksi location will provide better coverage of the Arctic waters than Yakutsk. A station located in Tiksi will be using the antenna system of the "Orbita-2" receiving station. Such antennae installations are also available at several other locations within the RF. This implies that several other locations may be relevant and based on the project information on the user applications one such location may be Salekhard located in at the Arctic circle around 65° east. The following arguments are identified for the various locations (4-5) with respect to the four main identified application areas.

4.4.1 Ice Monitoring

For an optimal coverage of the Russian Arctic sector the receiving station could be located in Yakutsk or Tiksi. The Yakutsk location will provide adequate SAR coverage of the currently "uncovered" central parts of the Northern Sea Route (Laptev sea) in which the main economic shipping activities occur, and 88% of the responses to the survey indicate prime interest to sea navigation applications in this region. In combination with the current European and Alaska stations the entire NSR will then be covered. Shipping activities in this central part of the NSR are, however, currently limited to the "summer period" and mainly for regional transportation, with only a very limited ship transportation through the entire NSR. Also the Salekhard location will cover these remaining uncovered central parts of the NSR. The Yakutsk location will also cover the Far East seas of interest to Russia, including the Sea of Okhotsk and parts of the Sea of Japan, although parts of the Bering Sea will not be covered. In this region 44% of the respondents indicated the use of data for sea ice navigation support.

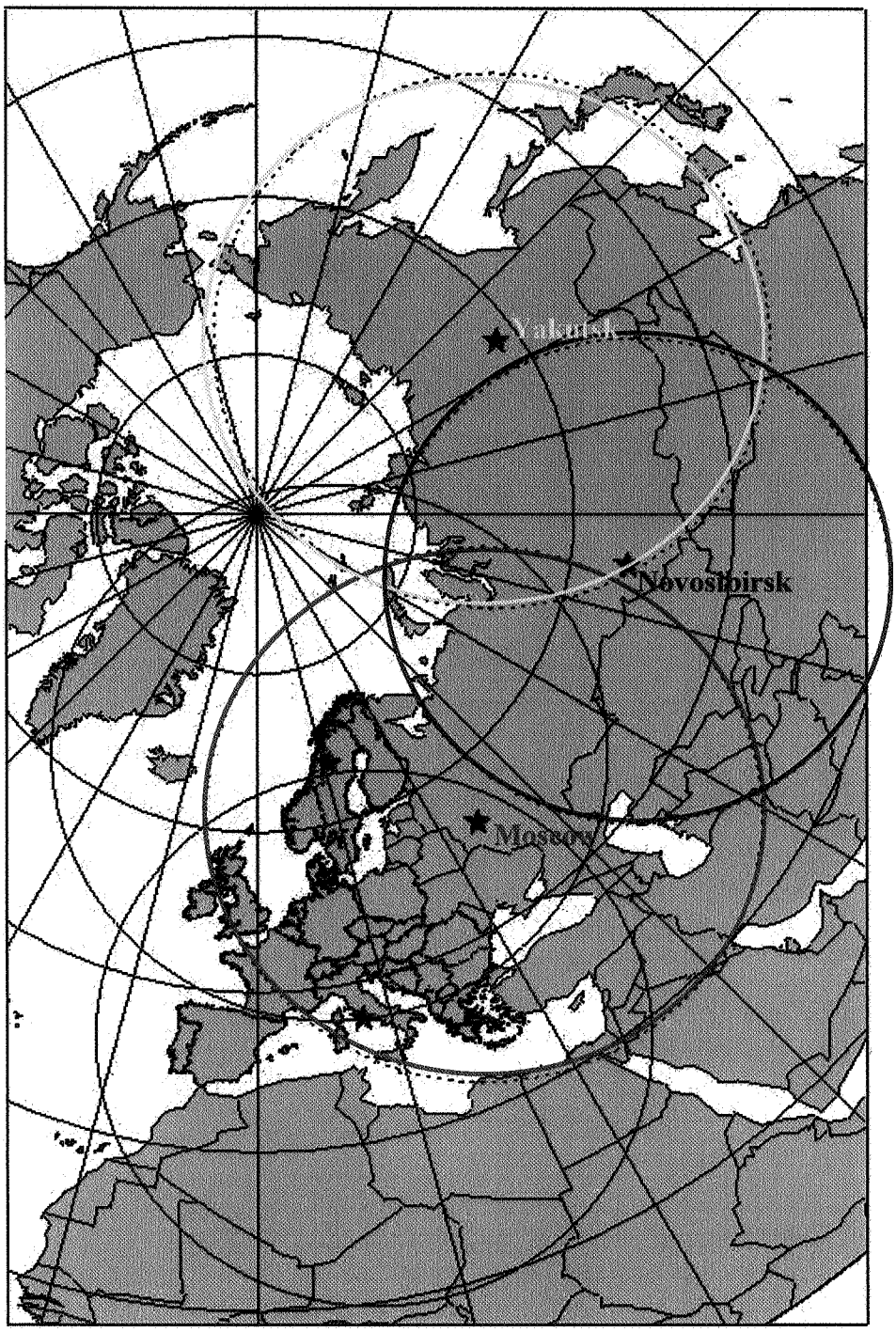
Half of the respondents also indicated a need for sea ice information for the Baltic Sea, which is covered by both ESA stations and from a station located in the Moscow region.

Also in the lower Volga and northern Caucasus including the northern part of the Caspian Sea are hampered by ice cover which cause concern to the oil and gas exploration and shipping activities of the region. A station located in the Moscow region will uniquely cover these

areas and in addition overlap the coverage of the European stations with respect to the southern Barents, Petchora and the western Kara Seas.

The Novosibirsk station location will not provide any additional coverage of the NSR and only partly cover the Caspian Sea.

Figure 4-15: An indication of three possible locations for ERS SAR receiving stations within the Russian Federation – in Moscow, Novosibirsk and Yakutsk. The radio visibility zones of each location as well as for the current ESA stations in Kiruna and Fucino are indicated.



4.4.2 Environmental Monitoring and Hazards

The main oil exploration activities within the Russian Federation are located on the land territories of northern Siberia, off-shore in the Barents, Pechora and Kara Seas and in the shelf region of Far East seas (Sea of Okhotsk, Sakhalin shelf and the Kamchatka region). The majority of the respondents to the survey indicated a prime interest in the regions including Siberia and westward as well as the Caspian Sea, which contains significant oil and gas resources. A station located in the Moscow region will, partly in overlap with the current ESA stations (Kiruna and Norwegian Tromsø stations), cover the greater part of the oil fields of the northern parts of Russia and uniquely provide coverage of the Caspian Sea region.

The Novosibirsk location will also cover the main parts of the exploration areas of interest, with the exception of parts of the Barents Sea and parts of the marine transportation routes.

The Yakutsk station location will cover both the main marine transportation routes in the Arctic and the Bering Sea, the Sea of Okhotsk and the Sea of Japan including the area of the Sakhalin shelf as well as the transportation routes to Japan and the south-east Asian countries. In addition parts of the land-based oil fields of the Yamal region (north of Salekhard) will be covered. In this respect the Tiksi location will not provide additional coverage. Around 25% of the respondents within environmental monitoring had interests in the Far East land regions and 15% in the ocean areas of the Far East.

The Moscow station location covers the parts where more that 80% of the population of the Russian Federation lives and in addition major parts of the surrounding countries such as Belarussia, the Ukraine, Kazakhstan, Turkmenistan and the Transcaucasian countries. These are the most populated and economically developed areas of the above countries in which monitoring of hazards such as floods, forest fires, ecological disasters etc. are of increased significance and impact for the population. The remote and difficult to access areas of Central Siberia and the far eastern parts of the Russian Federation are covered by the station locations in Novosibirsk and Yakutsk respectively.

4.4.3 Forest Management

The Novosibirsk station location will cover more than half of the total forests of the Russian Federation. The forest resources in Siberia are estimated to be 25% of the global timber resources. The geographical interests among the contacted organisations within forestry applications were mainly in the north-western parts of the RF (52%), central region (33%), and western (33%) and eastern (43%) Siberia and the Far East (38%), which supports a general strong interest in data coverage of the entire Russian Federation. According to other sources more than 60% of current logging activity takes place in the western parts of Siberia. The Yakutsk station location covers the forests of the Far East and, in particular, the Primorski Krai Territory where unique tree species grow and special control measures are put into force to monitor and preserve the forests and their use. The three main receiving station locations are complementary from the forest monitoring perspective. The Tiksi location in this respect is inferior to Yakutsk, due to limited coverage of parts of the forests in East Siberia and on Sakhalin.

4.4.4 Natural Resources (Geology)

The survey among the groups interested in geological mapping reveals a strong geographical focus towards the far northern parts (64%) of the RF as well as the mountain areas (e.g. Ural 33%) and the western Siberia (58%). This picture is consistent with the distribution of the natural (geological) resources within the RF. The mountain areas in south east Siberia (24%)

are also of interest with respect to terrain mapping and geological applications. The Altai region towards the Mongolian border was in this respect pronounced. A station location in Novosibirsk and Yakutsk will cover the main areas of interest in combination with existing station locations.

4.4.5 Agriculture

The Moscow station location covers more than 70% of the fields of wheat and rye crops cultivated within the RF. The Novosibirsk station location, which covers more than 60% of the agricultural fields, do not cover the most fertile lands of the central and southern European parts of the RF. The Yakutsk and Tiksi locations are in this respect less optimal in this respect. The survey did not specifically address the agricultural applications and the prime regions of interests are not investigated in detail. The data coverage of the ESA stations and the Novosibirsk location will cover main parts of the areas of interest for agricultural applications within the RF.

5. A Brief Overview of the Non-Russian Market Segments

Two major sectors of the international market for EO data covering the territories of the Russian Federation have been briefly investigated in this market survey. The first sectors covers are a limited number of international companies and organisations involved in activities of use of EO for the territories of the RF. Secondly, a review of the current Announcement of Opportunity (AO) projects within the framework of the ERS-1 and 2 missions, requesting EO data from the territories of the RF has been undertaken. The AO project evaluated has been on those requesting SAR data including both Russian and non-Russian project scientists.

5.1 International EO relevant activities within the Russian Federation

A series of telephone and personal interviews has been conducted with the help of a set of discussion guideline to assess to what degree non-Russian companies or organisations have currently some projects, commercially or research oriented covering the Russian territories. A total of about 20 organisations involved in the four main application areas have been contacted. It was not intended to perform an comprehensive survey, because of the lack of time and resources, but rather to have the opinion of some organisations which could have activities in Russia, or which could have information on the situation in Russia. This information from non-Russian users was collected with the objective to complete the qualitative and quantitative analysis, based mainly with information coming from Russian users, on the market situation for EO data in Russia. The information obtained from this part of the project is mainly of qualitative nature.

The four main application areas defined in the market survey were covered by interviews completed including shipping companies in sea ice navigation, geology (oil, gas or mineral exploration), forestry, and environmental studies. The information obtained illustrates the fact that none of the companies we have contacted currently have important or significant activities in Russia that involves use of EO data. However, some of the companies contacted do have activities in which EO data could be used, mainly in the field of oil and gas exploration and within Arctic shipping. Some project activities within other fields were also established, however most of the projects are pending or has been terminated. Several western companies recognise a significant interest in the Russian natural resources within forestry or in non-renewable resources. The reasons and explanations given on the fact that so few activities are running for their organisation in Russia point to the unstable economic situation, the current economic crisis, as well as the legal regulations for international involvement in e.g. exploitation of natural resources. However, almost all persons contacted regard the need for geographic information as essential. Therefore the use of EO data is regarded as a potential important source of information, due to the complex infrastructure and vast distances within the RF. New project activities, mainly founded by international agencies like the World Bank, are currently being set up; however the process to establish such activities generally takes a long time.

At any rate, the discussions confirm the interest of western organisations in use of EO data within all the four application areas. Within geology, forestry and environment, none of the contacted persons have expressed a strong requirement for use of radar data, but are more familiar with the use of optical EO data, which for some have had well-established application procedures.

The oil and gas resources within the Russian Federation are significant at a global scale. The proven reserves at the end of 1998 were estimated at 65.4 thousand million barrels of oil, and the oil production in 1998 (304.5 million tonnes) was twice as high as for Norway (BP Amoco, 1999). The proven gas reserves at end of 1998 are estimated to 56.7 trillion cubic meters or approximately one-third of the known global resources. The oil and gas exploration industry, with its related shipping and off-shore activities in ice-covered waters, may hence be regarded as the most promising potential field for development of SAR and other EO data applications in the future. Within the time frame of this market survey (≈5 years), three main regions have current and a potential for development of the oil and gas exploration activities. These are the Caspian Sea, Western Siberia (Barents, Timan-Pechora and Kara Seas, land areas in NW Siberia, including the Yamal and Ob region) and the Sakhalin area in the Far East. The main Russian oil and gas companies are LukOil and Gazprom, which both have established collaborative efforts with several international oil companies such as BP Amoco, Conoco, Texaco, Exxon, Norsk Hydro, Statoil and ELF. LukOil has expressed their strong perspectives of the future Arctic operations through, for example, their purchase of Murmansk Shipping Company in 1999. The exploration of the potential hydrocarbon resources in the central and eastern northern parts of Siberia and the Sea of Okhotsk will most likely not be developed extensively within the time frame of this market survey (<5 years). All the three regions have sea ice cover during parts of the year, which influences the operations. Ship transportation of the resources from the region to the consumer market is relevant except for the Caspian Sea where a pipeline network has/is being developed. However, there are only a very limited number of vessels available for year-round transportation of oil and gas in the Arctic waters and significant development of the ships to be used is needed in order to develop cost-effective operations. For the NW Siberia region, additional expenses for ice design and operations of both exploration platforms and for the transportation imply significant additional costs, which limits the profitability of such operations.

The known resources of hydrocarbon in this region are estimated as significant – for gas condensate at the same level as in the Middle East. For the off-shore operations in the Barents, Timan-Pechora and Kara Seas, shuttle transportation using ice-going tankers are needed for the transportation from the platforms to either reloading terminals or transportation to the European market. For the land-based sources, specially-designed and -operated loading terminals must be established, and the current infrastructure is far from capable of serving the operational needs. In both the design, location and operations of such loading terminals EO data may become a significant source of information. It is also the impression that pipelines over land will not substitute the need for additional ship transportation, due to both strategic and practical reasons. The main factor hampering a more extensive involvement of the international oil and gas industry in the exploration and exploitation activities within the RF is the process in obtaining clear and firm licences for their operation conditions in the exploitation phase. The use of "compulsory" information sources and measures, such as e.g. a national Russian ice service, may also impact the decisions of the companies in their use of e.g. EO data in support of their activities in the RF. The fluctuation in the prices for oil and gas products at the world market may also impose a more strict cost-effectiveness evaluation by the companies in their implementation of measures needed for their operations, including use of EO data in support of their operations.

The domestic ship transport within the northern parts of the former Soviet Union was considerable and very important for the regional activities. The total cargo volume was estimated to 7 million tons/year at its peak period, however the current volume of regional cargo transportation was reduced to a level of below 2 million tons in 1998. There is, however, a growing regional interest within the RF in shipping their natural resources directly

to the markets using ship transportation along parts of the Northern Sea Route and within the major Siberian Rivers. In this respect, the area west of the river Yenisei is of year-round interest, while the areas further east are restricted to "summer" operations. The port of Dudinka, serving the mining activities of Norilsk, is the main cargo port of the northern Russia. This kind of domestic and export transport is today mainly served by Russian cargo vessels and shipping companies. Except for transportation of hydrocarbon resources, the project has not been able to identify a significant international interest from the shipping industry in serving the transportation market in this region. However, since the need for ice classified vessels is limited to the winter period in e.g. the European waters the non-Russian shipping companies with ice-class vessels may envisage a market to be served during the summer season.

When the Northern Sea Route (NSR) was opened in July 1991 for the international shipping industry, there was great optimism about the utilisation of this route between Europe and Asia. The saving of around 50% sailing time compared to the traditional routes through the Suez or Panama canals was envisaged to initiate significant shipping activities in the NSR. However, the optimists in 1991 have failed in their short-term expectations and there is still very little international presence in the NSR. The International Northern Sea Route Programme (INSROP) was established to extensively study the challenges in developing the international ship traffic in the NSR. INSROP concludes that the NSR still has a potential for profitable shipping, though there remain obstacles related to "lack of a predictable and competitive tariff regime, reliable NSR infrastructure, due to the current political and economic instability of Russia". Further research on design of environmentally safe and ice-classified ships, in order to lower the investments costs for vessels capable to operate in this harsh environment, will also contribute to increased interest from the international shipping for this region.

In order to investigate the actual conditions of year-round operations of a tanker vessel in the western parts of the Russian Arctic waters, European industry, CEC, Russian authorities and institutions implemented the project "Arctic Demonstration and Exploratory Voyage – ARCDEV" in 1998. The project was co-ordinated by Fortum Oil and Gas (formerly Neste Shipping) in Finland and the objectives were to investigate the practical conditions, regulations for and economy in year-round ship transportation of hydrocarbons from NW Siberia to the European market. The conclusions of ARCDEV indicate that today it is not economic profitable to transport gas condensate from this region to Europe. However, with changes related to the Russian infrastructure, such as customs port clearance, icebreaker support fees and operations as well as increased loading speed at the port terminals, ship transportation of gas condensate to the European market will become profitable. ARCDEV also identified several tasks for further development, covering the range from the actual ship design to the support operations of ship navigation in sea ice, including use of EO data for more efficient ship operations in sea ice.

The above opinions reflect to a large extent the general trend for many western companies involved in the RF. However it could be that other organisation in Europe, US or Japan have more extensive activities in Russia involving use of EO data, but information on this subject has not been indicated from the persons we have contacted. One exception is the Siberia project, which is an European Union project (CEO project) which will use significant amount of ERS and JERS SAR data on Siberia, but not on a commercial basis. The project has also performed a search on the Internet to try to localise some companies having projects in Russia involving use of EO data, but no information has been found. Discussions with some Sales Area Managers of Spot Image also did not identify companies having purchased EO data over Russia.

The general conclusion is that the market for EO data over the Russian territory seems low for non-Russian users, even if the potential needs for information are very large. The market will firstly be developed when the economic situation and infrastructure will significantly improve and stabilise, and when western companies or organisation will start to invest significantly in the use of the resources available within the Russian Federation.

5.2 The ERS AO Projects

The Announcement of Opportunity (AO) Calls is the prime mechanism to stimulate development of applications and scientific research using the ESA satellite data. In the first four ESA ERS AO Calls (AO-1, AO-2, AO-Libreville, AO-Tandem) Russian Principal Investigators have been completely absent. Some projects, however, involved co-operations with Russian Co-PI's. A few Russian scientific institutions have also purchased a very limited number of ERS SAR scenes in connection with their scientific project activities, although not to our knowledge from areas within the Russian Federation. Through these four first AO calls around 69 non-Russian PI's have requested ERS SAR data from locations within the Russian Federation, although only a few (<10 projects) were focused on objectives specifically requiring SAR data from the territories of the Russian Federation. During the first three ERS Symposia only one paper on SAR applications were, to our knowledge, given by a Russian scientist.

After the ERS AO-3 Call the situation has changed drastically and 16 Russian scientists have become ERS PI's requesting ERS sensor data from the territories NIS countries as well as other geographical parts of the world. 14 of these PI's have requested SAR data alone or in combination with other ERS sensor data (Table 5-1). Altogether 31 PI's (both Russian and non-Russian) have requested ERS SAR data from the territories of the Russian Federation, including 6 projects requesting data from the Arctic sector. The non-Russian PI's are mainly from European countries (16 projects) and USA (5 projects) (Table 5-2). The application areas cover the land surface, ice covered and open ocean areas of the Russian Federation from the Baltic Sea to the Far East as well as from the Arctic to the southern countries of the NIS.

The increased number of Russian PI's is both due to better awareness of the AO data possibilities as well as current lack of any SAR sensors on Russian satellites. In addition the increased international scientific co-operation has also increased the awareness and fostered co-operation such as required in AO announcements.

Table 5-1: Summary of the registered Russian PI´s under the ERS-2 AO3 announcement.

Code	PI	Institution	Title	Application
AO-172	Litovchenko, Konstantin, Ph. D.	Space Research Institute of Russian Academy of Science	Study of phenomena in the surface layer of inland seas and large lakes	Inland Waters
AO-174	Yuri M. Timofeyev, Dr., Prof.	St. Petersburg State University	GOME measurements validation, and the higher level products development	Validation
AO-188	Sharkov Eugene, Prof.	Space Research Institute	SAR remote sensing for monitoring and investigation of hydrogeological and hydrophysical processes the Caspian Sea basin.	Coastal Zone
AO-216	Trokhimovski Yuri, Ph.D.	Space Research Institute of Russian Academy of Sciences	Development of techiques for search of submarine fresh water springs on the Crimean shelf by the use of the satellite data	Ocean Features
AO-219	Pereslegin, Sergey V.Dr.	Institute of Oceanology, Russian Academy of Sciences	Experimental Verification of the Method for Restoration Mesoscale Ocean Current Velocity Fields Using ERS Synthetic Aperture Radar Data	Circulation
AO-224	Lavrova Olga, Ph.D.	Space Research Institute of Russian Academy of Sciences	Investigation of perturbing action of atmospheric and internal oceanic processes on the waved sea surface using ocean remote sensing data	Sea-Air Interaction
AO-246	Zakharov Alexander	Institute of Radio-engineering and Electronics, RAS	The ecological consequences of the accident at the Chernobyl power plant in 1986 based on the analysis of ERS archival data.	Forestry
AO-248	Romanov Alexey, Prof.	Rus. Fed. Research Inst. of Fisheries and Oceanography	Use of high resolution SAR data in fishery regions monitoring	Fishery
AO-276	Kucheryavenkova, Irina	Institute of Radioengineering and Electronics, RAS	Observation of flooding of Caspian sea shore process based on the analysis of ERS-1 and ERS-2 data.	Flooding
AO-343	Zakharov Alexander	Institute of Radio-engineering and Electronics, RAS	Research and development of highly efficient calibration techniques for spaceborne SAR systems on the base of ground based reflector antennas.	Methods
AO-401	Mitnik, Leonid Dr.Sci.	Pacific Oceanological Institute	Mesoscale oceanic and atmospheric phenomena in the coastal area of Japan and Okhotsk seas: study and monitoring with ERS SAR	Coastal Zone
AO-403	Bobylev Leonid P, Dr	Nansen International Environmental And Remote Sens	Retrieving UV irradiances from GOME Level 1 data	UV Radiation
AO-428	Alexandrov, Vitali, Dr.	Nansen International Environmental And Remote Sens	Synergestic use of ERS (SAR and ATSR) and other satellite data for ice studies	Sea ice
AO-429	Dashi D. Darizhapov	Dpt of Physical Problems, Siberian Branch, RAS	On establishing the regional system of ecological monitoring of natural objects in Lake Baikal basin	Environment
AO-431	Bobylev, Leonid P. Dr.	Nansen International Environmental And Remote Sens	The study of Siberian boreal forests current state using ERS-2 data	Forestry
AO-440	Melentyev Vladimir V., Dr. Prof.	Nansen International Environmental And Remote Sens	Application of ERS SAR Data for Studying Migration of White Sea Population of Greenland Seals	Sea-Ice

Table 5-2: Summary of the registered non-Russian PI's under the ERS-2 AO3 announcement requesting data coverage from the territories of the Russian Federation.

Code	PI	Institution	Country	Title	Application
AO-118	Zebker, Howard A., Prof.	Stanford University	USA	Distributions of atmospheric phase artifacts in radar interferograms	Methods
AO-120	Schmullius, Christiane, Dr.	DLR NE-HF	Germany	SIBERIA - Sar Imaging for Boreal Ecology and Radar Interferometry Applications	Forestry
AO-124	Pampaloni Paolo Dr.	IROE/CNR	Italy	Multisensor Microwave data for global scale monitoring of soil and vegetation	Vegetation
AO-202	De Grandi Franco Dr.	Joint Research Centre/SAI/MTV	Italy	Regional scale mapping of a boreal wetland area by ERS tandem data	Wetlands
AO-270	Simpson, George, Dr.	EOS	UK	Use of ERS Archive Data in Facility Design and Siting Studies on the Yenisey River	Sea-Ice
AO-317	Kasischke, Eric S., PhD	Earth Sciences Group, ERIM International	USA	Monitoring Fire-disturbed Boreal Forests Along the Baikal-Amur Mainline Railroad, Siberia using Multi-temporal ERS SAR Imagery	Forest Fire
AO-334	Bodechtel, Johann, Prof.Dr.	Teledata	Italy	A planning and monitoring system for oil and gas pipelines from Siberia to Europe with ERS radar and optical satellite data in connection with GIS - a pilot project in cooperation with GAZPROM and ROSNYEFT, Russia	Subsidence
AO-348	Ori, Gian Gabriele, Prof.	Dipartimento di Scienze - Universita' d'Annunzio	Italy	Quaternary climatic variations and hydrological implications in arid enviroments using SAR images	Geology
AO-370	Smith, Laurence C. Dr. Assistant Professor	University of California, Los Angeles (UCLA)	USA	Precise flood inundation mapping from ERS interferometric phase coherence	Flooding
AO-382	Johannessen, Ola M, Prof.	Nansen Environmental and Remote Sensing Center	Norway	Detection of changes in Arctic and Antarctic sea ice using ERS SAR and other microwave data	Sea-ice
AO-398	Schrum Corinna Dr.	University of Hamburg	Germany	Limnological studies in Lake Baikal	Inland Waters
AO-411	Stolz, Roswitha	Institute of Geography	Germany	The Utilisation of ERS Data for Environmental Monitoring in the Remote Areas of the Altai Mountains and the Ob-Plateau (southwest Sibiria)	Environment
AO-415	Hartmann, Rolf, Dr.	Jena-Optronik GmbH (DJO)	Germany	AGRO-EAST:2ERS-SAR data for the Agrologistic and Landuse of Eastern European Countries	Agriculture
AO-416	Zimmermann, Reiner, Dr.	Lehrstuhl fur Pflanzenoekologie	Germany	TRANSECT - SAR Imaging and Interferometry for the IGBP-NES Boreal Transect Study	Forestry
AO-423	Muller, Jan-Peter, Professor	University College London	UK	AIRMAP: PM10 atmospheric particulate air pollution maps from ATSR2 over 10 world cities.	Pollution
AO-426	Mann, Paul, Dr.	UT Institute for Geophysics	USA	Investigating Surface Change on Kamchatka Peninsula Though Thematic and Interferometic Studies of ERS-1/2 Radar Data	Volcanoes
AO-435	Ranson Jon K. Dr.	Biospheric Sciences Branch - Code 923,Goddard SFC	USA	Mapping Siberian Landscapes: Natural and Anthropogenic Factors Affecting Carbon Balance	Forestry

6. Conclusions and Recommendations

During the project around 450 Russian institutions have been contacted, informed and asked about their needs for EO based information, in particular SAR data to solve their main missions. The result is that 189 institutions has responded with useful information to be included in the project relational database concerning their requirements to and use of EO based information products. All together round 100 individuals attended the three project workshops organised in St. Petersburg, Moscow and Novosibirsk at which further information was obtained on integrated use of SAR data within the Russian Federation.

The study concludes that a wide range of SAR applications has been developed for use within the Russian Federation. The Market segments needs to SAR data are well defined within several sectors, however the commercial applications are limited due to the current financial situation in the RF. The scientific sector has a large potential to contribute to development of SAR applications and their request for data has been increasing over the last years. Hence a data demand is well defined, however with limited commercial ability to purchase SAR data. The international market for SAR applications for the territories of the RF are in situation of awaiting changes in the Russian economy before implementing new initiatives in this respect. The need for one or more SAR receiving station within the Russian Federation are documented to serve the users needs with respect to both SAR data coverage and facilitate the user access to actual data. The necessary infrastructure and local initiatives to meet the operational needs of such stations are identified, however this was outside the main scope of this project to investigate.

The project has analysed the retrieved information concerning the Russian awareness and use of SAR based EO data according to the following conclusive statements:

State-of-the–art

- Optical and infrared EO data have for many years been operationally used within areas such as:
    - Sea ice monitoring;
    - forest fire detection and damage assessment;
    - weather forecasts;
    - pollution monitoring and assessment;
    - river flooding monitoring;
    - ecological mapping;
    - crop status monitoring;
    - coastal zone monitoring;
    - geology and natural resources mapping, and others.
- A national network of EO acquisition stations has been established in order to serve the regional needs for data and information from the Russian and earlier Soviet Union EO satellites.
- Russian experience with spaceborne radar systems has been established by various Russian institutions under the Almaz SAR program.
- Use of Russian EO data has declined over the last decade, but an increase is again observed over the last years, despite the current financial problems in Russian economy.
- Lack of information on state-of-the-art SAR application areas limits the actual use to be

considered by "non-expert" EO users.

- Regional authorities (environment, natural resources and industry) of the Russian Federation are currently using EO information sources.
- Regional Authorities have shown willingness to further explore EO data as major source of information.
- Regional environmental authorities cover part of their budgets through local taxes from the industry involved in exploration of natural resources.
- The use and awareness of EO data are more limited in the private sector, than in the public sector.
- No respondent to the market survey has provided information on the financial aspects of their activities (current budget, costs of services etc.). Accordingly the expected future outlook for development has been impossible to assess from their responses to the survey.

Awareness and Requirements

- A high level of awareness for use of EO data is established in a wide range of public and semi-public organisations – in particular at scientific research institutions.
- Despite a general high level of awareness most user groups need information and routines for generation of value added products. In particular the knowledge of non-Russian EO data and sensor systems are very limited.
- The forest authorities and industry, as well as the oil companies and mining industry, are in general sceptical about the benefit of SAR until their direct applications are better validated and demonstrated within their own fields of operation.
- Tailored and dedicated information on state-of-the–art applications for SAR data are very much needed in order to develop new application areas and to stimulate the increased use and further development of EO data.
- User training and documentation of application algorithms and methods are needed in order to increase the awareness in a large section of the Russian user community.
- Near real-time applications and year around operations are identified within all the user categories.
- An increased demand for ERS SAR data for the territories of the Russian Federation is identified among Russian scientific users, regional authorities and partly among the international user community involved in activities in the RF.
- In order to meet the identified user requirements for SAR coverage of the RF, a combination of three station locations are required - in Moscow, Novosibirsk and in Yakutsk.
- One or more ground station located within the Russian Federation will significantly facilitate the access to and promotion of use of SAR data for the Russian user community.
- To serve the data needs of the Russian and international PI's under the Third ERS Announcement of Opportunity (AO3) a station located in Novosibirsk is required.
- The Yakutsk station location will *uniquely* cover the eastern part of the Northern Sea Route (Laptev Sea) as well as land areas of the Far East of RF. The Far East seas will also be covered in partly overlap with other existing station locations.
- The SAR data costs are a significant and limiting factor for application development within all application areas.
- The market survey has contributed to an increased awareness of Russian SAR application forming a basis for future market and application development.

Application Areas

- SAR data has its particular benefit among EO information sources in the high latitude regions of the Russian Federation, due to the frequent occurrence of cloud, haze and winter darkness.
- The basic industrial use and exploration of natural resources are located mainly in the northern regions of the Russian Federation.
- Regional authorities have indicated significant benefit in the use of EO data, including SAR, within environmental mapping for planning of new activities and installations (roads, railroads, pipe lines etc.) and environmental monitoring and assessment of impact from existing installations.
- Regional authorities envisage EO data to become a prime source of information within mapping and monitoring of natural phenomena such as sea ice, flooding including ice blocking in rivers, forest state and damage as well as forest fires.
- SAR applications in support of ship navigation in ice covered areas is the most developed application area, although, wide spread commercial use is currently limited by the data costs, due to limited geographical coverage of the current ERS SAR sensor (100 km swath) and the current financial situation in Russia. Despite the technical limitations SAR data has proven significant value when available.
- Ship detection is of interest to local authorities in order to monitor illegal fisheries particular in the Far East seas.
- The oil exploration industry operates often through intermediate companies, providing environmental assessment and other services in which EO data can be used as an integrated source of information. These end-users do not regard EO data alone as a source of information, but require integrated retrieval of the information content as essential to increase the use of EO data.
- Previous forest monitoring was mainly done using aerial surveys. However this has declined significantly over the recent years due to the budget situation. A cost-efficient substitute or complement could be obtained through use of satellite SAR data in combination with other information sources.

Future Development

- An increasing interest in the Russian and international scientific community for SAR data from the territories of the Russian Federation is observed through the increased number of projects in response to the later ERS AO calls.
- The Russian scientific community has expertise in existing and future thematic application areas of SAR data, which will be of benefit to the Russian and international user communities.
- Within mapping and monitoring of terrestrial pollution, forestry and natural resources (geology) exploration, SAR data have a significant national potential of development provided that the application methods well demonstrated and validated.
- Within the oil exploration industry, partly shipping industry, forestry (industry and authorities) and mining companies there are financial resources and willingness to invest in use of *documented and beneficial applications* of EO data.
- Increased availability and access to ERS SAR data within the RF will foster research and application development. Furthermore this will stimulate the development of future operational applications and the market for ENVISAT SAR data from year 2001.

The non-Russian Market

The most significant interest in the possible use of EO data for the Russian territories is identified within the sector of exploration of hydrocarbon resources. Related to these activities is also the support of shipping and off-shore operations in ice covered waters as well as planning of pipeline structures. Within international research programs for monitoring of the forest resource there is also a pronounced interest for EO data coverage of the forested parts of the RF. Most of the relevant international activities within the RF are depending on non-Russian funding of its activities, however many companies regards their presence to day as were important for a more active future activity in the Russian market.

The general conclusion through the limited number of contacts is that the non-Russian market for EO data over the Russian territory seems low, even if the potential needs for information are very large. The market will firstly be developed when the economic situation and infrastructure will significantly improve and stabilise, and when western companies or organisation will start to invest significantly in the use of the resources available within the Russian Federation.

A SAR Receiving Station Location

An assessment of the importance of the suggested station locations for ERS/Envisat SAR station within the Russian Federation has been made (Table 6-1) under the assumptions of the current network of stations and the requirements for data coverage within each application area obtained through the survey. Each application area has different priorities with respect to geographical coverage although requirements for coverage of the entire Russian Federation is required. Year around operation of the SAR data acquisition is required for most application areas, however with some seasonal preferences for the different applications.

Table 6-1: An assessment of the importance (ranked from 1 to 4) of the various ERS/ENVISAT SAR station locations for each application area. The coverage of the existing ESA stations is taken into consideration when ranking the station locations. N/A: not applicable compared to the higher priorities or other current stations.

Application area		Moscow	Novosibirsk	Salekhard	Yakutsk	Tiksi
Ice Monitoring		4 [1)]	N/A	3	1	2
Env. Monitoring & Hazards	marine	2	N/A	1	3	3
	land	1	2	3	3	N/A
Forest management		1	2	3	3	N/A
Natural Resources (Geology)		3	1	3	2	N/A
Agriculture		1	2	3	(3)	N/A

1) area covered entirely by the Tromsø & Kiruna stations.

SAR Use Assessment

The project team has assessed the probability that the contacted users in future will purchase or use SAR data within their mission areas (see Figure 4-11 to Figure 4-13). The conclusion of this assessment is that with an acceptable level of confidence around 1/3 of the contacted organisations will to some extent be purchasing SAR data in the future. Around the same number will also be using data in the future with a very high level of confidence. As much as close to 90 % of the contacted organisations will use SAR data in their mission areas,

provided that they are offered at a free-of-charge basis.

The Russian market for SAR data has a large potential of development, but in the current financial state it is difficult to obtain both quantitative commitments or firm figures on its development. In order to become commercial viable the market will need both information and training to adopt use of SAR data at a regular basis.

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The Nansen Environmental and Remote Sensing Center

NERSC

a non-profit
research institute affiliated with
the University of Bergen

Edv. Griegsvei 3a,
N-5059 Solheimsviken – Bergen
Norway

NERSC Technical Report no. 165
under contract with
European Space Agency (ESA)
no. 12861/98/F/TB
and
Russian Space Agency (RSA)

SYNERGETIC USE OF ERS AND ENVISAT SYNTHETIC APERTURE RADAR (SAR) WITH OTHER EO DATA

—

A MARKET SURVEY FOR THE RUSSIAN TERRITORIES

by
Lasse H. Pettersson and Ola M. Johannessen

in co-operation with

SPOT Image	NIERSC	NITs IPR	SRSC
Toulouse, France	St.Petersburg, Russia	Moscow, Russia	Novosibirsk, Russia

Bergen, August, 1999

Table of Contents

A. Report Annex A

A.1 The Project Team

The *Nansen Centers* in Bergen (NERSC) and St. Petersburg (NIERSC) have both been instrumental in the execution of the current ICEWATCH activities in the framework of the ESA and RKA co-operation in earth observation (EO). Particular the efforts of the Nansen Centers have been within applications of SAR data for monitoring of sea ice conditions for ice navigation and climate studies. NIERSC has in co-operation with NERSC also developed several terrestrial application areas within fields such as mapping of forests and land pollution. The Nansen Centers have during the last six years established an extensive network among the satellite earth observation user community in Russia and also among non-Russians operating within the Russian territories. The Nansen Center in Bergen has been the project co-ordinator for this market study.

Development of the Russian market for EO data has for a long period been one of the strategic foci of *SPOT Image*. This effort includes both SPOT and ERS satellite data and value-added application products and services. As a part of the development of new EO services, integrated use of SPOT and ERS-2 SAR data are among the current development foci of SPOT Image. Since 1996 SPOT Image has also operated a SPOT receiving station in Obninsk, south-west of Moscow. The current Russian operations of the SPOT station covers downloading and use of the optical data from the SPOT satellite series over the central Russian territories. The prime customers and users for the SPOT data in Russia are currently interested in terrestrial applications within forestry, vegetation and geology. A significant market is, however, envisaged for combined data products and services from Russian and non-Russian clients operating on the Russian territories. The representative of SPOT Image in Russia, Mr. Evgéne I. Krivtchenko of DERSI in Moscow, took part in the project.

The *Russian Space Agency (RKA)* is the leading Russian authority on EO policy, co-ordination, implementation and operations. The role of RKA in this study was to support the project with guidance as well as to facilitate contacts with the Russian EO users community as well as to analyse and forward the information retrieved. Their participation has assured that the most relevant Russian actors and users have been contacted, and that the appropriate level of contact has been made within each organisation in order to obtain relevant and reliable information for the market survey analysis. After the initial stage of the project the team has been extended to include two additional Russian partners. The *Scientific Research Centre for Exploration of Natural Resources* (NITs IPR) in Moscow, under the auspices of RosHydromet, were appointed to practically represent RKA within the project team. Further the *Siberian Remote Sensing Center* (SRSC) in Novosibirsk, under the Inter-regional Association "Siberian Accord", RosHydromet service and the Siberian branch of the Russian Academy of Sciences were also incorporated in the project team. In the project NITs IPR has made their network of EO data clients available to the project and performed parts of the survey and participated in the three regional workshops. SRSC was created in 1997 as a non-profit non-governmental scientific organisation. The purpose of SRSC is to provide interested departments and organisations of Siberia with satellite data for various purposes of environmental monitoring and management. This extension of the project partners has been made in order to better cover all aspects of the developing EO applications within the Russian Federation, nationally and regionally.

A.2 The Questionnaire Forms

The Questionnaire forms used follows on the next pages.

QUESTIONNAIRE

Use of Satellite Data for the Russian Territories.

The survey is carried out by the joint initiative of the European Space Agency and Russian Space Agency

The aim of this survey is to get your opinion on how and in what areas satellite Earth Observation (EO) data may help your organization to efficiently and successfully achieve its aims. According to the filling in of the questionnaire, you will be provided by additional informational materials concerning themes of interest for your organization. The results of this survey will also help to form the future Earth Observation policies for the Russian territories.

All information about your organization will be treated confidentially.

This questionnaire is intended completed through a personal interview. When filling in the questionnaire cross out an appropriate rectangle, circle, or text field indicated.

Primary Application Area:
○ **Sea Ice** ○ **Environment** ○ **Forestry** ○ **Geology**

Secondary Application Area:
○ **Sea Ice** ○ **Environment** ○ **Forestry** ○ **Geology**

1. What Organization do you represent?

1.1 Name of Organization:

.....
.....

1.2 Organization Type

Governmental:

☐ Budget
☐ Unitary
☐ Joint-stock company with government as a major shareholder
☐ Other (specify) .....

Private:

☐ Private limited liability company (Co. Ltd.)
☐ Incorporated enterprise
☐ Other (specify) .....

1.3 Subordination Level (for State Organizations only)

☐ Federal level
☐ Krai (Republican) level
☐ Oblast' (region, city) level

1.4 Activity Area

Note: More than one choice is possible.

☐ Management
☐ Funding (projects, programs etc.)
☐ Manufacturing
☐ Transportation
☐ Energy
☐ Exploration and production of natural resources
☐ Transportation services
☐ Infrastructure maintenance
☐ Agriculture
☐ Services/Consultancy
☐ Environmental monitoring
☐ Thematic mapping
☐ Development of software
☐ Research and design
☐ Education
☐ Data collection:
  ○ common
  ○ satellite earth observation

Types of industry:
○ Mining
○ Oil and gas
○ Timber
○ Other (specify) .....

1.5 Type of Clients (Customers of your Organization)

☐ International Agencies
☐ National Authorities
☐ Regional Authorities
☐ Other Public Organizations
☐ Oil/Gas Industry
☐ Other lage-scale Industries
☐ Minor Industry
☐ Consulting Companies
☐ Private Organizations
☐ Education
☐ Research/University
☐ Other .....

2. Amount and type of information that is necessary for your organization

2.1 General description of Organization Mission

.....
.....
.....

2.2 What information (type, character, requirements, etc.) does your organization need

.....
.....
.....
.....

2.3 Area of Interest

Note: More than one choice is possible.

☐ **Environmental and Pollution Monitoring**
- ☐ Oceans, seas and inland water monitoring:
- ☐ Oil pollution (water)
- ☐ Other types of pollution (water)
- ☐ Land surface monitoring:
- ☐ Oil pollution (land)
- ☐ Other types of pollution (land)
- ☐ Changes in soil cover
- ☐ Changes in vegetation
- ☐ Changes in landscapes
- ☐ Atmospheric monitoring
- ☐ Environmental monitoring of the Northern territories

☐ **Agriculture**
- ☐ Farm land mapping
- ☐ Agriculture work planning
- ☐ Agricultural resources monitoring and crop forecasts

☐ **Forestry:**
- ☐ Forests mapping
- ☐ Forests inventory
- ☐ Forests state monitoring
- ☐ Forest use
- ☐ Forest fire monitoring

☐ **Mapping of Natural Resources (geology):**
- ☐ Mineral resources exploration
- ☐ Monitoring of oil and mining activies

☐ **Navigation:**
- ☐ Planning and support for navigation in ice
- ☐ Sea ice mapping and monitoring
- ☐ Icebreaker services

☐ **Fishery, seafood, sea animals**
- ☐ Marine biological resources mapping
- ☐ Fish stock studies
- ☐ Sea mamal studies
- ☐ Sea and ice process studies

☐ **Climate Studies (Global Change)**
- ☐ Sea Ice
- ☐ Tundra
- ☐ Forrestry
- ☐ Other (specify) .....

☐ **Urban territories monitoring:**
- ☐ Land-use mapping
- ☐ Planning
- ☐ Management and monitoring
- ☐ Heat losses assessment
- ☐ Other (specify) .....

☐ **Risk Management**
- ☐ Forest fires
- ☐ Earthquakes
- ☐ Volcanic eruptions
- ☐ Floods
- ☐ Storms
- ☐ Drought
- ☐ Transport accidents
- ☐ Industrial accidents
- ☐ Oil / gas pipelines leakage
- ☐ Radioactive pollution
- ☐ Other (specify) .....

☐ **Cadastral compilation:**
- ☐ Land cadaster
- ☐ Soil cadaster
- ☐ Forest cadaster
- ☐ Water cadaster

☐ **Geographical Information Systems (GIS) devel**

☐ **Cartography and production of thematic maps**

2.4 Geographical Coverage of Activity

- ☐ Russian Federation
- ☐ Republic, Krai
- ☐ Region, city
- ☐ Other (specify) .....

2.5 Typical Scale Of Studied Areas:

- ☐ Less than 50 000 km2
- ☐ 50 000 - 200 000 km2
- ☐ 200 000 - 1 000 000 km2
- ☐ More than 1 000 000 km2
- ☐ Other (specify) .....

2.6 Main Regions Of Interest Within The Russian Federation:

Land regions

- ☐ North-western part of the RF
- ☐ Far North
- ☐ Central region of the RF
- ☐ South of the European part of Russia
- ☐ Povolzhje (Volga region)
- ☐ Ural
- ☐ Western Siberia
- ☐ Eastern Siberia
- ☐ Far East
- ☐ Other (specify) .....

Oceans

- ☐ Arctic seas
- ☐ Far East seas
- ☐ Azov-Black seas area
- ☐ Baltic sea
- ☐ Inland water bodies
- ☐ Other (specify) .....

2.7 Frequency And Season Of Observations (Information Updates)

Frequency

- ☐ Daily
- ☐ Once every few days
- ☐ Weekly
- ☐ Monthly
- ☐ Annual
- ☐ One-off
- ☐ Depending on event
- ☐ Once every few years
- ☐ Other (specify) .....

Season

- ☐ All-the-year-round
- ☐ Open water season
- ☐ Ice cover season
- ☐ Vegetation phase
- ☐ Winter
- ☐ Spring
- ☐ Summer
- ☐ Autumn
- ☐ Other (specify) .....

2.8 Estimated Budget of Activity

Choose the most convenient for you type of estimation

Year of reference 199.....	% from annual budget	Roubles per year	USD per year
information acquisition			
information processing			

2.9 Estimated development of Your Activity

How do you assess the overall development trend of your activity during the next years to come?

	Time perspective	
	1-3 years	5 years
Decrease by	..... %	..... %
Unchanged	☐	☐
Increase by	..... %	..... %

3. Assessment Of The Role Of Satellite Information In Support Of The Activities Of Your Organization

3.1. Does Your Organization Use Satellite Data?

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☐ Yes ☐ No

If Yes, What Data Are Used Or Would You Like To Use?

Satellite (sensor)	Currently used	Intend to use
Meteor - Russia	☐	☐
Resurs - Russia	☐	☐
Okean/Radar - Russia	☐	☐
Almaz - Russia	☐	☐
Kosmos - Russia	☐	☐
SPOT - France	☐	☐
ERS/SAR - Europe	☐	☐
Landsat - USA	☐	☐
Radarsat - Canada	☐	☐
High Resolution (specify)		
Other (specify)		

3.2. Application Area

What natural or technogenic information obtained from satellite data would be of interest for your organization?

Oceans, Seas and Inland Water Bodies:

☐ Surface temperature
☐ Near-water wind direction and speed
☐ Sea waves characteristics
☐ Direction and speed of water masses transport
☐ Phytoplankton content
☐ Content of suspended matter
☐ Content of dissolved organic matter
☐ Oil pollution characteristics
☐ Ice cover (ice concentration, state, type, etc.)
☐ Changes of coastal line location
☐ Changes of bottom relief in coastal zone
☐ Other (specify)

.....

Land Surface:

☐ Surface temperature
☐ Soil humidity
☐ Soil state characteristics
☐ Oil pollution characteristics
☐ Land-use parameters
☐ Vegetation state and characteristics
☐ Farmland state and characteristics
☐ Near-surface wind direction and speed
☐ Topographical maps parameters
☐ Other (specify)

.....

Atmosphere:

☐ Humidity
☐ Wind speed and direction
☐ Cloud cover
☐ Ozone content
☐ Small gas components content
☐ Characteristics of air pollution
☐ Transboundary transport parameters
☐ Other (specify)

.....

Forests:

☐ Distribution of vegetation
☐ Forest density
☐ Types of vegetation
☐ Trees taxation characteristics
☐ Characteristics of forests state
☐ Forest fires parameters
☐ Other (specify)

.....

Natural Resources (Geology):

☐ Relief characteristics
☐ Soil-ground characteristics
☐ Rock characteristics
☐ Tectonic dislocation characteristics
☐ Other (specify)

.....

4

Characteristics Of Urban Areas State:

☐ Relief and soil-ground characteristics for new building areas
☐ Characteristics of vegetation
☐ Characteristics of water systems
☐ Heat losses
☐ Other (specify) .....

3.3. What Level Of Satellite Data Processing Do Your Organization Needs?

☐ Raw data
☐ Signal (brightness) corrected
☐ Calibrated data
☐ Geocoded
☐ Ortho imagery
☐ Data with applied atmospheric correction
☐ Image analysis and thematic mapping
☐ Improvement of the existing thematic maps
☐ Other (specify)
☐ Unable to respond
.....

3.4. What Do You Consider As Main Obstacles For Use Of Satellite Data In Your Organization ?

☐ High price
☐ Inappropriate area coverage
☐ Availability
☐ Non-operational delivery
☐ Information content
☐ Analysis tools (software)
☐ Missing information on where and how to obtain these data
☐ Legislation issues
☐ Other (specify)
.....

ORGANIZATION INFORMATION

Address:
City:
Postal code:
Country:
Number of Employees: .....
Contact Person: .....
Annual Budget: .....

INFORMATION ON ANSWERING PERSON(S)

Name:
Position:
Phone:
Fax:
E-mail:
Role in Organization: ○ Decide ○ Recommend ○ Propose ○ Purchase ○ Other

Thank You for your assistance!!

For further information and questions about this survey, please contact;

Nansen Environmental and Remote Sensing Center
Edv. Griegsvei 3, N-5059 Solheimsviken - Bergen, NORWAY
Point of contact: Lasse H. PETTERSSON
Phone: +47 55 29 72 88, Fax: +47 55 20 00 50
e-mail: lasse.pettersson@nrsc.no

Nansen International Environmental and Remote Sensing Cente
Korpusnaya street 18, RU-197110 St. Petersburg, RUSSIA
Point of contact: Leonid P. BOBYLEV
Phone: + 7 812 235 7493 Fax: +7 812 230 7994
e-mail: nansen@online.ru

Date of Completion: Completed by:

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Evaluation by Surveyor

Possibility for purchase of EO data ○ **High** ○ **Medium** ○ **Low** ○ **Unable to evaluate**

Possibility for use of EO data ○ **High** ○ **Medium** ○ **Low** ○ **Unable to evaluate**

Comments:

A.3 Summary Report of Survey Statistics

The statistical summary report derived form the survey relational database. Similar reports have been made for various subsets of the database in order to perform the market analysis.

SUMMARY REPORT
Use of Satellite Data for the Russian Territories.

Criteria: "Grand Summary Report" based on 189 of 189 records

Primary Application Area:

Sea Ice	8%		
Environment	62%		
Forestry	11%		
Geology	17%	Empty	1%

Secondary Application Area:

Sea Ice	23%		
Environment	40%		
Forestry	22%		
Geology	15%	Empty	1%

1. What Organization do you represent?

1.2 Organization Type

Governmental:		Private:	
Budget	69%	Private limited liability company	10%
Unitary	8%	Incorporated enterprise	6%
Joint-stock company	4%		
		Other	3%
		Empty	1%

1.3 Subordination Level (for State Organizations only)

Federal level	72%		
Krai	6%		
Oblast	6%	Empty	19%

1.4 Activity Area

Note: More than one choice is possible.

Management	26%	Agriculture	5%
Funding (projects, programs etc.)	18%	Services/Consultancy	13%
Manufacturing	2%	Environmental monitoring	69%
Transportation	12%	Thematic mapping	52%
Energy	1%	Development of software	23%
Exploration and production of natural resources	26%	Research and design	52%
Transportation services	10%	Education	21%
Infrastructure maintenance	2%	Data collection:	48%
		Empty	2%

1

1.5 Type of Clients (Customers of your Organization)

International Agencies	**24%**	**Other lage-scale industries**	**22%**
National Authorities	**40%**	**Minor Industry**	**24%**
Regional Authorities	**65%**	**Consulting Companies**	**16%**
Other Public Organizations	**10%**	**Private Organizations**	**13%**
Oil/Gas Industry	**42%**	**Education**	**19%**
		Research/University	**45%**
		Other	**43%**
		Empty	**4%**

2. Amount and type of information that is necessary for your organization

2.3 Area of Interest

Note: More than one choice is possible.

Environmental and Pollution Monitoring	**68%**	**Climate Studies (Glocal Change)**	**24%**
Oceans, seas and inland water monitoring	**42%**	Sea Ice	**25%**
Oil pollution (water)	**29%**	Tundra	**14%**
Other types of pollution (water)	**25%**	Forrestry	**15%**
Land surface monitoring	**54%**	**Urban territories monitoring**	**21%**
Oil pollution (land)	**19%**	Land-use mapping	**23%**
Other types of pollution (land)	**14%**	Planning	**33%**
Changes in soil cover	**32%**	Management and monitoring	**18%**
Changes in vegetation	**40%**	Heat losses assessment	**6%**
Changes in landscapes	**44%**	**Risk Management**	**50%**
Atmospheric monitoring	**23%**	Forest fires	**25%**
Environmental monitoring of the Northern territories	**34%**	Earthquakes	**7%**
Agriculture	**14%**	Volcanic eruptions	**4%**
Farm land mapping	**16%**	Floods	**24%**
Agriculture work planning	**3%**	Storms	**20%**
Agricultural resources monitoring and crop forecasts	**24%**	Drought	**13%**
Forestry	**35%**	Transport accidents	**20%**
Forests mapping	**10%**	Industrial accidents	**21%**
Forests inventory	**18%**	Oil / gas pipelines leakage	**27%**
Forests state monitoring	**28%**	Radioactive pollution	**13%**
Forest use	**16%**	**Cadastral compilation**	**22%**
Forest fire monitoring	**20%**	Land cadaster	**10%**
Mapping of Natural Resources (geology)	**34%**	Soil cadaster	**7%**
Mineral resources exploration	**23%**	Forest cadaster	**14%**
Monitoring of oil and mining activities	**23%**	Water cadaster	**6%**
Navigation	**21%**	**Geographical Information Systems (GIS)**	**41%**
Planning and support for navigation in ice	**18%**	**Cartography and production of thematic maps**	**40%**
Sea ice mapping and monitoring	**20%**		
Icebreaker services	**8%**		
Fishery, seafood, sea animals	**12%**		
Marine biological resources mapping	**13%**		
Fish stock studies	**7%**	**Other**	**14%**
Sea mamal studies	**3%**	**Empty main**	**1%**
Sea and ice process studies	**10%**	**Empty sub**	**1%**

2.4 Geographical Coverage of Activity

Russian Federation	38%
Republic, Krai	40%
Region, city	40%
Other	11%
Empty	11%

2.5 Typical Scale Of Studied Areas:

Less than 50 000 km2	44%
50 000 - 200 000 km2	50%
200 000 - 1 000 000 km2	29%
More than 1 000 000 km2	15%
Other	4%
Empty	12%

2.6 Main Regions Of Interest Within The Russian Federation:

Land regions	
North-western part of the RF	39%
Far North	39%
Central region of the RF	23%
South of the European part of Russia	18%
Povolzhje (Volga region)	21%
Ural	24%
Western Siberia	43%
Eastern Siberia	18%
Far East	26%

Oceans	
Arctic seas	37%
Far East seas	14%
Azov-Black seas area	12%
Baltic sea	13%
Inland water bodies	29%
Other	27%
Empty	4%

2.7 Frequency And Season Of Observations (Information Updates)

Frequency	
Daily	19%
Once every few days	16%
Weekly	10%
Monthly	19%
Annual	19%
One-off	31%
Depending on event	55%
Once every few years	11%

Season	
All-the-year-round	53%
Open water season	15%
Ice cover season	15%
Vegetation phase	13%
Winter	6%
Spring	24%
Summer	30%
Autumn	21%
Other	3%
Empty	3%

3

3. Assessment Of The Role Of Satellite Information In Support Of The Activities Of Your Organization

3.1. Does Your Organization Use Satellite Data?

Yes 76%
No 17%
Empty 7%

If Yes, What Data Are Used Or Would You Like To Use?

Satellite (sensor)	Currently used	Intend to use
Meteor - Russia	31%	25%
Resurs - Russia	58%	64%
Okean/Radar - Russia	13%	27%
Almaz - Russia	11%	9%
Kosmos - Russia	20%	22%
SPOT - France	12%	49%
ERS/SAR - Europe	14%	73%
Landsat - USA	17%	25%
Radarsat - Canada	5%	37%
High Resolution	17%	
Other	30%	

Empty 11%

3.2. Application Area

What natural or technogenic information obtained from satellite data would be of interest for your organization?

Oceans, Seas and Inland Water Bodies:

Surface temperature	30%
Near-water wind direction and speed	23%
Sea waves characteristics	22%
Direction and speed of water masses transp.	21%
Phytoplankton content	17%
Content of suspended matter	22%
Content of dissolved organic matter	19%
Oil pollution characteristics	37%
Ice cover (ice concentration, state, type, etc.)	37%
Changes of coastal line location	24%
Changes of bottom relief in coastal zone	20%

Land Surface:

Surface temperature	18%
Soil humidity	21%
Soil state characteristics	31%
Oil pollution characteristics	32%
Land-use parameters	36%
Vegetation state and characteristics	39%
Farmland state and characteristics	22%
Near-surface wind direction and speed	6%
Topographical maps parameters	36%

Atmosphere:

Humidity	11%
Wind speed and direction	16%
Cloud cover	15%
Ozone content	5%
Small gas components content	5%
Characteristics of air pollution	16%
Transboundary transport parameters	8%

Forests:

Distribution of vegetation	30%
Forest density	20%
Types of vegetation	28%
Trees taxation characteristics	16%
Characteristics of forests state	20%
Forest fires parameters	23%

Natural Resources (Geology):

Relief characteristics	38%
Soil-ground characteristics	32%
Rock characteristics	24%
Tectonic dislocation characteristics	20%

Characteristics Of Urban Areas State:

Relief and soil-ground characteristics	25%
Characteristics of vegetation	24%
Characteristics of water systems	15%
Heat losses	6%

Other	13%
Empty	2%

3.3. What Level Of Satellite Data Processing Do Your Organization Needs?

Raw data	32%
Signal (brightness) corrected	9%
Calibrated data	21%
Geocoded	34%
Ortho imagery	39%

Data with applied atmospheric correction	16%
Image analysis and thematic mapping	51%
Improvement of the existing thematic maps	42%
Unable to respond	5%
Other	2%
Empty	4%

3.4. What Do You Consider As Main Obstacles For Use Of Satellite Data In Your Organization ?

High price	49%
Inappropriate area coverage	9%
Availability	31%
Non-operational delivery	23%
Information content	32%

Analysis tools (software)	20%
Missing information	20%
Legislation issues	3%
Other	12%
Empty	17%

Evaluation by Surveyor

Possibility for purchase of EO data:	High	6%
	Medium	32%
	Low	50%
	Unable to evaluate	12%
	Empty	1%

Possibility for use of EO data		
	High	30%
	Medium	58%
	Low	5%
	Unable to evaluate	6%
	Empty	1%

5

A.4 Program of and Participants at the Project Workshops

Below follows the sample program for the Workshop in St. Petersburg. The program for the Workshops in Moscow and Novosibirsk was only modified slightly according to the participating project staff as well as the thematic focus areas of the majority of the participants.

USER DEMONSTRATION WORKSHOP:
APPLICATIONS OF SATELLITE EARTH OBSERVATION DATA
FOR THE RUSSIAN TERRITORIES

9 December 1998

House of Scientists, St.Petersburg

PROGRAMME

SESSION 1:	
Chairman:	Mr. Pettersson L., NERSC, Bergen, Norway
10 : 00 - 11 : 10	**Welcoming and opening**
	Dr. Bobylev L.P., NIERSC, St. Petersburg
(15 min)	**Project. Background, Objectives and Tasks**
	Mr. Pettersson L., NERSC, Bergen, Norway
(30 min)	**The ESA Earth Observation Programs**
	Mr. Pettersson L., NERSC, Bergen, Norway
(25 min)	**Russian systems of acquisition and using of operative and archived data of the Earth observation - status and perspectives**
	Dr. Volkov A., Scientific Research Center for Natural Resources Study, Moscow
	Dr. Polischuk G., RSA, Moscow
11 : 10 - 11 : 30	**Coffee Break**
SESSION 2:	
Chairman:	**Dr. Bobylev L.P., NIERSC, St.Petersburg**
11 : 30 - 12 : 10	**Application of satellite radar in support of navigation and off-shore activity along the Arctic seas shelf**
	Prof. Melentyev V.V., NIERSC, St. Petersburg
12 : 10 - 12 : 40	**Environmental monitoring using satellite radars**
	Dr. Kotova LA., NIERSC, St. Petersburg
12 : 40 - 13 : 30	**Lunch**
13 : 30 - 14 : 00	**Boreal forests mapping and monitoring using satellite data**
	Dr. Donchenko V.V., NIERSC, St. Petersburg
14 : 00- 14 : 30	**Mapping natural resources using satellite radar**
	Dr. Korotkevich O.Eu., NIERSC, St. Petersburg
14 : 30 - 14 : 50	**Practical use of satellite data in Russia - Experience of SPOT IMAGE**
	Dr. Krivtchenko E.I., DERSI/SPOT IMAGE, Moscow
14 : 50 - 15 : 10	**Coffee Break**
15 : 10 - 15 : 30	**Application areas of the Russian satellite remote sensing data**
	Dr. Khizhnitchenko V.I., Scientific Research Center for Natural Resources Study, Moscow
SESSION 3:	
Chairmen:	Mr. Pettersson L., NERSC, Bergen, Norway
	Dr. Bobylev L.P., NIERSC, St. Petersburg
15 : 30 - 17 : 00	**Requirements to use satellite Earth observation data.**
	Workshop participants contributions and discussion

A.4.1 Participants in St. Petersburg, House of Scientists – 9. December, 1998

Name	Organisation	Address	tel., fax, E-MAIL
BOBYLEV Leonid P. Director	NIERSC	Korpusnaya str., 18 197110 St.Petersburg Russia	Ph.: (812) 235 74 93 Fax: (812) 230 79 94 e-mail: nansen@online.ru
DONCHENKO Viktoria V. Scientist	NIERSC	Korpusnaya str., 18 197110 St.Petersburg Russia	Ph.: (812) 235 74 93 Fax: (812) 230 79 94 e-mail: nansen@online.ru
ERMOLOV Sergey A. Vice-Chairman	LENKOMECOLOGIA	Bolshaya Morskaya, 51 St.Petersburg Russia	Ph.: (812) 312 79 82 Fax: (812) 279 76 45 e-mail: -
GUSEV Vitaly G. Head of Laboratory	Forestry Research Institute	Institutsky pr., 21 194021 St.Petersburg Russia	Ph.: (812) 552 80 21 Fax: (812) 552 80 42 e-mail: serg@forest.spb.su
HOUIX Jean-Pierre	French National Geographic Institute IGN-France International	Bolshaya Konushenaya 29, Office 208/210 St. Petersburg Russia	Ph.: (812) 314 18 40 Fax: (812) 314 18 40 e-mail:
IVANOV Viktor N. Leading Scientist	GIPROSPETSGAS	Suvorovsky pr., 26 St.Petersburg Russia	Ph.: (812) 271 08 88 Fax: (812) 271 08 65 e-mail:
KHILOV Alexey M. Senior Scientist	Forestry Research Institute	Institutsky pr., 21 194021 St.Petersburg Russia	Ph.: (812) 552 80 21 Fax: (812) 552 80 42 e-mail: serg@forest.spb.su
KHIZHNITCHENKO Vitaky I. Head of Department	Research Center for Natural Resources Study	Pervomaiskaya Str., 7 141700 Dolgoprudny Moscow region Russia	Ph.: (095) 483 31 11 Fax: (095) 483 33 74 e-mail: adm@m.astelite.ru
KLIMASHEVSKY Stanislav N. Leading Scientist	Krylov Shipbuilding Research Institute	Moskovskoe shosse 44 196158 St.Petersburg Russia	Ph.: (812) 293 97 45 Fax: - (812) 127 93 49 e-mail:
KOLESNIKOVA Galina A.	Nature Resources Committee of Republik Karelia	Varkausa emb. 1-A 185031 Petrozavodsk Republic of Karelia Russia	Ph.: (814) 2 77 42 61 Fax: (814) 2 74 87 29 e-mail:
KOROTKEVICH Oleg Eu. Senior Scientist	NIERSC	Korpusnaya str., 18 197110 St.Petersburg Russia	Ph.: (812) 235 74 93 Fax: (812) 230 79 94 e-mail: nansen@online.ru
KOTOVA Lola A. Scientist	NIERSC	Korpusnaya str., 18 197110 St.Petersburg Russia	Ph.: (812) 235 74 93 Fax: (812) 230 79 94 e-mail: nansen@online.ru
KRIVTCHENKO Evgene I. SPOT IMAGE Representative in RF	Industrial Space Firms International Cooperation Development (DERSI) SPOT IMAGE	Shmitovsky proezd, 13 123100 Moscow Russia	Ph.: (095) 259 52 38 Fax: (095) 259 67 38 e-mail: dersi@dol.ru
KSENOFONTOV Alexey V. Vice-Chairman of the Committee	Leningrad province Government Committee of Natural Resources Use and Ecological Safety	Smolnogo Str., 3 St.Petersburg Russia	Ph.: (812) 274 93 81 Fax: (812) 271 56 27 e-mail:
MAKEEV Viacheslav M. Director	State Research Institute of Nature Protection of Arctic Countries	Chilieva Str., 13 St.Petersburg Russia	Ph.: (812) 352 33 89 Fax: (812) 352 33 89 e-mail: rimcan@rimcan.spb.ru

MARTYANOV Viacheslav L. Deputy Head	Russian Antarctic Expedition	St.Petersburg Russia	Ph.: (812) 352 18 15 Fax: (812) 352 28 27 e-mail: rusanexp@comset.net
MELENTYEV Vladimir V. Leading Scientist	NIERSC	Korpusnaya str., 18 197110 St.Petersburg Russia	Ph.: (812) 235 74 93 Fax: (812) 230 79 94 e-mail: nansen@online.ru
OBOZHIN Alexey L. Director	MORINTECH Co.	Pr. Kima, 6 199155 St.Petersburg Russia	Ph.: (812) 325 40 48 (812) 350 40 55 Fax: (812) 350 41 55 e-mail: alo@morintech.spb.su
ORGO Vladimir V. Head of West-Arctic Party	Polar Marine Ecological Research Expedition	Pobedy Str., 24 189510 Lomonosov Russia	Ph.: (812) 422 49 63 (812) 422 04 94 Fax: (812) 423 19 00 e-mail: -
PETTERSSON Lasse H. Marketing Director	NERSC	Edv. Griegsvei 3A N-5037 Solheimsviken Bergen, Norway	Ph.: (47) 55 29 72 88 Fax: (47) 55 20 00 50 e-mail: lasse.pettersson@nrsc.no
PONOMARENKO Alexandr P. Deputy General Director	LUKOIL St.Petersburg	Tverskaya Str., 8 193015 St.Petersburg Russia	Ph.: (812) 275 30 29 Fax: (812) 279 96 42 e-mail: aponomar@lukoil.spb.ru
ROZANOV Oleg V. Head, Department of Ecological Monitoring	Yamal-Nenets Committee on Environment Protection	Mira Str., 40 626608 Salekhard Russia	Ph.: (095) 915 02 91 (34 591) 4 70 64 Fax: (34 591) 4 70 64 e-mail: space@salekhard.ru
SHIGABUTDINOV Albert R. Senior Scientist	Central Marine Research and Design Institute (CNIIMF)	Kavalergardskaya 6 193015 St.Petersburg Russia	Ph.: (812) 275 89 72 Fax: (812) 274 38 64 e-mail: als@satmarin.spb.su
SHTAGER E.A. Leading Scientist	ECOS KONVERSIA	Zhdanovskaya Str., 37 St.Petersburg Russia	Ph.: (812) 230 89 50 Fax: (812) 230 89 50 e-mail:
SHUBINA Arina A. Leading Scientist	Institute of Remote Sensing Methods for Geology (VNIIKAM)	Birjevoi proezd 6, 199034 St.Petersburg Russia	Ph.: (812) 328 28 01 Fax: (812) 328 39 16 e-mail: sur@vniikam.spb.ru
SOROKIN Mikhail Yu. Chief Ingeneer	Polar Marine Ecological Research Expedition	Pobedy Str., 24 189510 Lomonosov Russia	Ph.: (812) 422 04 94 Fax: (812) 423 19 00 e-mail: sorm@adm.polarex.spb.ru
SUDNIK Alexander G. Director	NORDECO St.Petersburg	Moskovski pr., 143 Office 440 St.Petersburg Russia	Ph.: (812) 294 77 10 (812) 298 33 67 Fax: (812) 298 33 67 e-mail: sudnik@infopro.spb.su
TREIVUS Sergey S. Chief Specialist	Forestry Research Institute	Institutsky pr., 21 194021 St.Petersburg Russia	Ph.: (812) 552 80 21 Fax: (812) 552 80 42 e-mail: serg@forest.spb.su
TURBIN Yuri G. Head of Laboratory	Ministry of Natural Resources RF "SEVMORGEO"	Rozenshteina str., 36 198095 St.Petersburg Russia	Ph.: (812) 252 37 10 Fax: (812) 252 44 16 e-mail:
VINOGRADOV Roman A. Ingeneer	Arctic and Antarctic Research Institute "Arcticshelf" Laboratory	Beringa Str., 38 St.Petersburg Russia	Ph.: (812) 352 31 29 Fax: (812) 352 26 88 e-mail: dne@aari.nw.ru gup@aari.nw.ru
VOLKOV Aleksey M. Director	Research Center for Natural Resources Study	Pervomaiskaya Str., 7 141700 Dolgoprudny Moscow region Russia	Ph.: (095) 483 31 11 (095) 483 31 90 Fax: (095) 483 33 74 e-mail: adm@astelite.ru
YAKSHEVICH E.V. Head of Laboratory	Central Marine Research and Design Institute (CNIIMF)	Kavalergardskaya 6 193015 St.Petersburg Russia	Ph.: (812) 275 89 72 Fax: (812) 274 38 64 e-mail:

ZAITSEV Alexandr N. Head of Department	Institute of Earth Magnetism and Ionosphere	142092 Troitsk Moscow Region Russia	Ph.: (095) 334 02 93 Fax: (095) 334 01 24 e-mail:
ZAVIALOVA Tatyana A. Head Aerophoto Survey Group	North-West State Forest Enterprise	Kd Tomchaka St, 16 196084 St.Petersburg Russia	Ph.: (812) 298 63 88 Fax: (812) 298 03 84 e-mail: nwsfme@mail.admiral.ru
ZINOVYEV Yury S. Leading Scientist	ECOS-KONVERSIA	Kosmonavtov 34-34 196244 St.Petersburg Russia	Ph.: (812) 264 74 43 Fax: e-mail:

A.4.2 Participants in Moscow, ESA Mission to Russia – 12. December, 1998

Name	Organisation	Address	tel., fax, E-MAIL
ANDREEV N.A. Head of Central Station	Central Station of Forest Aerial Survey	Gorkogo str.,20 141200, Pushkino, Moscow region, RUSSIA	Tel.: (095) 584 37 56 Fax: (095) 584 37 56
ARKHIPOV Vladimir I. Director	North-West State Forest Management Etr.	Koli Tomchaka str., 16, SPB, 196084, RUSSIA	Tel.: (812) 298 26 93 Fax: (812) 298 03 84 e-mail: nwsfme@mail.admiral.ru
BARTALEV Sergey A. Head of laboratory	MIF	Novocheremushkinskay a str.,69 117418, Moscow RUSSIA	Tel.: (095) 332 68 77 Fax: (095) 332 29 17 e-mail: gisfores@mx.iki.rssi.ru
BOBYLEV Leonid P. Director	NIERSC	Korpusnaya str, 18 193210; SPB RUSSIA	Tel: (812) 235 74 93 Fax: (812) 230 79 94 e-mail: nansen@online.ru
BOGDANOV Anatoly V. Head of Department	Ministry of Science and Technology RF	Tverskaya str., 11 Moscow RUSSIA	Tel.: (095) 229 17 64 Fax: (095) 229 44 64
FOURNIER –Sikr Alan	ESA	Sretensky bul., 6/1-122 101000 Moscow RUSSIA	Tel.: (095) 928 75 29 Fax: (095) 928 53 52 e-mail: afournie@emo.esa.int
GRIDINVitaly I. Professor	Oil and Gas State University im Gubkina	Leninsky pr.,65 Moscow RUSSIA	Tel.: (095) 135 50 05 Fax: (095) 135 88 95 (095) 135 86 96
GUSEVANina N. Head of Department	NITzIPR	Pervomaiskaya str., 7 Dolgoprudny RUSSIA	Tel.: (095) 483 32 56 (095) 483 31 90 Fax: (095) 483 33 74 e-mail: adm@m.astelit.ru
GZIN Vladimir V. Head of Department	EMERCOM	Moscow	Tel.: (095) 445 50 14 Fax: (095) 445 44 62 e-mail: asic@asic.ss.msu.ru gvv@asic.ss.msu.ru
HOUIX Jean-Pierre	French National Geographical Institute	B.Konushennaya,29, S.-Petersburg RUSSIA	Tel.: (812) 314 18 40 Fax: (812) 314 18 40 e-mail: houix@mail.rcom.ru
KHIZNITCHENKO Vitaly I. Head of dept.	NITzIPR	Pervomayskaya str, 7 141700, Dolgoprudny RUSSIA	Tel.: (095) 483 32 56 (095) 483 31 90 fax: (095) 483 33 74 e-mail: adm@m.astelit.ru

KOTOVA Lola A. Scientist	NIERSC	Korpusnaya str., 18 Spb	Tel.: (812) 235 74 93 Fax: (812) 230 79 94 e-mail: nansen@online.ru
KOURAEV Alexey V. Senior Scientist	NIERSC	Korpusnaya str., 18 Spb	Tel.: (812) 235 74 93 Fax: (812) 230 79 94 e-mail: nansen@online.ru
KRIVCHENKO Evgeny I.	DERSI / SPOT IMAGE	Shmitovsky pr., Moscow 13	Tel.: (095) 259 52 38 Fax: (095) 259 67 38 e-mail: dersi@dol.ru
MANANENKOVA Elena Head of Foreing Relations department	NITz «PLANETA»	Bolshoy Predtechensky pr.,7 123242 Moscow; RUSSIA	Tel: (095) 255 12 63 Fax: (095) 200 42 10
MELENTEV Vladimir V. Head Scientists	NIERSC	Korpusnaya str.,18 Spb	Tel: (812) 235 74 93 Fax: (812) 230 79 94 e-mail: nansen@online.ru
MESHKOV Mikael N.	OKB MEI		Tel.: (095) 362 56 52 362 10 29 362 73 97 fax: (095) 362 55 76
PAVLOV Victor Yu. Main Technologists	Dep. Of Science, new technology and Ecology RAO «GAZPROM»	Nametkina str.,16 Moscow	tel.: (095) 349 22 00, 719 22 00 fax: (095) 719 45 74
PETTERSSON Lasse H.	NERSC	Edv. Griegsvei 3A N-5037 Solheimsviken Bergen Norway	Tel.: (47) 55 29 72 88 Fax: (47) 55 20 00 50 e-mail: lasse.pettersson@nrsc.no
SHAKHRAMANYAN Mikhail A. Direcor of Agency	EMERCOM	Moscow	Tel.: (095) 443 83 44 (095) 445 44 45 fax: (095) 443 83 15
TARAKANOVA Olga N. Vice-President	«SCANEKS» Engenerring and Technology Center	L.Tolstogo str.,22/5 Moscow RUSSIA	Tel: (095) 939 56 40 Fax: (095) 939 42 84 e-mail: scanex@scan.ss.msu.ru
VOLDEN Arnold Technical Manager	STATOIL Moscow	Tcvetnoi bul., 16 Moscow RUSSIA	Tel.: (095) 967 38 18 Fax:(095) 967 38 24 (095) 967 38 25
VOLKOV Alexey M. Director	NITzIPR	Pervomayskaya str, 7 141700, Dolgoprudny RUSSIA	Tel.: (095) 483 32 56 (095) 483 31 90 Fax: (095) 483 33 74 e-mail: adm@m.astelit.ru

A.4.3 Participants in Novosibirsk, RAS – 15. December, 1998

Name	Organisation	Address	tel., fax, E-MAIL
ALEKSEEV Anatoly Semenovich Director of institute	Institute of Computational Mathematics and Mathematical Geophysics (Computing Center) Siberian Branch of the Russian Academy of Sciences	630090 Novosibirsk, Av.Lavrent'eva 6	Ph. .: (383-2) 34-26-50 Fax : (383-2) 32-42-59
ANASHKIN Sergey Borisovich Main engineer of Center	Center of Governmental Relationship of Novosibirsk Region	630007, Novosibirsk St.Sibrevkoma, 7	Ph. . (383-2) 90-21-69

BELOV Vladimir Vasil'exich Deputy director	Institute of atmosphere optics SB RAS	634055 Tomsk Av. Akademicheski, 1	Ph. .: (382-2) 25-92-37
BOBYLEV Leonid Petrovich Director	NIERSC	197110 St. Petersburg Korpusnaya St., 18	Ph. .: (812) 235 74 93 Fax : (812) 230 79 94
BOGDANOV Anatoly Vladimirovich Chief of the Department	Ministry of Science and Technologies Russian Federation	403905 Moscow Tverskai St. 11	Ph. .: (095) 229 17 64 Fax : (095) 229 44 64
BOYKOV Anatoliy Fedorovich Chief of natural resources department	Administration of Novosibirsk Region, Main economic management	630011 Novosibirsk Krasnii Av., 18	Ph. .: (383-2) 23-88-27; Ph. .: (383-2) 22-24-66
DEIHIN Leonid Evsigneevich	Novosibirsk Regional Center GIT SB RAS	630090, Tereshkova St., 29	Ph. . (383-2) 34-26-37
EROHIN Gennadiy Nikolaevich Director	Siberian Remote Sensing Center	630090 Novosibirsk Av. Lavrent'eva 6	Ph. . (383-2) 34-27-52; Fax (383-2) 34-45-76
EVTYUSHKIN Arkadiy Victorovich Laboratory head	AGU NII EM Image processing Lab	656099 Barnaul Dimitrov 66	Ph. /(385-2) 36-70-61
FEDORCHENKO Vyacheslav Leonidovich Director	State enterprise "Sahalingeoinform"	693000, Yuzhno-Sahalinsk Box # 71	Ph. (424) 242-01-02 Fax (424) 225-55-15
GRIGOR'EV Valentin Vasil'evich Leading geolog	Geological enterprise "Berezovgeologiya"	Novosibirsk St.Kamenskaya 74	Ph. . (383-2) 20-74-62
HIZHNICHENKO Vitaliy Ivanovich Head of department	Research Center of Natural resources	Pervomayskaya St. 7 141700, Moscow region Dolgoprudniy	Ph. : (095) 483 32 56 (095) 483 31 90 Fax : (095) 483 33 74
HMEL'NITCKIY Sergey Sergeevich Director	Industrial enterprise "Tomskmezhhozles"	636138 Tomsk region Kornilovo, St. Kredrovaya7	Ph. (382-2) 26-49-71
HMEL'NITCKIY Gennadiy Sergeevich Head of department	Tomsk State University	Tomsk, Lenin St., 36 Tomsk, Russia	Ph. (382-2) 41-55-79 Fax (382-2)22-40-61
KAMISHNIKOV Aleksey Ivanovich Chair head	Altai State university	656099, Barnaul Dimitrov 66	Ph. (385-2) 23-87-25; 23-26-74; 22-28-75
KARMISHIN Aleksandr Mihailovich Head of department	Radiotechnics and electronics department Krasnoyarsk Scientific Center SB RAS	660036, Krasnoyarsk Akademgorodok	Ph. (391-2) 49-44-94 Fax 391-2) 43-97-65
KISELEV Anatoliy Georgievich Information department head	Executive Council of "Siberian Agreement"	660099, Novosibirsk St. Uritckiy, 19	Ph. (383-2) 23-97-34 Fax (383-2) 23-77-38 e-mail
KOMARNITCKIY Gavriil Maksimovich	Novosibirsk State Academy of Economics and Management	630112, Novosibirsk Ippodromskaya 32 app.143	Ph. (383-2) 11-24-49
KOPILOV Vasiliy Nikolaevich Head of center	West Siberian Regional Data Acquisition Center of Rosgidromet	630099, Novosibirsk Sovetskaya St., 30	Ph. (383-2) 22-33-0
KOROTKEVICH Maria Nikitichna Program director	"Siberian Agreement", Ecological program	630099 Novosibirsk, St. Uritckiy 19	Ph. (383-2) 23-67-53 Fax (383-2) 23-77-38

KOTOVA Lola Aleksandrovna Research fellow	NIERSC	197110, Ñ.-Ïåòåðáóðã, Korpusnaya St., 18	Ph. : (812) 235 74 93 Fax : (812) 230 79 94
KRIVCHENKO Eugene Igorevich Engineer	"Dersi" company	123100 Moscow Shmidtovskiy Av.13	Ph. (095) 259-67-38 Fax (095) 259-52-38
KRUTIKOV Vladimir Alekseevich President	Tomsk Scientific Center SB RAS	634055, Tomsk Av.Akademicheskiy 2	Ph. (382-2) 25-93-09 (383-2) 25-81-7 Fax (382-2) 25-97-13
KUDRIN Victor Ivanovich Deputy chairman	Environment protection state committee of Hanty-Mansy Region	626200, Hanty-Mansiysk St. Mira 129	Ph. (346-71)03-31-91
LOGINOV Vladimir Timofeevich Leading specialist	Natural resources committee of Altai republic	659701 Altai republic Maima St.Zavodskaya 52	Ph. (38844) 22-0-30 Fax (38844) 22-7-90
LUK'YANENKO Dmitry Nikolaevich Postgraduate student	Altai State University	656099, Barnaul St.Dimitrov 66	Ph./Fax 385-2 367061
MARCHENKO Yury Yur'evich Head of department	Ecological State committee of Novosibirsk region	630091 Novosibirsk Krasnii Av., 81	Ph. (383-2) 17-33-70 Fax (383-2) 20-54-94
MARTINOV Andrey Vladimirîâè÷ Research fellow	Institute of Computational Mathematics and Mathematical Geophysics SB RAS	630090, Novosibirsk Av. Lavrent'eva, 6	Ph. (383-2) 34-14-50
MELENTYEV Vladimir Vladimirîâè÷ Deputy director	NIERSC	197110 S-Peterburg St. Korpusnaya 18	Ph. (812) 235-74-93 Fax (812) 230-79-94
MIN'KO Nikolay Petrovich Head	Space Monitoring Center of Solar- terrestrial Physics Institute SB RAS	664033 Irkutsk Box # 4026	Ph. (395-2) 461865 Fax (395-2)46-25-57;46-05-65
MIRONOV Valeriy Leonidovich Chief research fellow	Ecological Monitoring Institute ASU	656099 Barnaul Dimitrov 66	Ph. /Fax (385-2) 36-70-61
NAUMOV Yury Vladimir Head of ecological department	State environment protection committee of republic Hakasia	662600 Abakan St. Vyatkina 4a	Ph. (39022) 59478 Fax (39022)59489
OSKORBIN Nikolay Mihailovich ASU chair head	Altai State University	656031, Barnaul St.Yadrintceva 130 app.73	Ph. /Fax (385-2) 36-70-18
PENENKO Vladimir Victorovich Laboratory head	Institute of Computational Mathematics and Mathematical Geophysics SB RAS	630090, Novosibirsk Av Av. Lavrent'eva 6	Ph. (383-2) 34-11-52
PETTERSON Lasse H. Director	NIERSC	Edv. Griegsvei 3A N-5037 Solheimsviken Bergen Norway	Ph. : (47) 55 29 72 88 Fax : (47) 55 20 00 50
POLYAKOV Yury Aleksandrovich Director	Lands Monitoring Institute	656099, Barnaul Dimitrov 66	Ph./Fax: .(385-2) 23-87-25
REMEZOV Valeriy Vladimirovich Deputy director	State communication Center	630007 Novosibirsk St.Sibrevkoma 7	Ph. (383-2) 90-21-12 Fax (383-2) 90-24-19
RICHKOVA Nataly Vladislavovna Research fellow	Institute of ecological Monitoring ASU	656099, Barnaul St.Dimitrov 66	Ph./Fax (385-2) 367061

SUHARIN Eugene Konstantinovich Head of forestry department	Forestry board of Novosibirsk region	630091, Novosibirsk, Krasnii Av. 82	Ph. (383-2) 17-29-11;17-36-05 Fax (383-2) 21-74-92
TEPLOV Aleksey Nikolaevich Deputy director	"Vostok"	Novosibirsk Av.Dimitrov 7/7 app. 715	Ph. (383-2) 21-51-51 Fax (383-2) 24-65-11
TKACHENKO Vladimir Aleksandrovich Chief engineer	Rosgidromet _ÖÏÍÄ	Novosibirsk St. Sovetskaya, 30	Ph. (383-2) 35-35-42;35-65-42
VLADIMIROV Valeriy Michailovich Deputy director of KSC	Presidium of Krasnoiarsk Scientific Center SB RAS	660036 Krasnoiarsk, 36 Akademgorodok	Ph. . (391) 2 43-97-65 Fax (391) 2-49-44-94
VRAGOV Andrey Vladimirovich,	Novosibirsk State university	630090 Novosibirsk Pirogov St. 2	Ph. . (383-2) 39-75-82 Ph. . (383-2) 39-75-83
VRAGOV Vladimir Nikolaevich NSU chair head	Novosibirsk State university	630090 Novosibirsk Pirogov St.2 app.232-à	Ph. . (383-2) 39-75-82 Ph. . (383-2) 39-75-95
ZABADAEV Igor Sergeevich Director	SB RAS GIS Center	630090 Novosibirsk Av.Universitetskiy 3	Ph. . (383-2) 34-26-37
ZACEPIN Anatoliy Georgievich Deputy director	Executive Council of "Siberian Agreement"	630099 Novosibirsk St.Uritckiy 19	Ph. (383-2) 23-67-53;23-97-34; Fax (383-2) 23-77-38
ZADOROZHNY Vasiliy Michailovich Deputy head	SB RAS Presidium "Scientific researches organization committee"	630090, Novosibirsk Av. Lavrent'eva, 17	Ph. . (383-2) 35-75-47; (383-2)35-05-71
ZINENKO Vasiliy Ivanovich Head of board	Western Siberia board of hydrometeorology and environment monitoring of Rosgidromet	630099, Novosibirsk Sovetskaya St., 30	Ph. (383-2) 21-14-33 Fax (383-2) 22-63-47

A.5 List of Russian Organisations Relevant to EO Applications

A.5.1 Ice Management and Navigation

The project has identified a total of 166 Russian organisations within the fields of ice management and navigation, which includes;

Federal Management Body

1. The Ministry of Transport of the Russian Federation (Marine Operation Department)
2. The Ministry of Natural Resources of Russian Federation (Marine Department)
3. The Committee of Fishery of Russian Federation (Marine Fishery Department)
4. Russian Federal Service for Hydrometeorology and Environmental Monitoring (Arctic, Antarctic and Marine Department)
5. The Committee of Environmental Protection of Russian Federation (Ecological Monitoring Department)
6. Administration of the Northern Sea Route (NSR)

Regional and Territorial Bodies

Shipping Companies

7. Murmansk Shipping Company (Murmansk)
8. Arctic Shipping Service Ltd (Murmansk)
9. Northern Shipping Company (Arkhangelsk)
10. White Sea-Onega Shipping Company (Petrozavodsk)
11. Western Shipping Company (St. Petersburg)
12. Azov/Black Seas Shipping Company (Taganrog)
13. Caspean Shipping Company (Astrakhan)
14. Far Eastern Shipping Company (Vladivostok)
15. Sakhalin Shipping Company (Y. Sakhalinsk)
16. Arctic Shipping Company (Tiksi)
17. Pechora Shipping Company (Naryan-Mar)
18. Yamal Shipping Company (Salekhard)

Administrations of the Sea Ports, Channels and Regional Water Basins (ice management and navigation)

Administrations of the Sea Ports

19. Administration of St.Petersburg Sea port (Baltic Sea, Finnish Gulf)
20. Administration of Kaliningrag Sea port (Baltic Sea)
21. Administration of Arkhangelsk Sea port (White Sea)
22. Administration of Kandalaksha Sea port (White Sea)
23. Administration of Medvezgegorsk Sea port (White Sea)
24. Administration of Mezen Sea port (White Sea)
25. Administration of Dikson Sea port (Kara Sea, Enisey Gulf)
26. Administration of Dudinka River port (Kara Sea, Enisey Gulf)
27. Administration of Novy port (Kara Sea, Ob Bay)
28. Administration of Salekhard River port (Kara Sea, Ob Bay)

29. Administration of Khatanga Sea port (Laptev Sea)
30. Administration of Pevek Sea port (East-Siberian Sea)
31. Administration of Cape Shmidt Sea port (Chukchi Sea)
32. Administration of Anadyr Sea port (Bering Sea)
33. Administration of Providenya Sea port (Bering Sea)
34. Administration of Palana Sea port (Okhotsk Sea)
35. Administration of Petropavlovsk Sea port (Bering Sea)
36. Administration of Magadan Sea port (Okhotsk Sea)
37. Administration of Okhotsk Sea port (Okhotsk Sea)
38. Administration of Vanino Sea port (Japan Sea)
39. Administration of Korsakov Sea port (Japan Sea)
40. Administration of Rostov Sea port (Azov Sea)

Administrations of the Channels

41. Administration of the Channel Volga - Baltic Sea «VolgoBalt-Kanal» (St. Petersburg)
42. Administration of the Channel White Sea - Baltic Sea «BeloMorKanal» (St. Petersburg)
43. Administration of the Channel Moscow - Volga «Moskva-Volga-Kanal» (Moscow)
44. Administration of the Channel Volga - Don «Volga-Don Kanal» (Volgograd)
45. Administration of the Channel Volga - Ural (Volgograd)
46. Administration of the Sayma Channel (Helsinki)

Administrations of the Regional Water Basins

47. Administration of the Upper Volga Water Basin (Tver)
48. Administration of the Middle Volga Water Basin (Samara)
49. Administration of the Lower Volga Water Basin (Volgograd)
50. Administration of the Neva Water Basin (St. Petersburg)
51. Administration of the Northern Dvina Water Basin (Arkhangelsk)
52. Administration of the Ob Water Basin (Novosibirsk)
53. Administration of the Yenisey Water Basin (Volgograd)
54. Administration of the Lena Water Basin (Yakutsk)
55. Administration of the Amur Water Basin (Khabarovsk)

Oil/Gas Offshore Companies and Institutions

55. Russian JSC GAZPROM (Moscow)
56. NPO «Eko-Systema Ltd.» (Moscow/St. Petersburg)
57. NPO «Maritime Engineering Ltd.» (St. Petersburg)
58. NPO «VNIIOkeangeologia» (St. Petersburg)
59. St. Petersburg State Technical University (St. Petersburg)
60. Kaliningrad State Technical University (Kaliningrad)
61. NPO «Maritime Engineering Ltd.» (St. Petersburg)
62. NPO «Maritime Engineering Ltd.» (St. Petersburg)
63. JSC «ArkhangelskGeolDobycha» (Arkhangelsk)
64. Krylov Shipbuilding Institute (St. Petersburg)
65. NPO «Morzaschita» (St. Petersburg)
66. Arctic Marine Engineering Geological Expedition «AMIGE», (Murmansk)
67. Arctic and Antarctic Research Institute «AARI» (St. Petersburg)
68. Geological Institute of Kola Branch of RAS (Appatity)
69. Environmental Company «NORDEKO» (Arkhangelsk)
70. Geological Institute of Komi Department of RAS (Syktivkar)

71. State Company «Sevmorgeo» (St. Petersburg)
72. VNIPIMorNeftegas (Moscow)
73. JV «Meteko-Nord» (Moscow)
74. JV «INTAARI» (St. Petersburg)
75. Institute of Remote Sensing Methods for Geology «INTAARI» (St. Petersburg)
76. ZAO «SeverGas SERVICE» (Tumen)
77. AO «TumenNefteGeophysika» (Tumen)
78. AO «Northern Lights» (Novy Urengoy)
79. Oil and Gas Research Institute of RAS (Moscow)
80. Polar Marine GeoSurvey Expedition (St. Petersburg)

Fishery industry company and research institutions

81. AO «Sevryba» - «Northern Fish» (Murmansk)
82. Central Research Instutute of Marine Fisheries and Oceanography «VNIRO» (Moscow)
83. Northern Atlantic Research Instutute of Marine Fisheries and Oceanography «AtlantNIRO» (Kaliningrad)
84. Polar Research Instutute of Marine Fisheries and Oceanography «PINRO» (Murmansk)
85. Polar Research Instutute of Marine Fisheries and Oceanography - Northern Branch PINRO «SevPINRO» (Arkhangelsk)
86. Caspian Research Instutute of Marine Fisheries and Oceanography (Astrakhan)
87. Azov-Black Sea Research Instutute of Marine Fisheries and Oceanography (Rostov)
88. Kamchatka Research Instutute of Marine Fisheries and Oceanography (Petropavlovsk)
89. Pacific Research Instutute of Marine Fisheries and Oceanography - (Vladivostok)
90. Sakhalin Research Instutute of Marine Fisheries and Oceanography (Yu. Sakhalinsk
91. Okhotsk Research Instutute of Marine Fisheries and Oceanography (Magadan).

Hydrometeorological and ecological control

92. NPO «Planeta» (Moscow)
93. Center of the Ecological Monitoring of Siberia (Novosibirsk)
94. Institute of the Industrial Ecology Problems of the North (Apatity)
95. Russian Antarctic Expedition (St. Petersburg)
96. Pacific Oceanological Institute RAS (Vladivostok)
97. Institute of the Ecological Problems of the North (Arkhangelsk)
98. Institute of Water Transport Engineers (Nizhny Novgorod)
99. State Committee of Environmental Protrection Yamal-Nenets Autonomous District (Salekhard)
100. State Committee of Environmental Protrection Khanty-Mansiysk Autonomous District (Khanty-Mansiysk)
101. State Committee of Environmental Protrection Komy Autonomous Respublic (Syktyvkar)
102. State Committee of Environmental Protrection Arkhangelsk Province (Arkhangelsk)

Fundamental sciences (ice and oceanology)

103. Oceanological Institute of Russian Academy of Sciences (Moscow, and the Kola, Karelian and Komi Autonomous Republic's Departments)
104. Insitute of Oceanography of the H/M Committee (Moscow, St. Peterburg)
105. Institute of Marine Biology of RAS (Murmansk)

A.5.2 Forestry

The project has identified a total of 213 Russian organisations within the fields of forestry, which includes;

Federal Management Body

1. Federal Forestry Service of the Russian Federation

Forestry Management Bodies in the Republics of the Russian Federation

2. Forest Committee of Adygeya republic
3. Forest Committee of Altai republic

Forestry Ministry of Bashkortostan Republic

4. Forestry Ministry of Buryatiya republic
5. Forest Committee of Dagestan republic
6. State Forest Committee of Ingushetiya republic
7. State Forestry Committee of Kabardino-Balkariya republic
8. State Forestry Committee of Kalmykiya republic
9. State Forestry Committee of Karachaevo-Cherkessiya republic
10. State Forestry Committee of Karelia republic
11. Forestry Committee of Komi republic
12. Forestry Committee of Mariy El republic
13. State Forestry Committee of Mordoviya republic
14. Forestry Management division of Sakha (Yakutiya) republic
15. Forestry Committee of Northern Osetiya- Alaniya republic
16. Forestry Ministry of Tatarstan republic
17. State Forestry Committee of Tyva republic
18. Forestry Ministry of Udmurtiya republic
19. State Forestry Committee of Khakassiya republic
20. State Forestry Committee of Chechen republic
21. Forestry Committee of Chuvash republic

Forestry Management Bodies in Krais, Oblast' and Autonomous districts

22. Aginsko-Buryat Autonomous Districs (AD) Forest Management Division
23. Altay Forest Management Division
24. Amur Forest Management Division
25. Arkhangelsk Forest Management Division
26. Belgorod Forest Management Division
27. Bryansk Forest Management Division
28. "Buzulukskiy bor" Forest Management Division
29. Vladimir Forest Management Division
30. Volgograd Forest Management Division
31. Volodga Forest Management Division
32. Voronezh Forest Management Division
33. Jewish Autonomous District Forest Management Division
34. Ivanovo Forest Management Division
35. Irkutsk Forest Management Division
36. Kaliningrad Forest Management Division
37. Kaluga Forest Management Division
38. Kamchatka Forest Management Division

39. Kemerovo Forest Management Division
40. Kirov Forest Management Division
41. Komi-Permyak AD Forest Management Division
42. Kostroma Forest Management Division
43. Krasnodar Forest Management Division
44. Krasnoyarsk Krai Forest Management Division
45. Kurgan Forest Management Division
46. Kursk Forest Management Division
47. Lipetsk Forest Management Division
48. Leningrad Region Forest Management Division
49. Magadan Forest Management Division
50. Moscow Forest Management Division
51. Murmansk Forest Management Division
52. Nizhniy Novgorod Forest Management Division
53. Novosibirsk Forest Management Division
54. Omsk Forest Management Division
55. Orenburg Forest Management Division
56. Orlov Forest Management Division
57. Penza Forest Management Division
58. Perm' Forest Management Division
59. Primorskoye Forest Management Division
60. Pskov Forest Management Division
61. Rostov Forest Management Division
62. "Russkiy Les" Experimental Forest Management Division
63. Ryazan' Forest Management Division
64. Samara Forest Management Division
65. Saratov Forest Management Division
66. Sakhalin Forest Management Division
67. Sverdlovsk Forest Management Division
68. Smolensk Forest Management Division
69. Stavropol' Forest Management Division
70. Tambov Forest Management Division
71. Tver' Forest Management Division
72. Tomsk Forest Management Division
73. Tula Region Forest Management Division
74. Tyumen' Region Forest Management Division
75. Ulyanovsk Region Forest Management Division
76. Khabarovsk Krai Forest Management Division
77. Khanty-Mansiysk AD Forest Management Division
78. Chelyabinsk Forest Management Division
79. Chita Forest Management Division
80. Chukotka AD Forest Management Division
81. Evenkiya AD Forest Management Division
82. Yamalo-Nenets AD Forest Management Division
83. Yaroslavl' Forest Management Division

National Parks – Federal Management

84. "Vodlozerskiy" National Park
85. "Kenozerskiy" National Park
86. "Pribaikal'skiy" National Park

87. "Tunkinskiy" National Park

National Parks – Regional Management

88. "Alaniya"
89. "Bashkiriya"
90. Valday National Park
91. Zabaikal'skiy National Park
92. "Zyuratkul'"
93. "Kurshskaya kosa"
94. "Mariy Chodra"
95. "Meshchera"
96. "Meshcherskiy"
97. "Nechkinskiy"
98. "Nizhnyaya Kama"
99. "Orlovskoye Polesye"
100. "Plesheevo ozero"
101. "Paanayarvi"
102. "Pripyshminskiye bory"
103. "Prielbrusye"
104. "Russkiy Sever"
105. "Samarskaya Luka"
106. "Sebezhskiy"
107. "Smolenskoye poozer'e"
108. "Smol'niy"
109. Sochi National Park
110. "Taganay"
111. "Ugra"
112. "Khvalinskiy"
113. "Chavash Varmane"
114. Shorskiy National Park
115. "Shushenskiy Bor"
116. "Yugyd-Va"

State Forest Management Enterprises

117. Amur State Forest Management Enterprise (Amurlesproekt)
118. State Specialised Forest Management Enterprise "Voronezhlesproekt"
119. East Siberian State Forest Management Enterprise (VSLUP)
120. Far Eastern State Forest Management Enterprise (Dal'lesproekt)
121. Western State Forest Management Enterprise (Bryansklesproekt)
122. West Siberian State Forest Management Enterprise (Zapsiblesproekt)
123. Karelian State Forest Management Enterprise (Karellesproekt)
124. Moscow State Forest Management Enterprise (Moslesproekt)
125. Povolzhskoe State Forest Management Enterprise (Povolzhskoe Enterprise "Lesproekt")
126. Pribajkal'skoe State Forest Management Enterprise (Pribajkallesproekt)
127. Northern State Forest Management Enterprise (Sevlesproekt)
128. North-Western State Forest Management Enterprise (SZGLP)
129. Central State Forest Management Enterprise (Centrlesproekt)

Scientific Research Organisations

130. All-Russian Scientific Research Institute for Forestry and Mechanisation of Forestry (VNIILM)
131. Central Experimental Design Office of Forestry Machine Industry (TsOKBLeshkhozmash)
132. All-Russian Scientific Research Institute for Forest Fire Protection and Forestry Resources (VNIIPOMLeskhoz)
133. All-Russian Scientific Research Institute Information Centre for Forest Resources (VNIITsLesresours)
134. All-Russian Scientific Research Institute for Implementation of Chemistry in Forestry (VNIIKhLeskhoz)
135. Far Eastern Scientific Research Institute of Forestry (Dal'NIILKh)
136. Scientific Research Institute of Forest Genetics and Selection (NIILGiS)
137. Scientific Research Institute of Mountain Forest Management and Forest Ecology (NIIGorlesekol)
138. Northern Scientific Research Institute of Forestry (SevNIILeskhoz)
139. Saint Petersburg Scientific Research Institute of Forestry (Saint Petersburg NIILKh)
140. Vyritsa Experimental Mechanical Factory
141. Scientific and Production Centre for Forest Seed Production (CentrLesSem)
142. Ivanteevskiy Experimental and Demonstration Forest Selection Planting Enterprise
143. Ozherelyevskiy Fruit and Planting Enterprise

Educational Institutes

144. All-Russian Institute for Improvement of Education of Forestry Managers and Specialists (VIPKLKh)
145. Institute for Improvement of Education of Forestry Managers and Specialists in Siberia and Far East (VIPKLKh for Siberia and Far East)

Schools of Federal Forestry Service

146. Apsheron Forest Technical School
147. Archedinskiy Forest Technical School (Forest College)
148. Biyskiy Forest Technical School
149. Buzuluk Forest Technical School
150. Velikiye Luki Forest Technical School
151. Vyaz'ma Forest Technical School
152. Divnogorsk Forest Technical School
153. Kalashnikovo Planning and Accounting Technical School
154. Krapivenskiy Forest Technical School
155. Krasnobakovskiy Forest Technical School
156. Lisinskiy Forest Technical School (Forest College)
157. Lubyanskiy Forest Technical School
158. Mariinsko-Posadskiy Forest Technical School
159. Muromzevskiy Forest Technical School
160. Penza High Forest School
161. Pravdinskiy Forest Technical School
162. Rybinskiy Forest Technical School
163. North-Caucasian Forest Technical School
164. Suvodskiy Forest Technical School
165. Toguchinskiy Forest Technical School
166. Ufimskiy Forest Technical School

Forest Technical High Schools

167. Aleksandrovskaya Forest Technical High School
168. Mariyskaya Forest Technical High School
169. Teikovskaya Forest Technical High School
170. Educational and Methodic Unit

Other Public Organisations

171. Russian State Design and Research Institute for Design of Forest Management Enterprises and Forest Protection Objects (Rosgiproles)
172. State Organisation "Russian Centre for Forest Protection" of Rosleskhoz
173. Russian Forest Museum
174. Central Base of Aerial Forest Protection "Avialesookhrana"
175. Amur Aerial Base
176. Far East Aerial Base
177. Zabaikal Aerial Base
178. Western Siberian Aerial Base
179. Irkutsk Aerial Base
180. Kamchatka Aerial Base
181. Koryak Aerial Base
182. Krasnoyarsk Aerial Base
183. Primorye Aerial Base
184. Northern Aerial Base
185. North-Eastern Aerial Base
186. North-Western Aerial Base
187. Syktyvkar Aerial Base
188. Tomsk Aerial Base
189. Tymen' Aerial Base
190. Ural Aerial Base
191. Khanty-Mansiysk Aerial Base
192. Chita Aerial Base
193. Yakutsk Aerial Base
194. Vologda Aerial Unit
195. Gorno-Altaysk Aerial Unit
196. Kostroma Aerial Unit
197. Nizhniy Novgorod Aerial Unit
198. Sakhalin Aerial Unit
199. Vladimir Aerial Enterprise
200. Uniform Manufacture
201. Russian Forest Information Organisation "Roslesinforg"
202. Forest Machine Test Station

Other Organisations

203. Russian Forest Planters Union
204. Joint Stock Company "Leskhozmash"
205. Roslesinterbank
206. Joint Stock Company "Russian Forest"
207. Association "Gidromeliorator" (GILM)
208. "Forest Journal"
209. "Forestry" Magazine
210. "Lesnaya Nov'" Magazine

211. Joint Stock Company "Ekos-Inform Magazine"

A.5.3 Natural Resources (Geology)

The project has identified a total of 1132 Russian organisations and entities within the fields of Geological Services. The majority is among institutions and enterprises. Some of the public organisations includes;

Federal Management Body

1. The Ministry of Natural Resources of the Russian Federation

Regional and Territorial Management Bodies

2. Central Regional Geological Center
3. North-West Regional Geological Center
4. Adygeya Republic Committee on geology and mineral resources
5. Bashkortostan Republic State Committee on geology and mineral resources use
6. Buryat Republican Committee on geology and mineral resources use
7. Administration on geology, fuel, power and mineral resources use (Ministry of Industry), transport and communication, Dagestan Republic
8. State Committee on natural resources, Ingushetia Republic
9. Committee on geology and mineral resources use, Kabardino-Balkarian Republic
10. State committee on geology and mineral resources use, Kalmykia - Khal'mg Tangch Republic
11. State committee on geology and mineral resources use, Karachaevo-Cherkessk Republic
12. Karelia Republic Committee on geology and mineral resources use
13. The Ministry of natural resources and environmental protection, Komi Republic
14. Committee on geology, Mariy El Republic
15. Committee on geology and mineral resources use, Mordovia Republic
16. State committee on geology and mineral resources use, Sakha Republic /Yakutia/
17. State committee on geology and mineral resources use, Northern Osetia-Alania Republic
18. The Ministry of natural resources, Tyva Republic
19. Committee on mineral resources, Udmurt Republic
20. State committee on natural resources, Khakassia Republic
21. The Ministry of natural resources, Chuvash Republic
22. Committee on natural resources, Amur Region
23. Northern committee on geology and mineral resources use
24. Committee on geology and mineral resources use, Astrakhan Region
25. Geology and mineral resources use Administration of the Belgorod area
26. Geology and mineral resources use Administration of the Bryansk area
27. Geology and mineral resources use Administration of the Vladimir area
28. Committee on geology and mineral resources use, Volgograd Region
29. Board of geology and mineral resources use, Department of natural resources and nature use, Vologda Region administration
30. Geology and mineral resources use Administration of the Voronezh Region
31. Ivanovo territorial management authority of geology and mineral resources use
32. Committee on geology and mineral resources use, Irkutsk Region
33. Department on geology and mineral resources use of Ust'-Ordynsky Buryat autonomous district
34. Geology and mineral resources use Administration of the Kaluga area

35. Committee on geology and mineral resources use, Kamchatka Region
36. South-Siberian regional committee on geology and mineral resources use
37. Committee on geology and mineral resources use, Kirovsk Region
38. Geology and mineral resources use Administration of the Kostroma area
39. Committee on natural resources, Kurgan area
40. Geology and mineral resources use Administration of the Kursk area
41. Geology and mineral resources use Administration of the Lipetsk area
42. Committee on natural resources, Magadan area
43. Committee on natural resources, Chukotsk autonomous district
44. Committee on geology and mineral resources use, Murmansk Region
45. Committee on geology and mineral resources use, Nizhegorodsky Region
46. Territorial committee on geology and mineral resources use, Novosibirsk and Omsk areas
47. Committee on geology and mineral resources use, Orenburg area
48. Geology and mineral resources use Administration of the Orel area
49. Committee on geology and mineral resources use, Penza area
50. Perm territorial committee on geology and mineral resources use
51. Coordination council on geology and mineral resources use, Rostov area
52. Geology and mineral resources use Administration of the Ryazan area
53. Committee on geology and mineral resources use, Samara area
54. Volga committee on geology and mineral resources use
55. Committee on natural resources, Sakhalin area
56. Ural committee on geology and mineral resources use
57. Geology and mineral resources use Administration of the Smolensk area
58. Geology and mineral resources use Administration of the Tambov area
59. Geology and mineral resources use Administration of the Tver area
60. Committee on geology and mineral resources use, Tomsk area
61. Geology and mineral resources use Administration of the Tula area
62. West-Siberian regional geological centre
63. Committee on natural resources, Khanty-Mansiysk autonomous district
64. Yamalo-Nenets committee on geology and mineral resources use
65. Committee on geology and mineral resources use, Ulyanovsk area
66. Chelyabinsk territorial committee on geology and mineral resources
67. Committe on geology and mineral resources use, Chita area
68. Aginsky department, Committee on geology and mineral resources use, Chita area
69. Geology and mineral resources use Administration of the Belgorod area Yaroslavl
70. Krasnodar territorial committee on geology and mineral resources use
71. Committee on geology and mineral resources use, Krasnoyarsk region
72. Committee on geology and mineral resources use, Taimyr (Dolgano-Nenetsk) autonomous district
73. Committee on geology and mineral resources use, Primorsky krai
74. North-Caucuses regional geological center
75. Committee on geology and mineral resources use, Stavropolsky krai
76. Far East Committee on geology and mineral resources use
77. Committee on geology and mineral resources use, Jewish autonomous district

A.5.4 Water Resources

The project has identified a total of 159 Russian organisations within the fields of water resource management, which includes;

Federal Management Body

1. The Ministry of Natural Resources of the Russian Federation

Water Resources Administration of the Russian Federation

2. Azov Water Resources Use and Coastal Line Protection Administration
3. Amur Basin Administration
   - 3.1. Committee on water resources use of the Primorsky area
   - 3.2. Committee on natural resources of the Amur area
   - 3.3. Committee on water resources use of the Khabarovsk area
   - 3.4. Committee on water resources use of the Jewish autonomous district
   - 3.5. Zeisk reservoir exploitation Administration
4. Anadyr - Kalmykia Water Basin Administration
   - 4.1. Committee on natural resources of the Magadan area
   - 4.2. Committee on natural resources of the Chukotka autonomous district
5. Angar - Baikal Water Basin Administration
   - 5.1. Water resources Management Department of Northern regions of the Irkutsk area
   - 5.2. Water resources Department of Aginsky Buryat autonomous district
   - 5.3. Water resources Department of Ust-Ordunsky Buryat autonomous district
   - 5.4. Committee on water resources use of Buryatiya Republic
   - 5.5. Committee on water resources use of the Chita area
   - 5.6. Committee on water resources use of the Irkutsk area
   - 5.7. Angar reservoirs exploitation Administration
   - 5.8. Angar reservoirs exploitation Administration, Bratsk region
   - 5.9. Lake Baikal exploitation Administration
6. Bel'sk Water Basin Administration
   - 6.1. Reservoirs exploitation Administration of the Bashkortostan Republic
   - 6.2. Operation of engineering protection of Nizhnekamsk water power station reservoirs Administration of Bashkiria
7. Upper-Volga Water Basin Administration
   - 7.1. Committee on water resources use of the Ivanovo area
   - 7.2. Committee on water resources use of the Kostroma area
   - 7.3. Committee on water resources use of the Vladimir area
   - 7.4. Committee on water resources use of the Yaroslavl area
   - 7.5. Committee on water resources use of Maryi El Republic
   - 7.6. Committee on water resources use of Mordovia Republic
   - 7.7. The Ministry of natural resources of Chuvash Republic
   - 7.8. Committee on water resources use of the Nizhnegorodsky area
   - 7.9. Federal Program "Volga revival" Directorship
   - 7.10. Gor'ky reservoir exploitation Administration
   - 7.11. Uglech reservoir exploitation Administration
   - 7.12. Rybinsk and Sheksninsk reservoirs exploitation Administration
8. Upper-Ob Water Basin Administration
   - 8.1. Altay water resources committee
   - 8.2. Republican water resources committee of Gorny Altai Republic
   - 8.3. Kemerovo water resources committee
   - 8.4. The Tomi river water resources program executive Directorship
   - 8.5. Njvsk water resources committee
   - 8.6. Novosibirsk water resources committee
   - 8.7. Representation of the Ministry of Natural Resources of Russia at Interregional

Association "Siberian Accord"
8.8. Novosibirsk reservoir exploitation Administration
9. Dvina-Pechora Water Basin Administration
9.1. Vologda water resources committee
9.2. Water resources committee of Komi Republic
9.3. Murmansk territorial water resources committee
9.4. Arkhangelsk water resources committee
10. Don Water Basin Administration
10.1. Committee on water resources of the Belgorod area
10.2. Committee on water resources of the Voronezh area
10.3. Committee on water resources of the Kursk area
10.4. Committee on water resources of the Lipetsk area
10.5. Committee on water resources of the Tambov area
10.6. Rostov Regional Committee on water resources
10.7. Zimliansky reservoir water resources Administration
11. Enisey Water Basin Administration
11.1. Achinsk territorial water resources Administration
11.2. Taimyr water resources Committee
11.3. The Ministry of natural resources of Tyva Republic
11.4. State Committee on natural resources of Khakassia Republic
11.5. Evenkiysk water resources Committee
11.6. Norilsk Department of water resources complex use
11.7. Kansk territorial water resources Administration
11.8. Krasnoyarsk territorial water resources Administration
11.9. Minusinsk territorial water resources Administration
11.10. Krasnoyarsk reservoir exploitation Administration
11.11. Sayano-Shushensky reservoir exploitation Administration
11.12. Siberian forests territorial water resources Administration
12. West-Caspian Water Basin Administration
12.1. Water resources Committee of Northern Osetia-Alania Republic
12.2. Kabardino-Balkarian water resources Committee
12.3. State Committee on natural resources of Ingushetia Republic
12.4. Water resources Committee of Dagestan Republic
12.5. Water resources Administration of Chechenskaya Republic
13. Kamsk Water Basin Administration
13.1. Water resources Committee of Udmurtia Republic
13.2. Water resources Administration of Komi-Periazky autonomous district
13.3. Water resources Committee of Kirovsk area
13.4. Water resources Committee of Perm area
13.5. Kamsk and Votkinsk reservoirs exploitation Administration
14. Cuban Water Basin Administration
14.1. Water resources Committee of Adygea Republic
14.2. Water resources Committee of Karachaevo-Cherkessia Republic
14.3. Water resources Committee of Stavropolsky krai
14.4. Krasnodar reservoir exploitation Administration
15. Moscow-Oksk Water Basin Administration
15.1. Water resources Committee of the Kaluga area
15.2. Water resources Committee of the Orel area
15.3. Water resources Committee of the Tver area
15.4. Water resources Committee of the Ryazan area

15.5. Water resources Committee of Bryansk area
15.6. Water resources Committee of Smolensk area
15.7. Water resources Committee of the Tula area
15.8. Department of water resources complex use, Moscow
15.9. Water resources Committee of the Moscow area
15.10. Ivan'kovsky reservoir exploitation Administration
15.11. Vazuza hydro-technical system operation Administration
16. Neva-Ladoga Water Basin Administration
16.1. Water resources Committee of Republic Kareliya
16.2. Water resources Committee of the Pskov area
16.3. Water resources Committee of the Kaliningrad area
16.4. Water resources Committee of the Novgorod area
16.5. Department of water resources complex use, St.-Petersburg
16.6. Department of water resources complex use, St.-Petersburg Region
16.7. St.Petersburg region and the Ladoga and Onega lakes reservoirs Exploitation Administration
17. Lower-Volga Water Basin Administration
17.1. Water resources Committee of the Saratov area
17.2. Water resources Committee of the Astrakhan area
17.3. Water resources Committee of the Volgograd area
17.4. Volgograd reservoir exploitation Administration
17.5. Saratovsky reservoir exploitation Administration
18. Lower-Ob Water Basin Administration
18.1. Omsk Regional Committee on water resources
18.2. Tumen territorial Committee on water resources
18.3. Yamalo-Nenetz Committee on water resources
18.4. Natural resources Committee of Khanty-Mansiysk autonomous district
19. Middle-Volga Water Basin Administration
19.1. Water resources Committee of the Samara area
19.2. Water resources Committee of the Penza area
19.3. Water resources Committee of the Ulyanovsk area
19.4. Water resources Committee of Tatarstan Republic
19.5. Kuibyshevsky reservoir exploitation Administration
19.6. Nizhne-Kamsky reservoir exploitation Administration
20. Ural Water Basin Administration
20.1. Water resources Committee of the Chelyabinsk area
20.2. Water resources Committee of Sverdlovsk area
20.3. Water resources Committee of the Orenburg area
20.4. Water resources Committee of the Kurgan areas
20.5. Cheliabinsk area reservoirs exploitation Administration
20.6. Iriklinsky reservoir exploitation Administration
20.7. Sorochinsky reservoir exploitation Administration
21. Natural resources Committee of the Sakhalin area
22. Kamchatsky Water resources Committee
23. Department of complex water resources use of Koriaksky autonomous district
24. Water resources Committee of Kalmykia-Khal'm-Tangch Republic
24.1. Coastal protection works operating and the Caspian Sea coastal line monitoring Administration

B. External Reports Appendices

These reports/documents are <u>not</u> provided as Appendices to this main report.

2	**Brochure Material in Russian** "Sea Ice Monitoring" **Provided by: NIERSC**
3	**Brochure Material in Russian** "Pollution Monitoring" **Provided by NIERSC**
4	**Brochure Material in Russian** "Mapping and Exploration of Natural Resources" **Provided by NIERSC**
5	**Brochure Material in Russian** "Mapping and Monitoring of Forests" **Provided by: NIERSC**
6	**Sub-report:** Acquisition, distribution and use of satellite earth observation data in the Russian Federation **Provided by : NIERSC**
7	**Sub-report:** Synergetic use of ERS and ENVISAT Synthetic Aperture Radar (SAR) with other EO data - A market survey for the Russian Territories. **Provided by: NITs IPR**
8	**Sub-report:** Market Survey of potential users of satellite earth observation data in Siberia. **Provided by: SRSC**

The Nansen Environmental and Remote Sensing Center

NERSC

a non-profit
research institute affiliated with
the University of Bergen

Edv. Griegsvei 3a,
N-5059 Bergen
Norway

NERSC Technical Report no. 165

under contract with

European Space Agency (ESA)
no. 12861/98/F/TB
and
Russian Space Agency (RSA)

SYNERGETIC USE OF ERS AND ENVISAT SYNTHETIC APERTURE RADAR (SAR) WITH OTHER EO DATA

—

A MARKET SURVEY FOR THE RUSSIAN TERRITORIES

by
Lasse H. Pettersson and Ola M. Johannessen

in co-operation with

SPOT Image
Toulouse, France

NIERSC
St.Petersburg, Russia

NITs IPR
Moscow, Russia

SRSC
Novosibirsk, Russia

Bergen, August, 1999

Nansen Environmental and Remote Sensing Center
Edv. Griegsvei 3a
N-5059 Solheimsviken - Bergen
NORWAY
Phone: +47 55 29 72 88 Fax: +47 55 20 00 50
e-mail: ola.johannessen@nrsc.no
http://www.nrsc.no

a non-profit environmental research center affiliated with the University of Bergen

REPORT

TITLE	**REPORT No.**
Synergetic use of ERS and ENVISAT Synthetic Aperture Radar (SAR) with other Earth Observation (EO) data – A market survey for the Russian Territories.	Technical report no. 165
CLIENT	**CONTRACT No.**
European Space Agency (ESA), Paris	12861/98/F/TB
CONTACT PERSONS	**AVAILABILITY**
G. Duchossois, ESA HQ G. Kohlhammer, ESA/ESRIN	**OPEN**
AUTHORS	**DATE**
Lasse H. Pettersson [1], Ola M. Johannessen[1], Tor I. Olaussen[1], Louise- Francois Guerre[2], Alain Hirschfeld[2], Leonid P. Bobylev [3], Vladimir V. Melentyev[3] Oleg Eu. Korotkevich[3], Alexei V. Kouraev[3], Lola A. Kotova[3], Alexey M. Volkov[4], Vitaly I. Khizhnichenko[4], Larisa I. Permitina[4] and Gennady N. Erokhin[5]	August, 1999

PROJECT PARTNERS

1. Nansen Environmental and Remote Sensing Center, Bergen, Norway (co-ordinator)
2. SPOT Image, Toulouse, France
3. Nansen International Environmental and Remote Sensing Center (NIERSC), St. Petersburg
4. Scientific Research Centre for Exploration of Natural Resources (NITs IPR), Moscow Russia
5. Siberian Remote Sensing Center (SRSC) Novosibirsk, Russia

APPROVAL	
Lasse H. Pettersson	Ola M. Johannesssen, director

ESA STUDY CONTRACT REPORT

ESA CONTRACT NUMBER: 12861/98/F/TB	SUBJECT: Synergetic use of ERS and ENVISAT Synthetic Aperture Radar (SAR) with other earth observation (EO) data – A market survey for the Russian Territories.		CONTRACTOR: Nansen Environmental and Remote Sensing Center
ESA CR( )N(	STAR CODE:	NO. OF VOLUMES: 1 THIS VOLUME: 1	CONTRACTOR'S REFERENCE: Technical Report no. 165

ABSTRACT:

In 1995 the Russian (RSA) and European (ESA) Space Agencies initiated their first co-operation within earth observation - the "ICEWATCH" project, which aimed at demonstration of European ERS Synthetic Aperture Radar (SAR) for guidance of vessels and icebreakers along the coast and rivers of western Siberia. Over the last years the Nansen Centers in Bergen and St. Petersburg have conducted 12 demonstration campaigns for use of SAR in ice navigation of the Northern Sea Route using ERS SAR data. The SAR data acquired by the Norwegian satellite receiving station (Tromsø Satellite Station, TSS) in Tromsø, the ESA station in Kiruna, Sweden and the US station in Fairbanks, Alaska, covers major parts of the Northern Sea Route and the Siberian coast. However, large parts of the central Siberian mainland and the Laptev Sea are not covered. Therefore an acquisition station located within the Russian Federation is needed to provide SAR data from the entire northern Russian territory and the Arctic including the Northern Sea Route. The conclusions of the ICEWATCH project have so far been very positive with respect to the actual SAR applications within sea ice navigation.

The availability of ERS/ENVISAT SAR data will further stimulate and encourage a wider use of SAR data for the territories of the Russian Federation, both within the Russian EO user communities as well as at the international market operating within Russia.

A market survey to evaluate the potential use within Russia of ERS and ENVISAT SAR data in combination with other satellite EO data, including several Russian satellites and the French SPOT satellite, is being reported in the current document.

The project background is given in Section 1and the market survey approach in Section 2. In Section 3 and 4 an overview of the use of Russian EO data is given. In section 5 a review of the current market survey through interviews (questionnaires) and organisation of three regional workshops within Russia is given. Section 6 addresses the international use of EO data for the Russian Territories. In section 7 the project conclusions and recommendations are given.

NAMES OF AUTHORS:

Lasse H. Pettersson, Ola M. Johannessen, Tor I. Olaussen, Louise- Francois Guerre, Alain Hirschfeld, Leonid P. Bobylev, Vladimir V. Melentyev, Oleg Eu. Korotkevich, Alexei V. Kouraev, Lola A. Kotova, Alexey M. Volkov, Vitaly I. Khizhnichenko, Larisa I. Permitina and Gennady N. Erokhin

ESA STUDY MANAGERS:	ESA BUDGET HEADING:
G. Duchossois: ESA HQ, Paris, France G. Kohlhammer: ESA ESRIN, Frascati, Italy T. Beer, ESA HQ, Paris , France	

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0. Executive Summary

From the Soviet era extensive experience in design and applications of spaceborne radar systems have been established within the former Soviet states, in particular in the Russian Federation and the Ukraine. The year 1974 marked the beginning of the era of environmental and natural resources Earth Observation (EO) sensor satellites in the USSR. In this year the Meteor-18 satellite was launched and it was succeeded by a series of six other satellites, the last one - Meteor-31 - launched in 1981. This series of EO satellites has been followed by the launch of the Resurs-O1 satellites, which included the Kosmos-1689 in 1985, Kosmos-1939 in 1988, Resurs-O1 N 3 in 1994 and Resurs-O1 N 4 in 1998. The development of this EO program has mainly contributed to the development of terrestrial and coastal zone applications within the Russian Federation and data are currently distributed for use world–wide under international agreements. As a result, there exists today a diversified and structured system of EO data acquisition, distribution, processing and delivery, involving various organisations. The government of the Russian Federation approved a *Concept for State Space Policy* on 26. May, 1996, including EO data. This document determines the priorities of the Russian Space Agency in a broad range of application areas including EO development and applications. For the vast territories of the Russian Federation it is necessary to use satellite EO data for environmental monitoring as well as to obtain information about natural resources for their sustainable and cost-effective management. In 1997 a round table discussion - "*Russian space and remote sensing market*" - was organised. According to the survey conducted, the most frequently used EO data sources are aerial photography and data from the Resurs-O series. Then after come high-resolution photographic data (5 meter) from the KFA-1000 sensor and data from the NOAA AVHRR sensors, followed by information from MK-4 and SPOT sensors. The use of EO data from other space agencies was almost non-existing at among the participating organisations, although some Russian research institutions have used data from the ERS satellites.

The identified factors hampering development of the Russian EO data market includes; (i) complicated access to the information on availability, retrieval parameters and quality of EO data for a specified territory, (ii) difficulties to meet the users request for specific territorial data coverage by the Russian providers of EO data, and (iii) lack of knowledge on satellite remote sensing possibilities and poor popularisation of satellite retrieval methods for geo-information.

The most developed applications of Russian EO data are related to:

- monitoring inundation of river floodplains during spring floods,
- ecological monitoring of land surface pollution near large cities,
- monitoring of forest fires,
- estimation of crops status and harvest forecast,
- sea ice mapping and monitoring,
- mapping geological structures for assessment of mineral resources content and for detection of high risk zones related to mining activities, and
- monitoring coastal zones exposed to significant technogenic influence and pollution.

These main application areas are developed based on the use of high-resolution photographic image data, optical and infrared multi-spectral data, and passive and active microwave sensors, including real-aperture radar systems. The main Russian development of spaceborne radar satellite technology was carried out under the Almaz-program where civilian synthetic (SAR) and real-aperture radar systems have been developed and launched for both scientific and operational applications. Currently no Russian spaceborne SAR system is operational, although the real aperture Side-looking Radar on Okean was recently switched on again for operations. The planned launch of the Resurs-Arktika satellite with a SAR sensor is among the priorities of the Russian Space Agency.

To serve the EO data needs a national network of three main regional centres for satellite EO data acquisition is established - in Obninsk, Novosibirsk and Khabarovsk. In addition there are a number of personal ground stations (PGS) providing access to download images from the "Resurs-O1" satellite series, serving the local and regional needs for EO data.

In 1995 the Russian (RSA) and European (ESA) Space Agencies initiated their first co-operation within earth observation - the "ICEWATCH" project, which aimed at demonstration of European ERS Synthetic Aperture Radar (SAR) for ice navigation guidance of vessels and icebreakers along the coast and rivers of western Siberia. Through the use of SAR data acquired by the Norwegian satellite receiving station in Tromsø, the ESA station in Kiruna, Sweden and the US station in Fairbanks, Alaska, large parts of the Northern Sea Route and the Siberian coast are covered. However, major parts of the central Siberian mainland and the Laptev Sea are still not covered regularly by the current network of SAR acquisition stations.

An acquisition station located within the Russian Federation is needed to cover the entire northern Russian territory and the Arctic including the Northern Sea Route. The availability of such data will further stimulate and encourage a wider use of ERS and ENVISAT SAR data for the territories of the Russian Federation, both within the Russian EO user communities as well as within the international community and industry operating within the Russian Federation.

A market survey to evaluate the potential use of ERS and ENVISAT SAR data, in combination with Russian and other satellite EO data, for the territories of the Russian Federation, has been initiated by the European (ESA) and Russian (RSA) Space Agencies.

The objectives of this project was to perform a qualitative and quantitative assessment of the Russian market in the short-term (1-3 years) and mid-term (5 years) focusing on the user requirements for earth observation (EO) data and in particular ERS/ENVISAT SAR data.

The specific objectives included:

- Assess the market in the four main application areas: **sea ice monitoring, environmental and pollution monitoring, boreal forest mapping**, and **geological resource mapping** within such sectors as industry, government, international agencies and research organisations, excluding military and defence sectors.
- Assess the requirements of users and identify the role of integrated use of EO data to satisfy the users needs.
- Identify the geographical and seasonal demand for EO data.
- Identification of the required quantities of EO data and its market value, including assessment of the readiness and willingness to pay for EO data.

This market survey project is being co-ordinated by the *Nansen Environmental and Remote Sensing Center* (NERSC) in Bergen, Norway. In addition the project team consisted of *SPOT Image*, Toulouse, France, *Nansen International Environmental and Remote Sensing Center* (NIERSC), St. Petersburg, Russia, *Scientific Research Centre for Exploration of Natural Resources (NITs IPR)* in Moscow, and *Siberian Remote Sensing Center (SRCS)* in

Novosibirsk. The project has received important practical and technical support from both the *Russian Space Agency* (RSA) and *European Space Agency* (ESA).

The analysis of user requirements for EO data was performed after careful examination of earlier studies of the *market for Russian EO data*, by gathering user information through *personal interviews* and completion of a *questionnaire form*, as well as by organising three *thematic workshops* focusing on the key user groups. The Project team conducted the interviews in various regions of the Russian Federation and obtained responses from most parts of the Russian Federation (see Figure 4-1).

The Market Survey for SAR Applications

Information about state-of-the-art SAR applications within the four selected application areas and derived information products are essential for successful survey of the actual and potential use of this type of EO data. Although much information on EO applications are available to the Russian user community, linguistic and other reasons still significantly limit the awareness of both EO data and its applications. Hence, information material from ESA, RSA, and the project partners were gathered and distributed. The project team also produced a four-page brochure for each of the four main application areas in the Russian language, based on information material available from agency and other sources.

The questionnaire survey covered three main elements: the overall information needs and utilisation to meet the main mission objectives of the organisation, including the financial aspects of these current activities; the experience and possible use of EO data in this respect, including the requirements for, the availability of and access to SAR data for efficient use within these mission areas; management information on the organisation and respondents. The philosophy behind the questionnaire was to obtain very detailed information on the activities of each potential user contacted.

The completion of the questionnaires was done through personal interviews and to a lesser extent through mail distribution of the questionnaires to the identified potential users. In order to get higher level of confidence in the project responses the direct interview approach was preferred. The project team approached around 450 organisations and finally 189 of these organisations were included in the market survey. Around 60 of the contacted organisations found the use of satellite earth observation data of no relevance to their organisations and were therefore not included. Around 200 organisations were contacted by mail approach, from which the level of responses was very low. The direct interview approach was hence adopted

as the main method for information acquisition for the survey. The information from the questionnaires was stored in an appropriate relational database for statistical analysis and evaluation of the information.

Three thematic workshops were organised in respectively St. Petersburg, Moscow and Novosibirsk focused on the four selected SAR application areas. The aim of the workshops was to inform the users of the SAR applications and to assess in depth the users requirements. A preliminary analysis of the information obtained from the interviews aided in the selection of the workshop participants. The workshops included information about the availability and application areas of ERS SAR data as a basis for further discussion. The three workshops brought together respectively 35, 23 and 50 participants.

Assessment of Russian Users Requirements

Most of the territories of the Russian Federation were covered by the Project, with a focus on the European western and northern parts, central and southern Russia, west and central Siberia and only to minor extent the east Siberia and the Far East.

Organisation Types and Funding Sources: A wide range of funding agencies, authorities, industry, information providers and users, research and development groups, and educational institutions have been contacted. 82 % of the respondents were from organisations, which were wholly or predominantly state-owned. This reflects the fact that by tradition many Russian organisations are under public or semi-public administration. During the recent years a transition of organisations to private companies and organisations has occurred, leading to various joint-sector subsidiary organisations. The funding agencies and clients for EO related activities within the contacted organisations are to a very large extent supported from public budgets.

The private sector, including voluntary organisations and international organisations, accounted for only 18% of the survey responses. A large proportion of these organisations (71 %) obtained part funding from the oil and gas industry, indicating this as an important industrial application area. Several oil companies have established subsidiaries to serve their companies and to a large extent the EO relevant activities are allocated to this type of subsidiary organisations.

Mission areas: The responses on mission foci cover several application areas for EO data. For all institution categories more than half of the organisations have main mission goals related to "environmental monitoring" and "thematic mapping". Also, around 50% are engaged in

"data collection" and "research and design". Hence, to a large extent, the survey has been among organisations involved in the process of generating information used for environmental monitoring, i.e. the value-adding sectors of the EO data use. However, most categories of EO data users has been contacted through the Project, covering management use and decision making to actual processing and analysis of EO data.

EO Data Application Areas: The responses with respect to the EO applications cover all major areas. The application areas related to monitoring of "environmental pollution" are of concern to a large proportion of the contacted organisations. Related activities such as "risk management", "GIS" and "cartography" are also within the major application areas of many of the responding organisations. Also in the user categories such as sea ice navigation there is a high level of concern for these issues. The responses from basic and applied research institutions indicate that many of the respondents are involved in a wider range of EO relevant application areas. The application areas with greatest development potential seems to be within sea ice monitoring, where the users have identified a significant benefit in use of SAR data compared to the current observation methods. The fact that use of aerial surveys has practically almost vanished over the last years, encourage the use of alternative sea ice monitoring methods. "Risk management" is an application of general and high concern to all application areas and hence a field of potential development. The integrated use of EO data in "GIS" and "cartography" applications is also a field where SAR data will have a significant use and impact. Within mapping of natural resources various sectors of the exploration industry have identified their strong interest in using EO data provided that the application methods are well documented and are able to support their main mission and goals. In this respect the EO service providers have to document valid application methods in order to "convince" the market.

EO Data Coverage: The requirements on geographical SAR data coverage extends over all the main parts of the Russian Federation. For land areas the focus is in west Siberia and the northern and north-western regions of the Russian Federation. For "environmental monitoring" the geographical distribution of interest is quite homogeneous all over the RF, although with a stronger focus on western Siberia among the respondents. For forestry applications the northwest and central parts and Siberia are of prime interest. This is consistent with the location of the major forest resources within the RF. The geographical preferences of the private sector are slightly higher in northern regions, Ural, and Siberian parts of the RF, primarily due to the fact that these are the regions rich in major natural

resources.

For water areas the general focus in on the Arctic Seas and of the Baltic, Black, Caspian and Far East seas. For sea ice applications 88% are interested in the Arctic waters, about 50% in the Baltic sea, and in the Far East seas. A significant part of the respondents also indicated interest in use of SAR data for inland water bodies, although the geographical requirements for these were not investigated further.

In general, the areas of primary geographical interest are to a large extent covered by the existing ESA stations in Europe as well as through a new proposed station in the higher latitude regions of the central or eastern parts of the RF, e.g. Salekhard or Yakustsk.

Seasonal Coverage: Year round SAR data coverage are required by half of respondents, with variable seasonal interests for the different application areas. A clear requirement for SAR data coverage throughout the year is identified and a planned ESA ERS/Envisat SAR station in the Russian Federation should allow for year around operations.

Requirements on SAR Data Products: In general 33% of the respondents required the basic level image products (Level-1B types). For sea ice applications around 50% were able to use the basic image products and one-third the calibrated radar image product. This lower response to the calibrated products may be due to a lack of a complete understanding of the EO product differentiation. Most of the survey respondents had, however well defined requirements on the level of EO data and the derived data products, supporting the conclusion that the contacted institutions are quite well educated or experienced in the use of EO data. In the private sector and for industrial applications the thematic information products were of prime concern, implying that well documented processing methods should be applied to deliver the final information products. The international oil and gas industry expressed that their initiatives to a large extent will depend on the formal requirements imposed on their activities by the Russian authorities. Hence, they will not implement any oil spill monitoring service based on SAR data, unless it is required or agreed with the Russian authorities.

Based on the acquired information and impressions obtained during the interviews and workshops, the project team made an assessment of the potential for future "purchase" and /or "use (application)" of satellite SAR data as an information source for their activities. The evaluation of the respondents was, partly subjectively, ranked "high", "medium", "low" or "unable to evaluate" (see Figure 0-1). The conclusion of this assessment is that with an acceptable level of confidence around 1/3 of the contacted organisations will to some extent be purchasing SAR data in the future. Around the same number will also be using data in the

territories of the Russian Federation are identified. The eastern and northern stations locations are those providing maximum additional coverage compared to the existing network of ERS SAR stations.

Table 0-1: An assessment of the importance (ranked from 1 to 4) of the various ERS/ENVISAT SAR station locations for each application area. The coverage of the existing ESA stations is taken into consideration when ranking the station locations. N/A: not applicable compared to the higher priorities or other current stations.

Application area		Moscow	Novosibirsk	Salekhard	Yakutsk	Tiksi
Ice Monitoring		4 [1)]	N/A	3	1	2
Env. Monitoring & Hazards	marine	2	N/A	1	3	3
	land	1	2	3	3	N/A
Forest management		1	2	3	3	N/A
Natural Resources (Geology)		3	1	3	2	N/A
Agriculture		1	2	3	(3)	N/A

1) area covered entirely by the Tromsø & Kiruna stations.

The International Market Segments

The most significant interest in the possible use of EO data for the Russian territories is identified within the sector of exploration of hydrocarbon resources. Related to these activities is also the support of shipping and off-shore operations in ice covered waters as well as planning of pipeline structures. Within international research programs for monitoring of the forest resource there is also a pronounced interest for EO data coverage of the forested parts of the RF. Most of the relevant international activities within the RF are depending on non-Russian funding of its activities, however many companies regards their presence to day as were important for a more active future activity in the Russian market. The general conclusion through the limited number of contacts is that the non-Russian market for EO data over the Russian territory seems low, even if the potential needs for information are very large. The market will firstly be developed when the economic situation and infrastructure will significantly improve and stabilise, and when western companies or organisation will start to invest significantly in the use of the resources available within the Russian Federation.

The ERS Announcement of Opportunity (AO) Call is the prime mechanisms to stimulate development of applications and scientific research using the ESA satellite EO data. In the first four ESA ERS AO calls Russian Principal Investigators have been completely absent, although, some Russian Co-PI´s were involved. Direct experience and use of ERS SAR data

among Russian institutions was for various reasons very limited. Through the first ERS AO calls around 69 non-Russian PI´s have requested ERS SAR data from locations within the Russian Federation, although only a few (<10 projects) were focused on issues that specifically required SAR data for the territories of the Russian Federation, including the ICEWATCH project. After the ERS AO-3 Call the situation has changed drastically and 16 Russian scientists have become ERS PI´s requesting ERS sensor data over NIS countries as well as other geographical areas. The increased number of Russian ERS PI´s is due to increased awareness of the AO possibilities for data requests as well as an increased international scientific co-operation with Russia over the last couple of years.

Conclusions and Recommendations

The study concludes that a wide range of SAR applications has been developed for use within the Russian Federation. The Market segments needs to SAR data are well defined within several sectors, however the commercial applications are limited due to the current financial situation in the RF. The scientific sector has a large potential to contribute to development of SAR applications and their request for data has been increasing over the last years. Hence a data demand is well defined, however with limited commercial ability to purchase SAR data. The international market for SAR applications for the territories of the RF are in situation of awaiting changes in the Russian economy before implementing new initiatives in this respect. The need for one or more SAR receiving station within the Russian Federation are documented to serve the users needs with respect to both SAR data coverage and facilitate the user access to actual data. The necessary infrastructure and local initiatives to meet the operational needs of such stations are identified, however this was outside the main scope of this project to investigate.

State-of-the–art

- Optical and infrared EO data have for many years been operationally used within areas such as:
  - Sea ice monitoring;
  - forest fire detection and damage assessment;
  - weather forecasts;
  - pollution monitoring and assessment;

- river flooding monitoring;
- ecological mapping;
- crop status monitoring;
- coastal zone monitoring;
- geology and natural resources mapping, and others.

- A national network of EO acquisition stations has been established in order to serve the regional needs for data and information from the Russian and earlier Soviet Union EO satellites.
- Russian experience with spaceborne radar systems has been established by various Russian institutions under the Almaz SAR program.
- Use of Russian EO data has declined over the last decade, but an increase is again observed over the last years, despite the current financial problems in Russian economy.
- Lack of information on state-of-the-art SAR application areas limits the actual use to be considered by "non-expert" EO users.
- Regional authorities (environment, natural resources and industry) of the Russian Federation are currently using EO information sources.
- Regional Authorities have shown willingness to further explore EO data as major source of information.
- Regional environmental authorities cover part of their budgets through local taxes from the industry involved in exploration of natural resources.
- The use and awareness of EO data are more limited in the private sector, than in the public sector.
- No respondent to the market survey has provided information on the financial aspects of their activities (current budget, costs of services etc.). Accordingly the expected future outlook for development has been impossible to assess from their responses to the survey.

Awareness and Requirements

- A high level of awareness for use of EO data is established in a wide range of public and semi-public organisations – in particular at scientific research institutions.
- Despite a general high level of awareness most user groups need information and routines for generation of value added products. In particular the knowledge of non-Russian EO data and sensor systems are very limited.

- The forest authorities and industry, as well as the oil companies and mining industry, are in general sceptical about the benefit of SAR until their direct applications are better validated and demonstrated within their own fields of operation.
- Tailored and dedicated information on state-of-the–art applications for SAR data are very much needed in order to develop new application areas and to stimulate the increased use and further development of EO data.
- User training and documentation of application algorithms and methods are needed in order to increase the awareness in a large section of the Russian user community.
- Near real-time applications and year around operations are identified within all the user categories.
- An increased demand for ERS SAR data for the territories of the Russian Federation is identified among Russian scientific users, regional authorities and partly among the international user community involved in activities in the RF.
- In order to meet the identified user requirements for SAR coverage of the RF, a combination of three station locations are required - in Moscow, Novosibirsk and in Yakutsk.
- One or more ground station located within the Russian Federation will significantly facilitate the access to and promotion of use of SAR data for the Russian user community.
- To serve the data needs of the Russian and international PI's under the Third ERS Announcement of Opportunity (AO3) a station located in Novosibirsk is required.
- The Yakutsk station location will *uniquely* cover the eastern part of the Northern Sea Route (Laptev Sea) as well as land areas of the Far East of RF. The Far East seas will also be covered in partly overlap with other existing station locations.
- The SAR data costs are a significant and limiting factor for application development within all application areas.
- The market survey has contributed to an increased awareness of Russian SAR application forming a basis for future market and application development.

Application Areas

- SAR data has its particular benefit among EO information sources in the high latitude regions of the Russian Federation, due to the frequent occurrence of cloud, haze and winter darkness.

- The basic industrial use and exploration of natural resources are located mainly in the northern regions of the Russian Federation.
- Regional authorities have indicated significant benefit in the use of EO data, including SAR, within environmental mapping for planning of new activities and installations (roads, railroads, pipe lines etc.) and environmental monitoring and assessment of impact from existing installations.
- Regional authorities envisage EO data to become a prime source of information within mapping and monitoring of natural phenomena such as sea ice, flooding including ice blocking in rivers, forest state and damage as well as forest fires.
- SAR applications in support of ship navigation in ice covered areas is the most developed application area, although, wide spread commercial use is currently limited by the data costs, due to limited geographical coverage of the current ERS SAR sensor (100 km swath) and the current financial situation in Russia. Despite the technical limitations SAR data has proven significant value when available.
- Ship detection is of interest to local authorities in order to monitor illegal fisheries particular in the Far East seas.
- The oil exploration industry operates often through intermediate companies, providing environmental assessment and other services in which EO data can be used as an integrated source of information. These end-users do not regard EO data alone as a source of information, but require integrated retrieval of the information content as essential to increase the use of EO data.
- Previous forest monitoring was mainly done using aerial surveys. However this has declined significantly over the recent years due to the budget situation. A cost-efficient substitute or complement could be obtained through use of satellite SAR data in combination with other information sources.

Future Development

- An increasing interest in the Russian and international scientific community for SAR data from the territories of the Russian Federation is observed through the increased number of projects in response to the later ERS AO calls.
- The Russian scientific community has expertise in existing and future thematic application areas of SAR data, which will be of benefit to the Russian and international user communities.

- Within mapping and monitoring of terrestrial pollution, forestry and natural resources (geology) exploration, SAR data have a significant national potential of development provided that the application methods well demonstrated and validated.
- Within the oil exploration industry, partly shipping industry, forestry (industry and authorities) and mining companies there are financial resources and willingness to invest in use of *documented and beneficial applications* of EO data.
- Increased availability and access to ERS SAR data within the RF will foster research and application development. Furthermore this will stimulate the development of future operational applications and the market for ENVISAT SAR data from year 2001.

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A. Report Annex A

A.1 The Project Team

The *Nansen Centers* in Bergen (NERSC) and St. Petersburg (NIERSC) have both been instrumental in the execution of the current ICEWATCH activities in the framework of the ESA and RKA co-operation in earth observation (EO). Particular the efforts of the Nansen Centers have been within applications of SAR data for monitoring of sea ice conditions for ice navigation and climate studies. NIERSC has in co-operation with NERSC also developed several terrestrial application areas within fields such as mapping of forests and land pollution. The Nansen Centers have during the last six years established an extensive network among the satellite earth observation user community in Russia and also among non-Russians operating within the Russian territories. The Nansen Center in Bergen has been the project co-ordinator for this market study.

Development of the Russian market for EO data has for a long period been one of the strategic foci of *SPOT Image*. This effort includes both SPOT and ERS satellite data and value-added application products and services. As a part of the development of new EO services, integrated use of SPOT and ERS-2 SAR data are among the current development foci of SPOT Image. Since 1996 SPOT Image has also operated a SPOT receiving station in Obninsk, south-west of Moscow. The current Russian operations of the SPOT station covers downloading and use of the optical data from the SPOT satellite series over the central Russian territories. The prime customers and users for the SPOT data in Russia are currently interested in terrestrial applications within forestry, vegetation and geology. A significant market is, however, envisaged for combined data products and services from Russian and non-Russian clients operating on the Russian territories. The representative of SPOT Image in Russia, Mr. Evgéne I. Krivtchenko of DERSI in Moscow, took part in the project.

The *Russian Space Agency (RKA)* is the leading Russian authority on EO policy, co-ordination, implementation and operations. The role of RKA in this study was to support the project with guidance as well as to facilitate contacts with the Russian EO users community as well as to analyse and forward the information retrieved. Their participation has assured that the most relevant Russian actors and users have been contacted, and that the appropriate level of contact has been made within each organisation in order to obtain relevant and reliable information for the market survey analysis. After the initial stage of the project the team has been extended to include two additional Russian partners. The *Scientific Research Centre for Exploration of Natural Resources* (NITs IPR) in Moscow, under the auspices of RosHydromet, were appointed to practically represent RKA within the project team. Further the *Siberian Remote Sensing Center* (SRSC) in Novosibirsk, under the Inter-regional Association "Siberian Accord", RosHydromet service and the Siberian branch of the Russian Academy of Sciences were also incorporated in the project team. In the project NITs IPR has made their network of EO data clients available to the project and performed parts of the survey and participated in the three regional workshops. SRSC was created in 1997 as a non-profit non-governmental scientific organisation. The purpose of SRSC is to provide interested departments and organisations of Siberia with satellite data for various purposes of environmental monitoring and management. This extension of the project partners has been made in order to better cover all aspects of the developing EO applications within the Russian Federation, nationally and regionally.

A.2 The Questionnaire Forms

The Questionnaire forms used follows on the next pages.

QUESTIONNAIRE

Use of Satellite Data for the Russian Territories.

The survey is carried out by the joint initiative of the European Space Agency and Russian Space Agency

The aim of this survey is to get your opinion on how and in what areas satellite Earth Observation (EO) data may help your organization to efficiently and successfully achieve its aims. According to the filling in of the questionnaire, you will be provided by additional informational materials concerning themes of interest for your organization. The results of this survey will also help to form the future Earth Observation policies for the Russian territories.

All information about your organization will be treated confidentially.

This questionnaire is intended completed through a personal interview. When filling in the questionnaire cross out an appropriate rectangle, circle, or text field indicated.

Primary Application Area:
○ **Sea Ice** ○ **Environment** ○ **Forestry** ○ **Geology**

Secondary Application Area:
○ **Sea Ice** ○ **Environment** ○ **Forestry** ○ **Geology**

1. What Organization do you represent?

1.1 Name of Organization:

.....
.....

1.2 Organization Type

Governmental:

☐ Budget
☐ Unitary
☐ Joint-stock company with government as a major shareholder
☐ Other (specify) .....

Private:

☐ Private limited liability company (Co. Ltd.)
☐ Incorporated enterprise
☐ Other (specify) .....

1.3 Subordination Level (for State Organizations only)

☐ Federal level
☐ Krai (Republican) level
☐ Oblast' (region, city) level

1.4 Activity Area

Note: More than one choice is possible.

☐ Management
☐ Funding (projects, programs etc.)
☐ Manufacturing
☐ Transportation
☐ Energy
☐ Exploration and production of natural resources
☐ Transportation services
☐ Infrastructure maintenance
☐ Agriculture
☐ Services/Consultancy
☐ Environmental monitoring
☐ Thematic mapping
☐ Development of software
☐ Research and design
☐ Education
☐ Data collection:
  ○ common
  ○ satellite earth observation

Types of industry:
○ Mining
○ Oil and gas
○ Timber
○ Other (specify) .....

2.4 Geographical Coverage of Activity

☐ Russian Federation
☐ Republic, Krai
☐ Region, city
☐ Other (specify) .....

2.5 Typical Scale Of Studied Areas:

☐ Less than 50 000 km2
☐ 50 000 - 200 000 km2
☐ 200 000 - 1 000 000 km2
☐ More than 1 000 000 km2
☐ Other (specify) .....

2.6 Main Regions Of Interest Within The Russian Federation:

Land regions

☐ North-western part of the RF
☐ Far North
☐ Central region of the RF
☐ South of the European part of Russia
☐ Povolzhje (Volga region)
☐ Ural
☐ Western Siberia
☐ Eastern Siberia
☐ Far East
☐ Other (specify)
.....

Oceans

☐ Arctic seas
☐ Far East seas
☐ Azov-Black seas area
☐ Baltic sea
☐ Inland water bodies
☐ Other (specify) .....

2.7 Frequency And Season Of Observations (Information Updates)

Frequency

☐ Daily
☐ Once every few days
☐ Weekly
☐ Monthly
☐ Annual
☐ One-off
☐ Depending on event
☐ Once every few years
☐ Other (specify)
.....

Season

☐ All-the-year-round
☐ Open water season
☐ Ice cover season
☐ Vegetation phase
☐ Winter
☐ Spring
☐ Summer
☐ Autumn
☐ Other (specify)
.....

2.8 Estimated Budget of Activity

Choose the most convenient for you type of estimation

Year of reference 199.....	% from annual budget	Roubles per year	USD per year
information acquisition			
information processing			

2.9 Estimated development of Your Activity

How do you assess the overall development trend of your activity during the next years to come?

	Time perspective	
	1-3 years	5 years
Decrease by	..... %	..... %
Unchanged	☐	☐
Increase by	..... %	..... %

Characteristics Of Urban Areas State:

☐ Relief and soil-ground characteristics for new building areas
☐ Characteristics of vegetation
☐ Characteristics of water systems
☐ Heat losses
☐ Other (specify) .....

3.3. What Level Of Satellite Data Processing Do Your Organization Needs?

☐ Raw data
☐ Signal (brightness) corrected
☐ Calibrated data
☐ Geocoded
☐ Ortho imagery
☐ Data with applied atmospheric correction
☐ Image analysis and thematic mapping
☐ Improvement of the existing thematic maps
☐ Other (specify) .....
☐ Unable to respond

3.4. What Do You Consider As Main Obstacles For Use Of Satellite Data In Your Organization ?

☐ High price
☐ Inappropriate area coverage
☐ Availability
☐ Non-operational delivery
☐ Information content
☐ Analysis tools (software)
☐ Missing information on where and how to obtain these data
☐ Legislation issues
☐ Other (specify) .....

ORGANIZATION INFORMATION

Address:
City:
Postal code:
Country:
Number of Employees: .....
Contact Person: .....
Annual Budget: .....

INFORMATION ON ANSWERING PERSON(S)

Name:
Position:
Phone:
Fax:
E-mail:
Role in Organization: ○ Decide ○ Recommend ○ Propose ○ Purchase ○ Other

Thank You for your assistance!!

For further information and questions about this survey, please contact;

Nansen Environmental and Remote Sensing Center
Edv. Griegsvei 3, N-5059 Solheimsviken - Bergen, NORWAY
Point of contact: Lasse H. PETTERSSON
Phone: +47 55 29 72 88, Fax: +47 55 20 00 50
e-mail: lasse.pettersson@nrsc.no

Nansen International Environmental and Remote Sensing Cente
Korpusnaya street 18, RU-197110 St. Petersburg, RUSSIA
Point of contact: Leonid P. BOBYLEV
Phone: + 7 812 235 7493 Fax: +7 812 230 7994
e-mail: nansen@online.ru

Date of Completion: Completed by:

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A.3 Summary Report of Survey Statistics

The statistical summary report derived form the survey relational database. Similar reports have been made for various subsets of the database in order to perform the market analysis.

SUMMARY REPORT
Use of Satellite Data for the Russian Territories.

Criteria: "Grand Summary Report" based on 189 of 189 records

Primary Application Area:

Sea Ice	8%		
Environment	62%		
Forestry	11%		
Geology	17%	Empty	1%

Secondary Application Area:

Sea Ice	23%		
Environment	40%		
Forestry	22%		
Geology	15%	Empty	1%

1. What Organization do you represent?

1.2 Organization Type

Governmental:		Private:	
Budget	69%	Private limited liability company	10%
Unitary	8%	Incorporated enterprise	6%
Joint-stock company	4%		
		Other	3%
		Empty	1%

1.3 Subordination Level (for State Organizations only)

Federal level	72%		
Krai	6%		
Oblast	6%	Empty	19%

1.4 Activity Area

Note: More than one choice is possible.

Management	26%	Agriculture	5%
Funding (projects, programs etc.)	18%	Services/Consultancy	13%
Manufacturing	2%	Environmental monitoring	69%
Transportation	12%	Thematic mapping	52%
Energy	1%	Development of software	23%
Exploration and production of natural resources	26%	Research and design	52%
Transportation services	10%	Education	21%
Infrastructure maintenance	2%	Data collection:	48%
		Empty	2%

1

2.4 Geographical Coverage of Activity

Russian Federation	38%
Republic, Krai	40%
Region, city	40%
Other	11%
Empty	11%

2.5 Typical Scale Of Studied Areas:

Less than 50 000 km2	44%
50 000 - 200 000 km2	50%
200 000 - 1 000 000 km2	29%
More than 1 000 000 km2	15%
Other	4%
Empty	12%

2.6 Main Regions Of Interest Within The Russian Federation:

Land regions	
North-western part of the RF	39%
Far North	39%
Central region of the RF	23%
South of the European part of Russia	18%
Povolzhje (Volga region)	21%
Ural	24%
Western Siberia	43%
Eastern Siberia	18%
Far East	26%

Oceans	
Arctic seas	37%
Far East seas	14%
Azov-Black seas area	12%
Baltic sea	13%
Inland water bodies	29%
Other	27%
Empty	4%

2.7 Frequency And Season Of Observations (Information Updates)

Frequency	
Daily	19%
Once every few days	16%
Weekly	10%
Monthly	19%
Annual	19%
One-off	31%
Depending on event	55%
Once every few years	11%

Season	
All-the-year-round	53%
Open water season	15%
Ice cover season	15%
Vegetation phase	13%
Winter	6%
Spring	24%
Summer	30%
Autumn	21%
Other	3%
Empty	3%

3

Characteristics Of Urban Areas State:

Relief and soil-ground characteristics	25%
Characteristics of vegetation	24%
Characteristics of water systems	15%
Heat losses	6%

Other	13%
Empty	2%

3.3. What Level Of Satellite Data Processing Do Your Organization Needs?

Raw data	32%
Signal (brightness) corrected	9%
Calibrated data	21%
Geocoded	34%
Ortho imagery	39%

Data with applied atmospheric correction	16%
Image analysis and thematic mapping	51%
Improvement of the existing thematic maps	42%
Unable to respond	5%
Other	2%
Empty	4%

3.4. What Do You Consider As Main Obstacles For Use Of Satellite Data In Your Organization ?

High price	49%
Inappropriate area coverage	9%
Availability	31%
Non-operational delivery	23%
Information content	32%

Analysis tools (software)	20%
Missing information	20%
Legislation issues	3%
Other	12%
Empty	17%

Evaluation by Surveyor

Possibility for purchase of EO data:

High	6%
Medium	32%
Low	50%
Unable to evaluate	12%

Empty	1%

Possibility for use of EO data

High	30%
Medium	58%
Low	5%
Unable to evaluate	6%

Empty	1%

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A.4 Program of and Participants at the Project Workshops

Below follows the sample program for the Workshop in St. Petersburg. The program for the Workshops in Moscow and Novosibirsk was only modified slightly according to the participating project staff as well as the thematic focus areas of the majority of the participants.

A.4.1 Participants in St. Petersburg, House of Scientists – 9. December, 1998

Name	Organisation	Address	tel., fax, E-MAIL
BOBYLEV Leonid P. Director	NIERSC	Korpusnaya str., 18 197110 St.Petersburg Russia	Ph.: (812) 235 74 93 Fax: (812) 230 79 94 e-mail: nansen@online.ru
DONCHENKO Viktoria V. Scientist	NIERSC	Korpusnaya str., 18 197110 St.Petersburg Russia	Ph.: (812) 235 74 93 Fax: (812) 230 79 94 e-mail: nansen@online.ru
ERMOLOV Sergey A. Vice-Chairman	LENKOMECOLOGIA	Bolshaya Morskaya, 51 St.Petersburg Russia	Ph.: (812) 312 79 82 Fax: (812) 279 76 45 e-mail: -
GUSEV Vitaly G. Head of Laboratory	Forestry Research Institute	Institutsky pr., 21 194021 St.Petersburg Russia	Ph.: (812) 552 80 21 Fax: (812) 552 80 42 e-mail: serg@forest.spb.su
HOUIX Jean-Pierre	French National Geographic Institute IGN-France International	Bolshaya Konushenaya 29, Office 208/210 St. Petersburg Russia	Ph.: (812) 314 18 40 Fax: (812) 314 18 40 e-mail:
IVANOV Viktor N. Leading Scientist	GIPROSPETSGAS	Suvorovsky pr., 26 St.Petersburg Russia	Ph.: (812) 271 08 88 Fax: (812) 271 08 65 e-mail:
KHILOV Alexey M. Senior Scientist	Forestry Research Institute	Institutsky pr., 21 194021 St.Petersburg Russia	Ph.: (812) 552 80 21 Fax: (812) 552 80 42 e-mail: serg@forest.spb.su
KHIZHNITCHENKO Vitaky I. Head of Department	Research Center for Natural Resources Study	Pervomaiskaya Str., 7 141700 Dolgoprudny Moscow region Russia	Ph.: (095) 483 31 11 Fax: (095) 483 33 74 e-mail: adm@m.astelite.ru
KLIMASHEVSKY Stanislav N. Leading Scientist	Krylov Shipbuilding Research Institute	Moskovskoe shosse 44 196158 St.Petersburg Russia	Ph.: (812) 293 97 45 Fax: - (812) 127 93 49 e-mail:
KOLESNIKOVA Galina A.	Nature Resources Committee of Republik Karelia	Varkausa emb. 1-A 185031 Petrozavodsk Republic of Karelia Russia	Ph.: (814) 2 77 42 61 Fax: (814) 2 74 87 29 e-mail:
KOROTKEVICH Oleg Eu. Senior Scientist	NIERSC	Korpusnaya str., 18 197110 St.Petersburg Russia	Ph.: (812) 235 74 93 Fax: (812) 230 79 94 e-mail: nansen@online.ru
KOTOVA Lola A. Scientist	NIERSC	Korpusnaya str., 18 197110 St.Petersburg Russia	Ph.: (812) 235 74 93 Fax: (812) 230 79 94 e-mail: nansen@online.ru
KRIVTCHENKO Evgene I. SPOT IMAGE Representative in RF	Industrial Space Firms International Cooperation Development (DERSI) SPOT IMAGE	Shmitovsky proezd, 13 123100 Moscow Russia	Ph.: (095) 259 52 38 Fax: (095) 259 67 38 e-mail: dersi@dol.ru
KSENOFONTOV Alexey V. Vice-Chairman of the Committee	Leningrad province Government Committee of Natural Resources Use and Ecological Safety	Smolnogo Str., 3 St.Petersburg Russia	Ph.: (812) 274 93 81 Fax: (812) 271 56 27 e-mail:
MAKEEV Viacheslav M. Director	State Research Institute of Nature Protection of Arctic Countries	Chilieva Str., 13 St.Petersburg Russia	Ph.: (812) 352 33 89 Fax: (812) 352 33 89 e-mail: rimcan@rimcan.spb.ru

ZAITSEV Alexandr N. Head of Department	Institute of Earth Magnetism and Ionosphere	142092 Troitsk Moscow Region Russia	Ph.: (095) 334 02 93 Fax: (095) 334 01 24 e-mail:
ZAVIALOVA Tatyana A. Head Aerophoto Survey Group	North-West State Forest Enterprise	KdTomchakaSt,16 196084 St.Petersburg Russia	Ph.: (812) 298 63 88 Fax: (812) 298 03 84 e-mail: nwsfme@mail.admiral.ru
ZINOVYEV Yury S. Leading Scientist	ECOS-KONVERSIA	Kosmonavtov 34-34 196244 St.Petersburg Russia	Ph.: (812) 264 74 43 Fax: e-mail:

A.4.2 Participants in Moscow, ESA Mission to Russia – 12. December, 1998

Name	Organisation	Address	tel., fax, E-MAIL
ANDREEV N.A. Head of Central Station	Central Station of Forest Aerial Survey	Gorkogo str.,20 141200, Pushkino, Moscow region, RUSSIA	Tel.: (095) 584 37 56 Fax: (095) 584 37 56
ARKHIPOV Vladimir I. Director	North-West State Forest Management Etr.	Koli Tomchaka str., 16, SPB, 196084, RUSSIA	Tel.: (812) 298 26 93 Fax: (812) 298 03 84 e-mail: nwsfme@mail.admiral.ru
BARTALEV Sergey A. Head of laboratory	MIF	Novocheremushkinskay a str.,69 117418, Moscow RUSSIA	Tel.: (095) 332 68 77 Fax: (095) 332 29 17 e-mail: gisfores@mx.iki.rssi.ru
BOBYLEV Leonid P. Director	NIERSC	Korpusnaya str, 18 193210; SPB RUSSIA	Tel: (812) 235 74 93 Fax: (812) 230 79 94 e-mail: nansen@online.ru
BOGDANOV Anatoly V. Head of Department	Ministry of Science and Technology RF	Tverskaya str., 11 Moscow RUSSIA	Tel.: (095) 229 17 64 Fax: (095) 229 44 64
FOURNIER –Sikr Alan	ESA	Sretensky bul., 6/1-122 101000 Moscow RUSSIA	Tel.: (095) 928 75 29 Fax: (095) 928 53 52 e-mail: afournie@emo.esa.int
GRIDINVitaly I. Professor	Oil and Gas State University im Gubkina	Leninsky pr.,65 Moscow RUSSIA	Tel.: (095) 135 50 05 Fax: (095) 135 88 95 (095) 135 86 96
GUSEVANina N. Head of Department	NITzIPR	Pervomaiskaya str., 7 Dolgoprudny RUSSIA	Tel.: (095) 483 32 56 (095) 483 31 90 Fax: (095) 483 33 74 e-mail: adm@m.astelit.ru
GZIN Vladimir V. Head of Department	EMERCOM	Moscow	Tel.: (095) 445 50 14 Fax: (095) 445 44 62 e-mail: asic@asic.ss.msu.ru gvv@asic.ss.msu.ru
HOUIX Jean-Pierre	French National Geographical Institute	B.Konushennaya,29, S.-Petersburg RUSSIA	Tel.: (812) 314 18 40 Fax: (812) 314 18 40 e-mail: houix@mail.rcom.ru
KHIZNITCHENKO Vitaly I. Head of dept.	NITzIPR	Pervomayskaya str, 7 141700, Dolgoprudny RUSSIA	Tel.: (095) 483 32 56 (095) 483 31 90 fax: (095) 483 33 74 e-mail: adm@m.astelit.ru

BELOV Vladimir Vasil'exich Deputy director	Institute of atmosphere optics SB RAS	634055 Tomsk Av. Akademicheski, 1	Ph. .: (382-2) 25-92-37
BOBYLEV Leonid Petrovich Director	NIERSC	197110 St. Petersburg Korpusnaya St., 18	Ph. .: (812) 235 74 93 Fax : (812) 230 79 94
BOGDANOV Anatoly Vladimirovich Chief of the Department	Ministry of Science and Technologies Russian Federation	403905 Moscow Tverskai St. 11	Ph. .: (095) 229 17 64 Fax : (095) 229 44 64
BOYKOV Anatoliy Fedorovich Chief of natural resources department	Administration of Novosibirsk Region, Main economic management	630011 Novosibirsk Krasnii Av., 18	Ph. .: (383-2) 23-88-27; Ph. .: (383-2) 22-24-66
DEIHIN Leonid Evsigneevich	Novosibirsk Regional Center GIT SB RAS	630090, Tereshkova St., 29	Ph. . (383-2) 34-26-37
EROHIN Gennadiy Nikolaevich Director	Siberian Remote Sensing Center	630090 Novosibirsk Av. Lavrent'eva 6	Ph. . (383-2) 34-27-52; Fax (383-2) 34-45-76
EVTYUSHKIN Arkadiy Victorovich Laboratory head	AGU NII EM Image processing Lab	656099 Barnaul Dimitrov 66	Ph. /(385-2) 36-70-61
FEDORCHENKO Vyacheslav Leonidovich Director	State enterprise "Sahalingeoinform"	693000, Yuzhno-Sahalinsk Box # 71	Ph. (424) 242-01-02 Fax (424) 225-55-15
GRIGOR'EV Valentin Vasil'evich Leading geolog	Geological enterprise "Berezovgeologiya"	Novosibirsk St.Kamenskaya 74	Ph. . (383-2) 20-74-62
HIZHNICHENKO Vitaliy Ivanovich Head of department	Research Center of Natural resources	Pervomayskaya St. 7 141700, Moscow region Dolgoprudniy	Ph. : (095) 483 32 56 (095) 483 31 90 Fax : (095) 483 33 74
HMEL'NITCKIY Sergey Sergeevich Director	Industrial enterprise "Tomskmezhhozles"	636138 Tomsk region Kornilovo, St. Kredrovaya7	Ph. (382-2) 26-49-71
HMEL'NITCKIY Gennadiy Sergeevich Head of department	Tomsk State University	Tomsk, Lenin St., 36 Tomsk, Russia	Ph. (382-2) 41-55-79 Fax (382-2)22-40-61
KAMISHNIKOV Aleksey Ivanovich Chair head	Altai State university	656099, Barnaul Dimitrov 66	Ph. (385-2) 23-87-25; 23-26-74; 22-28-75
KARMISHIN Aleksandr Mihailovich Head of department	Radiotechnics and electronics department Krasnoyarsk Scientific Center SB RAS	660036, Krasnoyarsk Akademgorodok	Ph. (391-2) 49-44-94 Fax 391-2) 43-97-65
KISELEV Anatoliy Georgievich Information department head	Executive Council of "Siberian Agreement"	660099, Novosibirsk St. Uritckiy, 19	Ph. (383-2) 23-97-34 Fax (383-2) 23-77-38 e-mail
KOMARNITCKIY Gavriil Maksimovich	Novosibirsk State Academy of Economics and Management	630112, Novosibirsk Ippodromskaya 32 app.143	Ph. (383-2) 11-24-49
KOPILOV Vasiliy Nikolaevich Head of center	West Siberian Regional Data Acquisition Center of Rosgidromet	630099, Novosibirsk Sovetskaya St., 30	Ph. (383-2) 22-33-0
KOROTKEVICH Maria Nikitichna Program director	"Siberian Agreement", Ecological program	630099 Novosibirsk, St. Uritckiy 19	Ph. (383-2) 23-67-53 Fax (383-2) 23-77-38

SUHARIN Eugene Konstantinovich Head of forestry department	Forestry board of Novosibirsk region	630091, Novosibirsk, Krasnii Av. 82	Ph. (383-2) 17-29-11;17-36-05 Fax (383-2) 21-74-92
TEPLOV Aleksey Nikolaevich Deputy director	"Vostok"	Novosibirsk Av.Dimitrov 7/7 app. 715	Ph. (383-2) 21-51-51 Fax (383-2) 24-65-11
TKACHENKO Vladimir Aleksandrovich Chief engineer	Rosgidromet _ÖÏÏÄ	Novosibirsk St. Sovetskaya, 30	Ph. (383-2) 35-35-42;35-65-42
VLADIMIROV Valeriy Michailovich Deputy director of KSC	Presidium of Krasnoiarsk Scientific Center SB RAS	660036 Krasnoiarsk, 36 Akademgorodok	Ph. . (391) 2 43-97-65 Fax (391) 2-49-44-94
VRAGOV Andrey Vladimirovich,	Novosibirsk State university	630090 Novosibirsk Pirogov St. 2	Ph. . (383-2) 39-75-82 Ph. . (383-2) 39-75-83
VRAGOV Vladimir Nikolaevich NSU chair head	Novosibirsk State university	630090 Novosibirsk Pirogov St.2 app.232-à	Ph. . (383-2) 39-75-82 Ph. . (383-2) 39-75-95
ZABADAEV Igor Sergeevich Director	SB RAS GIS Center	630090 Novosibirsk Av.Universitetskiy 3	Ph. . (383-2) 34-26-37
ZACEPIN Anatoliy Georgievich Deputy director	Executive Council of "Siberian Agreement"	630099 Novosibirsk St.Uritckiy 19	Ph. (383-2) 23-67-53;23-97-34; Fax (383-2) 23-77-38
ZADOROZHNY Vasiliy Michailovich Deputy head	SB RAS Presidium "Scientific researches organization committee"	630090, Novosibirsk Av. Lavrent'eva, 17	Ph. . (383-2) 35-75-47; (383-2)35-05-71
ZINENKO Vasiliy Ivanovich Head of board	Western Siberia board of hydrometeorology and environment monitoring of Rosgidromet	630099, Novosibirsk Sovetskaya St., 30	Ph. (383-2) 21-14-33 Fax (383-2) 22-63-47

A.5 List of Russian Organisations Relevant to EO Applications

A.5.1 Ice Management and Navigation

The project has identified a total of 166 Russian organisations within the fields of ice management and navigation, which includes;

Federal Management Body

1. The Ministry of Transport of the Russian Federation (Marine Operation Department)
2. The Ministry of Natural Resources of Russian Federation (Marine Department)
3. The Committee of Fishery of Russian Federation (Marine Fishery Department)
4. Russian Federal Service for Hydrometeorology and Environmental Monitoring (Arctic, Antarctic and Marine Department)
5. The Committee of Environmental Protection of Russian Federation (Ecological Monitoring Department)
6. Administration of the Northern Sea Route (NSR)

Regional and Territorial Bodies

Shipping Companies

7. Murmansk Shipping Company (Murmansk)
8. Arctic Shipping Service Ltd (Murmansk)
9. Northern Shipping Company (Arkhangelsk)
10. White Sea-Onega Shipping Company (Petrozavodsk)
11. Western Shipping Company (St. Petersburg)
12. Azov/Black Seas Shipping Company (Taganrog)
13. Caspean Shipping Company (Astrakhan)
14. Far Eastern Shipping Company (Vladivostok)
15. Sakhalin Shipping Company (Y. Sakhalinsk)
16. Arctic Shipping Company (Tiksi)
17. Pechora Shipping Company (Naryan-Mar)
18. Yamal Shipping Company (Salekhard)

Administrations of the Sea Ports, Channels and Regional Water Basins (ice management and navigation)

Administrations of the Sea Ports

19. Administration of St.Petersburg Sea port (Baltic Sea, Finnish Gulf)
20. Administration of Kaliningrag Sea port (Baltic Sea)
21. Administration of Arkhangelsk Sea port (White Sea)
22. Administration of Kandalaksha Sea port (White Sea)
23. Administration of Medvezgegorsk Sea port (White Sea)
24. Administration of Mezen Sea port (White Sea)
25. Administration of Dikson Sea port (Kara Sea, Enisey Gulf)
26. Administration of Dudinka River port (Kara Sea, Enisey Gulf)
27. Administration of Novy port (Kara Sea, Ob Bay)
28. Administration of Salekhard River port (Kara Sea, Ob Bay)

71. State Company «Sevmorgeo» (St. Petersburg)
72. VNIPIMorNeftegas (Moscow)
73. JV «Meteko-Nord» (Moscow)
74. JV «INTAARI» (St. Petersburg)
75. Institute of Remote Sensing Methods for Geology «INTAARI» (St. Petersburg)
76. ZAO «SeverGas SERVICE» (Tumen)
77. AO «TumenNefteGeophysika» (Tumen)
78. AO «Northern Lights» (Novy Urengoy)
79. Oil and Gas Research Institute of RAS (Moscow)
80. Polar Marine GeoSurvey Expedition (St. Petersburg)

Fishery industry company and research institutions

81. AO «Sevryba» - «Northern Fish» (Murmansk)
82. Central Research Instutute of Marine Fisheries and Oceanography «VNIRO» (Moscow)
83. Northern Atlantic Research Instutute of Marine Fisheries and Oceanography «AtlantNIRO» (Kaliningrad)
84. Polar Research Instutute of Marine Fisheries and Oceanography «PINRO» (Murmansk)
85. Polar Research Instutute of Marine Fisheries and Oceanography - Northern Branch PINRO «SevPINRO» (Arkhangelsk)
86. Caspian Research Instutute of Marine Fisheries and Oceanography (Astrakhan)
87. Azov-Black Sea Research Instutute of Marine Fisheries and Oceanography (Rostov)
88. Kamchatka Research Instutute of Marine Fisheries and Oceanography (Petropavlovsk)
89. Pacific Research Instutute of Marine Fisheries and Oceanography - (Vladivostok)
90. Sakhalin Research Instutute of Marine Fisheries and Oceanography (Yu. Sakhalinsk
91. Okhotsk Research Instutute of Marine Fisheries and Oceanography (Magadan).

Hydrometeorological and ecological control

92. NPO «Planeta» (Moscow)
93. Center of the Ecological Monitoring of Siberia (Novosibirsk)
94. Institute of the Industrial Ecology Problems of the North (Apatity)
95. Russian Antarctic Expedition (St. Petersburg)
96. Pacific Oceanological Institute RAS (Vladivostok)
97. Institute of the Ecological Problems of the North (Arkhangelsk)
98. Institute of Water Transport Engineers (Nizhny Novgorod)
99. State Committee of Environmental Protrection Yamal-Nenets Autonomous District (Salekhard)
100. State Committee of Environmental Protrection Khanty-Mansiysk Autonomous District (Khanty-Mansiysk)
101. State Committee of Environmental Protrection Komy Autonomous Respublic (Syktyvkar)
102. State Committee of Environmental Protrection Arkhangelsk Province (Arkhangelsk)

Fundamental sciences (ice and oceanology)

103. Oceanological Institute of Russian Academy of Sciences (Moscow, and the Kola, Karelian and Komi Autonomous Republic's Departments)
104. Insitute of Oceanography of the H/M Committee (Moscow, St. Peterburg)
105. Institute of Marine Biology of RAS (Murmansk)

39. Kemerovo Forest Management Division
40. Kirov Forest Management Division
41. Komi-Permyak AD Forest Management Division
42. Kostroma Forest Management Division
43. Krasnodar Forest Management Division
44. Krasnoyarsk Krai Forest Management Division
45. Kurgan Forest Management Division
46. Kursk Forest Management Division
47. Lipetsk Forest Management Division
48. Leningrad Region Forest Management Division
49. Magadan Forest Management Division
50. Moscow Forest Management Division
51. Murmansk Forest Management Division
52. Nizhniy Novgorod Forest Management Division
53. Novosibirsk Forest Management Division
54. Omsk Forest Management Division
55. Orenburg Forest Management Division
56. Orlov Forest Management Division
57. Penza Forest Management Division
58. Perm' Forest Management Division
59. Primorskoye Forest Management Division
60. Pskov Forest Management Division
61. Rostov Forest Management Division
62. "Russkiy Les" Experimental Forest Management Division
63. Ryazan' Forest Management Division
64. Samara Forest Management Division
65. Saratov Forest Management Division
66. Sakhalin Forest Management Division
67. Sverdlovsk Forest Management Division
68. Smolensk Forest Management Division
69. Stavropol' Forest Management Division
70. Tambov Forest Management Division
71. Tver' Forest Management Division
72. Tomsk Forest Management Division
73. Tula Region Forest Management Division
74. Tyumen' Region Forest Management Division
75. Ulyanovsk Region Forest Management Division
76. Khabarovsk Krai Forest Management Division
77. Khanty-Mansiysk AD Forest Management Division
78. Chelyabinsk Forest Management Division
79. Chita Forest Management Division
80. Chukotka AD Forest Management Division
81. Evenkiya AD Forest Management Division
82. Yamalo-Nenets AD Forest Management Division
83. Yaroslavl' Forest Management Division

National Parks – Federal Management

84. "Vodlozerskiy" National Park
85. "Kenozerskiy" National Park
86. "Pribaikal'skiy" National Park

Scientific Research Organisations

130. All-Russian Scientific Research Institute for Forestry and Mechanisation of Forestry (VNIILM)
131. Central Experimental Design Office of Forestry Machine Industry (TsOKBLeshkhozmash)
132. All-Russian Scientific Research Institute for Forest Fire Protection and Forestry Resources (VNIIPOMLeskhoz)
133. All-Russian Scientific Research Institute Information Centre for Forest Resources (VNIITsLesresours)
134. All-Russian Scientific Research Institute for Implementation of Chemistry in Forestry (VNIIKhLeskhoz)
135. Far Eastern Scientific Research Institute of Forestry (Dal'NIILKh)
136. Scientific Research Institute of Forest Genetics and Selection (NIILGiS)
137. Scientific Research Institute of Mountain Forest Management and Forest Ecology (NIIGorlesekol)
138. Northern Scientific Research Institute of Forestry (SevNIILeskhoz)
139. Saint Petersburg Scientific Research Institute of Forestry (Saint Petersburg NIILKh)
140. Vyritsa Experimental Mechanical Factory
141. Scientific and Production Centre for Forest Seed Production (CentrLesSem)
142. Ivanteevskiy Experimental and Demonstration Forest Selection Planting Enterprise
143. Ozherelyevskiy Fruit and Planting Enterprise

Educational Institutes

144. All-Russian Institute for Improvement of Education of Forestry Managers and Specialists (VIPKLKh)
145. Institute for Improvement of Education of Forestry Managers and Specialists in Siberia and Far East (VIPKLKh for Siberia and Far East)

Schools of Federal Forestry Service

146. Apsheron Forest Technical School
147. Archedinskiy Forest Technical School (Forest College)
148. Biyskiy Forest Technical School
149. Buzuluk Forest Technical School
150. Velikiye Luki Forest Technical School
151. Vyaz'ma Forest Technical School
152. Divnogorsk Forest Technical School
153. Kalashnikovo Planning and Accounting Technical School
154. Krapivenskiy Forest Technical School
155. Krasnobakovskiy Forest Technical School
156. Lisinskiy Forest Technical School (Forest College)
157. Lubyanskiy Forest Technical School
158. Mariinsko-Posadskiy Forest Technical School
159. Muromzevskiy Forest Technical School
160. Penza High Forest School
161. Pravdinskiy Forest Technical School
162. Rybinskiy Forest Technical School
163. North-Caucasian Forest Technical School
164. Suvodskiy Forest Technical School
165. Toguchinskiy Forest Technical School
166. Ufimskiy Forest Technical School

211. Joint Stock Company "Ekos-Inform Magazine"

A.5.3 Natural Resources (Geology)

The project has identified a total of 1132 Russian organisations and entities within the fields of Geological Services. The majority is among institutions and enterprises. Some of the public organisations includes;

Federal Management Body

1. The Ministry of Natural Resources of the Russian Federation

Regional and Territorial Management Bodies

2. Central Regional Geological Center
3. North-West Regional Geological Center
4. Adygeya Republic Committee on geology and mineral resources
5. Bashkortostan Republic State Committee on geology and mineral resources use
6. Buryat Republican Committee on geology and mineral resources use
7. Administration on geology, fuel, power and mineral resources use (Ministry of Industry), transport and communication, Dagestan Republic
8. State Committee on natural resources, Ingushetia Republic
9. Committee on geology and mineral resources use, Kabardino-Balkarian Republic
10. State committee on geology and mineral resources use, Kalmykia - Khal'mg Tangch Republic
11. State committee on geology and mineral resources use, Karachaevo-Cherkessk Republic
12. Karelia Republic Committee on geology and mineral resources use
13. The Ministry of natural resources and environmental protection, Komi Republic
14. Committee on geology, Mariy El Republic
15. Committee on geology and mineral resources use, Mordovia Republic
16. State committee on geology and mineral resources use, Sakha Republic /Yakutia/
17. State committee on geology and mineral resources use, Northern Osetia-Alania Republic
18. The Ministry of natural resources, Tyva Republic
19. Committee on mineral resources, Udmurt Republic
20. State committee on natural resources, Khakassia Republic
21. The Ministry of natural resources, Chuvash Republic
22. Committee on natural resources, Amur Region
23. Northern committee on geology and mineral resources use
24. Committee on geology and mineral resources use, Astrakhan Region
25. Geology and mineral resources use Administration of the Belgorod area
26. Geology and mineral resources use Administration of the Bryansk area
27. Geology and mineral resources use Administration of the Vladimir area
28. Committee on geology and mineral resources use, Volgograd Region
29. Board of geology and mineral resources use, Department of natural resources and nature use, Vologda Region administration
30. Geology and mineral resources use Administration of the Voronezh Region
31. Ivanovo territorial management authority of geology and mineral resources use
32. Committee on geology and mineral resources use, Irkutsk Region
33. Department on geology and mineral resources use of Ust'-Ordynsky Buryat autonomous district
34. Geology and mineral resources use Administration of the Kaluga area

Federal Management Body

1. The Ministry of Natural Resources of the Russian Federation

Water Resources Administration of the Russian Federation

2. Azov Water Resources Use and Coastal Line Protection Administration
3. Amur Basin Administration
   - 3.1. Committee on water resources use of the Primorsky area
   - 3.2. Committee on natural resources of the Amur area
   - 3.3. Committee on water resources use of the Khabarovsk area
   - 3.4. Committee on water resources use of the Jewish autonomous district
   - 3.5. Zeisk reservoir exploitation Administration
4. Anadyr - Kalmykia Water Basin Administration
   - 4.1. Committee on natural resources of the Magadan area
   - 4.2. Committee on natural resources of the Chukotka autonomous district
5. Angar - Baikal Water Basin Administration
   - 5.1. Water resources Management Department of Northern regions of the Irkutsk area
   - 5.2. Water resources Department of Aginsky Buryat autonomous district
   - 5.3. Water resources Department of Ust-Ordunsky Buryat autonomous district
   - 5.4. Committee on water resources use of Buryatiya Republic
   - 5.5. Committee on water resources use of the Chita area
   - 5.6. Committee on water resources use of the Irkutsk area
   - 5.7. Angar reservoirs exploitation Administration
   - 5.8. Angar reservoirs exploitation Administration, Bratsk region
   - 5.9. Lake Baikal exploitation Administration
6. Bel'sk Water Basin Administration
   - 6.1. Reservoirs exploitation Administration of the Bashkortostan Republic
   - 6.2. Operation of engineering protection of Nizhnekamsk water power station reservoirs Administration of Bashkiria
7. Upper-Volga Water Basin Administration
   - 7.1. Committee on water resources use of the Ivanovo area
   - 7.2. Committee on water resources use of the Kostroma area
   - 7.3. Committee on water resources use of the Vladimir area
   - 7.4. Committee on water resources use of the Yaroslavl area
   - 7.5. Committee on water resources use of Maryi El Republic
   - 7.6. Committee on water resources use of Mordovia Republic
   - 7.7. The Ministry of natural resources of Chuvash Republic
   - 7.8. Committee on water resources use of the Nizhnegorodsky area
   - 7.9. Federal Program "Volga revival" Directorship
   - 7.10. Gor'ky reservoir exploitation Administration
   - 7.11. Uglech reservoir exploitation Administration
   - 7.12. Rybinsk and Sheksninsk reservoirs exploitation Administration
8. Upper-Ob Water Basin Administration
   - 8.1. Altay water resources committee
   - 8.2. Republican water resources committee of Gorny Altai Republic
   - 8.3. Kemerovo water resources committee
   - 8.4. The Tomi river water resources program executive Directorship
   - 8.5. Njvsk water resources committee
   - 8.6. Novosibirsk water resources committee
   - 8.7. Representation of the Ministry of Natural Resources of Russia at Interregional

15.5. Water resources Committee of Bryansk area
15.6. Water resources Committee of Smolensk area
15.7. Water resources Committee of the Tula area
15.8. Department of water resources complex use, Moscow
15.9. Water resources Committee of the Moscow area
15.10. Ivan'kovsky reservoir exploitation Administration
15.11. Vazuza hydro-technical system operation Administration

16. Neva-Ladoga Water Basin Administration
16.1. Water resources Committee of Republic Kareliya
16.2. Water resources Committee of the Pskov area
16.3. Water resources Committee of the Kaliningrad area
16.4. Water resources Committee of the Novgorod area
16.5. Department of water resources complex use, St.-Petersburg
16.6. Department of water resources complex use, St.-Petersburg Region
16.7. St.Petersburg region and the Ladoga and Onega lakes reservoirs Exploitation Administration

17. Lower-Volga Water Basin Administration
17.1. Water resources Committee of the Saratov area
17.2. Water resources Committee of the Astrakhan area
17.3. Water resources Committee of the Volgograd area
17.4. Volgograd reservoir exploitation Administration
17.5. Saratovsky reservoir exploitation Administration

18. Lower-Ob Water Basin Administration
18.1. Omsk Regional Committee on water resources
18.2. Tumen territorial Committee on water resources
18.3. Yamalo-Nenetz Committee on water resources
18.4. Natural resources Committee of Khanty-Mansiysk autonomous district

19. Middle-Volga Water Basin Administration
19.1. Water resources Committee of the Samara area
19.2. Water resources Committee of the Penza area
19.3. Water resources Committee of the Ulyanovsk area
19.4. Water resources Committee of Tatarstan Republic
19.5. Kuibyshevsky reservoir exploitation Administration
19.6. Nizhne-Kamsky reservoir exploitation Administration

20. Ural Water Basin Administration
20.1. Water resources Committee of the Chelyabinsk area
20.2. Water resources Committee of Sverdlovsk area
20.3. Water resources Committee of the Orenburg area
20.4. Water resources Committee of the Kurgan areas
20.5. Cheliabinsk area reservoirs exploitation Administration
20.6. Iriklinsky reservoir exploitation Administration
20.7. Sorochinsky reservoir exploitation Administration

21. Natural resources Committee of the Sakhalin area
22. Kamchatsky Water resources Committee
23. Department of complex water resources use of Koriaksky autonomous district
24. Water resources Committee of Kalmykia-Khal'm-Tangch Republic
24.1. Coastal protection works operating and the Caspian Sea coastal line monitoring Administration

B. External Reports Appendices

These reports/documents are <u>not</u> provided as Appendices to this main report.

2	**Brochure Material in Russian** "Sea Ice Monitoring" **Provided by: NIERSC**
3	**Brochure Material in Russian** "Pollution Monitoring" **Provided by NIERSC**
4	**Brochure Material in Russian** "Mapping and Exploration of Natural Resources" **Provided by NIERSC**
5	**Brochure Material in Russian** "Mapping and Monitoring of Forests" **Provided by: NIERSC**
6	**Sub-report:** Acquisition, distribution and use of satellite earth observation data in the Russian Federation **Provided by : NIERSC**
7	**Sub-report:** Synergetic use of ERS and ENVISAT Synthetic Aperture Radar (SAR) with other EO data - A market survey for the Russian Territories. **Provided by: NITs IPR**
8	**Sub-report:** Market Survey of potential users of satellite earth observation data in Siberia. **Provided by: SRSC**

1. Introduction

1.1 Project Background

From the Soviet era extensive experience in design and applications of spaceborne radar systems have been established within the former Soviet states, in particular in the Russian Federation and the Ukraine. The first Soviet spaceborne real aperture side-looking radar (SLR) was launched by Cosmos-1500 in September 1983. This led to the development of the Russian Satellite Oceanographic Program - "Okean", under which the first operational satellite Okean-0-1 was launched in 1988. The main development of spaceborne radar satellite technology was carried out under the Almaz-program where civilian synthetic (SAR) and real-aperture (RAR) radar systems have been launched for both scientific and operational applications. The Almaz prototype SAR mission was launched in 1987 on Cosmos-1870. The Almaz-1 launched in March 1991, proved its direct applications in essential support for rescue of the R/V Michael Somov, which was captured in the Antarctic winter sea ice in July 1991. Russian EO scientists and application users have put considerable efforts in the development of satellite radar applications ranging from terrestrial mapping to near real-time sea ice monitoring. Development of the planned follow-on satellite radar systems on Almaz-1B and Almaz-2 satellites have been started in Russia. The launch dates of these satellites are uncertain, despite the willingness of both national and international interests to participate in and partly fund the program. At present Program Almaz has been closed down due to financial priorities of the Russian EO program. Currently no Russian spaceborne synthetic aperture radar (SAR) system is operational, although the real aperture Side-looking Radar on Okean was recently switched on again for operations. The planned launch of the Resurs-Arktika satellite with a SAR sensor is among the priorities of the Russian Space Agency. Considerable knowledge on spaceborne SAR applications is established within the Russian Federation and there exists a high level experience in the use of satellite radar data for the Russian territories.

In 1995 the Russian (RSA) and European (ESA) Space Agencies initiated their first co-operation within earth observation - the "ICEWATCH" project [Johannessen et al, 1997 a,b and 1998], which aimed at demonstration of European ERS Synthetic Aperture Radar (SAR) for guidance of vessels and icebreakers along the coast and rivers of western Siberia. Over the last years the Nansen Centers in Bergen and St. Petersburg have conducted 12 demonstration campaigns for use of SAR in ice navigation of the Northern Sea Route, starting with the French "L´Astrolabe" expedition in 1991 two weeks after the launch of ERS-1 [Pettersson et al., 1992]. These campaigns have been executed with the aim both to apply and to validate the use of ERS SAR data for ice navigation. Through the use of SAR data acquired by the Norwegian satellite receiving station (Tromsø Satellite Station, TSS) in Tromsø, the ESA station in Kiruna, Sweden and the US station in Fairbanks, Alaska, large parts of the Northern Sea Route and the Siberian coast are covered. However, major parts of the central Siberian mainland and the Laptev Sea are not covered regularly by the current network of ESA and other national ERS SAR ground acquisition stations. Therefore an acquisition station located within the Russian Federation is needed to cover the entire northern Russian territory and the Arctic including the Northern Sea Route (see map Figure 1-1).

The conclusions of the ICEWATCH project have so far been very positive with respect to the actual SAR applications within sea ice navigation. There is a specific demand from the Murmansk Shipping Company for use of these data by their icebreaker fleet as well as from

the oil companies due to the increased exploration and exploitation activities both on land and off-shore in Siberia. In order to obtain full coverage of the Siberian coast and the central Russian mainland, direct negotiations for establishment of an ERS/ENVISAT SAR receiving station at the territories of the Russian Federation have been initiated between the two space agencies. Such a station would be implemented as a joint ESA and RSA co-operation within earth observation. However, location and market opportunities for such a SAR station have not been fully investigated.

Several other applications of spaceborne radar sensors have also been developed both in Russia and other countries within fields such as e.g. boreal forest mapping, thematic vegetation mapping, ocean circulation studies (e.g. the Kara Sea), as well as use of interferrometric analysis for determination of land and glacier topography.

The justification for the establishment of an ESA/RSA SAR satellite data receiving station in Russia is hence two-fold. A SAR satellite receiving station at the Russian territories will provide a unique data coverage, which will become available for several application areas, also under the ERS AO3 announcement. The availability of such data will further stimulate and encourage a wider use of ERS and ENVISAT SAR data for the territories of the Russian Federation, both within the Russian EO user communities as well as at the international market operating within Russia.

A market survey to evaluate the potential use within Russia of ERS and ENVISAT SAR data in combination with other satellite EO data, including the French SPOT satellite, has been initiated, under the present project.

The market survey project is being co-ordinated by the *Nansen Environmental and Remote Sensing Center* (NERSC) in Bergen, Norway. In addition the Project Team consist of *SPOT Image*, Toulouse, France, *Nansen International Environmental and Remote Sensing Center* (NIERSC), St. Petersburg, Russia, *Scientific Research Centre for Exploration of Natural Resources* (NITs IPR) in Moscow, and *Siberian Remote Sensing Center* (SRSC) in Novosibirsk. The project has received important practical and technical support from both the *Russian Space Agency* (RSA) and *European Space Agencies* (ESA).

1.2 Project Objectives

The overall objective is to set up a qualitative and quantitative assessment of the Russian market in the short-term (1-3 years) and mid-term (5 years) focusing on the user requirements for earth observation (EO) data and in particular ERS/ENVISAT sensor data.

1.3 Specific Objectives:

- The market survey will a priori address the following four application areas; sea ice monitoring, environmental and pollution monitoring, boreal forest mapping, and geological resource mapping; in the industry, government, international agencies and research sectors (private and public) at the local, regional, and national level.
- The survey will focus on the users requirements and identify the role of integrated use of EO data to satisfy the users needs.
- Identify the geographical and seasonal demand for EO data.
- Identify the required data volume and its market value, including assessment of the readiness and willingness to pay for EO data.

Figure 1-1: Map of the Russian Federation with names used in the report on major regions and ocean areas.

2. The Market Survey Study Approach

The market study approach is based on some constraints in order to obtain an overview of the potential market for use of SAR data over the territories of the Russian Federation. The main focus is to investigate the potential market for use of SAR data among the Russian users. The potential international market comprising non-Russian institutions operating over Russian territories has been limited to a selection of some institutions involved in applications areas for SAR.

The application areas for use of SAR data have been limited to four, which have been selected under certain criteria. The applications have also been selected with respect to suitability for development of synergetic use of EO data from European and Russian satellite sensors. The survey does *not* include EO applications dedicated to military or defence operations.

2.1 Selected Application Areas

In order to perform a survey of the market for EO data, the application areas and final information products need to be clearly defined. Limited project resources and logistical problems in acquisition of information from various user categories necessitated a selection of the actual application areas and users categories to be investigated in further depth. In the base line for the project, 10 relevant application areas for SAR data were investigated. These application areas covered:

- Agricultural Mapping
- Boreal Forest Mapping
- Cartography
- Climate Application Studies
- Environmental Monitoring
- Fisheries applications
- Mapping of Natural Resources
- Risk Management
- Sea Ice Monitoring
- Urban Planning

In the selection procedure, to limit the final number of application areas to be investigated in depth, the following criteria were used as a basis for selection:

- the maturity of each of the EO data application areas;
- the number of potential customers, both within and outside Russia;
- the willingness of users to pay for the EO data/services;
- the frequency of EO data requests and
- match with priorities of the Russian EO program.

In reality it was difficult to evaluate all these aspects without having performed an initial survey of the market and its demands. Hence the major focus was given to the first and last items, which implies that the maturity of the EO application products from both a Russian and European point of view was investigated. Also, the strategic focus and priorities of the two Space Agencies in the development of the application market for SAR data was taken into

account in the evaluation.

Since the ICEWATCH project formed the basis for the initiation of this market survey it was natural to take advantage of this application area with integrated Russian and European data products. Sea ice monitoring by SAR in support of ship navigation is also one application area with potential for growth, particularly as replacement for traditional observation methods. Such observational schemes (e.g. use of airborne survey, coastal and ice station observation network) have become too expensive to be used operationally on a regular basis and parts of this infrastructure now seem to have vanished.

Sea ice: Based on the experiences from the ICEWATCH project, the application of spaceborne SAR data for use in operational sea ice navigation has reached a high level of maturity within the relevant Russian and international user community with operations in ice-covered Russian waters. The task of preparing ice information is a national Russian activity, which has to be used by those operating in ice-covered waters of the Russian Federation.

Environmental Monitoring: The Russian Federation is very rich in natural resources including oil, gas and a wide range of minerals. Detection, use, production and protection of these resources are hence of great importance to both industry as well as the national and local authorities. Environmental monitoring to support sustainable and environmentally safe management of oil and gas resources is of great concern to Russian authorities at regional and national level. Monitoring efforts are initiated and maintained through regional authorities and funded through taxation of the industrial enterprises. The use of satellite EO data in this respect is well developed, based on a number of Russian and international satellite sensor systems, although SAR data are currently not well-exploited in this respect.

Natural Resources: The vast and remote areas of the Russian Federation contain a wide range of natural mineral and other resources. Several efforts, some quite successful, have been made in the Russian Federation to detect various mineral resources of significant value and use. The methodologies used are mainly based on optical EO data, although the large areas in winter darkness and frequent cloud cover and haze, stimulates investigation on the use of active microwave EO sensors such as the SAR.

Boreal Forests: The Boreal forests in Russia are one of the major resources of both regional and national concern with important impact for both the public and private sectors. A national network, based on regional monitoring nodes and extensive use of optical EO data, has been built up for monitoring the available resources, their condition and state, including health conditions and external threats such as forest fires, as well as the use and exploration of the forest resources. The applications of SAR data from the view of the resource management industrial exploration as well as with respect to the role of the Boreal forests in the context of global change emphasise the potential of this application area for development of SAR applications within the Russian Federation.

For all the above EO application areas, with possible the exception of mapping of the natural resources, the applications require repeated data coverage in order to detect the changes in the environment as well as to meet the monitoring requirements of each of the different application areas. Developments within these application areas are also among the foci of the RSA priorities (see Ch. 0) and the use of SAR data are complementary to the currently available Russian optical and microwave EO sensors.

In conclusion the project adopted the following four major application areas to focus on within the market survey:

1. Sea Ice Monitoring
2. Monitoring of Terrestrial and Marine Oil Pollution, including Environmental

Monitoring of the Northern Territories (regional authorities)

3. Boreal Forest Mapping
4. Mapping of Natural Resources (geology)

2.2 Information Material - Application products

Information about state-of-the-art applications and information products based on SAR data are essential for successful survey of the actual and potential use of this type of EO, within the four selected application areas. Although much information is available to the Russian user community, linguistic and other reasons still cause a limitation in the awareness of both EO data and the applications thereof.

In order to increase the awareness and on this basis to become better suited for performing a more realistic survey of the potential use of SAR data among users in the Russian Federation, information material was regarded as essential. In this respect information material from ESA, RSA, and the project partners were distributed and used. The project team also produced four-page brochures for each of the four main application areas. These brochures were produced in the Russian language for extensive use and distribution throughout the project, including to all participants at the three workshops in St. Petersburg, Moscow and Novosibirsk.

Through ESA ESRIN EO Help Desk ESA information materials were requested, including:

- "ERS & Marine Applications" (BR-128/I)
- "ERS & Land Applications" (BR-128/II) and
- some other brochures (SP-1185, SP-1221, SP-1176/I-II, BR-134, etc.).

The material was shipped directly to the ESA Office in Moscow for use at the workshops and in the survey. In addition both SPOT Image and the Nansen Center provided information material on various EO applications available from the institutions. Information material on the Russian EO data, satellite systems and their applications were provided by NITs IPR for distribution through the project.

A dedicated Web site for the Project was designed and installed at a server in Moscow (http:\\www.ocean.geogr.msu.su\eoma.htm). The site contains information in Russian language about the Project aims, application areas, project team, as well as examples of application of satellite imagery for the four areas - sea ice monitoring, oil pollution monitoring, boreal forest mapping and natural resources mapping. The content of the project web-page is similar to the information given in the technical material presented in Ch. 2.2.1 and Appendices A.2 - A.5.

2.2.1 Technical Information Material in the Russian Language

Based on information collected from various sources ESA promotion material and other information sources available among the project partners, NIERSC have produced four information brochures in the Russian language (four pages each, included in external Appendices A.2 to A.5). The topics of these brochures are on the main application areas, which were the selected foci of this market survey:

1. Sea Ice Monitoring
2. Oil Pollution Monitoring
3. Forest Monitoring, Inventory and Mapping
4. Natural Resources Exploration and Mapping

The folders are based on information collected from various ESA material, such as "ERS and its Applications: Marine", "Applications Achievements of ERS-1 - New Views of the Earth", "Earth Watching. Anthology", "Use of ERS-1 SAR data for Agricultural, Forestry and Environmental Applications in Central-Eastern Europe". Other information sources available to the project partners (SPOT IMAGE, Nansen Center) were also used in those brochures.

The information content of brochures reflects the Earth Observation data applications for environmental monitoring and research activity within the four application areas.

Particular focus on near real-time use of EO data for sea ice ship navigation is given in the brochure "*Sea Ice Monitoring*". The main principles of sea ice monitoring and ERS/SAR data advantages for the Arctic Seas ice survey are presented. The joint project activities between NERSC, NIERSC and Murmansk Shipping Company is illustrated by combined use of European (ERS-2) and Russian (OKEAN) satellite data within the ICEWATCH project. An example of the sea ice classification procedure is given. Future satellite systems, such as ENVISAT and RESURS-ARCTICA are suggested for future follow-on sensor systems.

The main steps of oil spill surveillance are presented in the brochure - "*Oil Pollution Monitoring*". The key information concerning oil spill monitoring with focus on the use of SAR data is given. The main elements of image analysis for oil detection are outlined. The experience of Norwegian Oil Spill Monitoring Service based on combined use of satellite and ground-based data is illustrated.

The state-of-art applications of ERS SAR data for mapping of natural resources are presented in the brochure "*Natural Resources Exploration and Mapping*". Some ERS/SAR data applications for mineral exploration are listed and illustrated. Integrated use of satellite and in-situ data for image analysis is shown. The two main ERS instruments (SAR and Radar Altimeter) application for oil exploration are illustrated.

The applications of ERS/SAR data for forest monitoring are presented in the brochure - "*Forest Monitoring, Inventory and Mapping*". Earth Observation data applications for localisation of forest fires, forest inventory and mapping are illustrated. The benefits of techniques based on the combined use of different satellites (ERS/SAR, LANDSAT/MSS) are demonstrated through an example for the St. Petersburg Region.

2.2.2 Dedicated ERS-2 SAR Data Requests

Prior to and during the completion of the actual survey it became clear that a range of experienced EO data users also would like to get relevant ERS SAR data examples from their own investigation areas. Through the survey a list of such relevant investigation areas within the Russian Federation were made and an order for these SAR data to the ESRIN ERS data service were made. The data request covers around 20 sites within Russia (see Table 2-1 and Figure 2-1). For demonstration purposes the Nansen Center has performed geo-location and some pre-processing of the data and made hard copies for distribution to the relevant users within each area. Distribution of digital PRI data has been done to some of the user institutions who have their own, or through NIERSC, capabilities to perform dedicated analysis of the data. During the workshops several participants had additional requests to obtain ERS SAR data coverage for areas of their specific interest. These SAR data were distributed to the contacted institutions and authorities, located in different regions of Russia: Kola Peninsula, Arkhangel´sk region, Polar Ural region, Yamal Peninsula, Western Siberia, Eastern Siberia, Altay, Khakassiya and Sakhalin island.

For these SAR data the main applications and investigation areas are:

- mineral resources deposits of Apatity and environmental monitoring (Kola Peninsula);
- Lomonosov Diamond Deposit, Onega Peninsula National Park, forestry and environmental monitoring (Arkhangel'sk region);
- mineral deposits and environmental monitoring (Polar Ural region),
- Cape Kharasavey and Bovanenkovo oil/gas fields and environmental monitoring (Yamal Peninsula);
- oil/gas deposits, forestry, water and soil pollution and environmental monitoring (Western Siberia: Khanty-Mansiysk, Surgut, Tomsk, Tumen - Priobskoye oil/gas deposit);
- forestry, quality of waters and environmental monitoring (Eastern and Central Siberia: Tunguska, Novosibirsk, Chany saline lakes),
- cities, mountains and steppes monitoring, agricultural and environmental monitoring (Altay, Khakassiya, Krasnoyarsk);
- Oil/gas deposits of shelf zone and sea ice navigation (Sakhalin island).

Some publications are under preparation based on integrated use of the SAR data with the regional expertise and data provided by the contacted institutions.

Figure 2-1: Location map of the sites of SAR data for demonstration purposes used in the market survey study (see Table 2-1 for site names and locations).

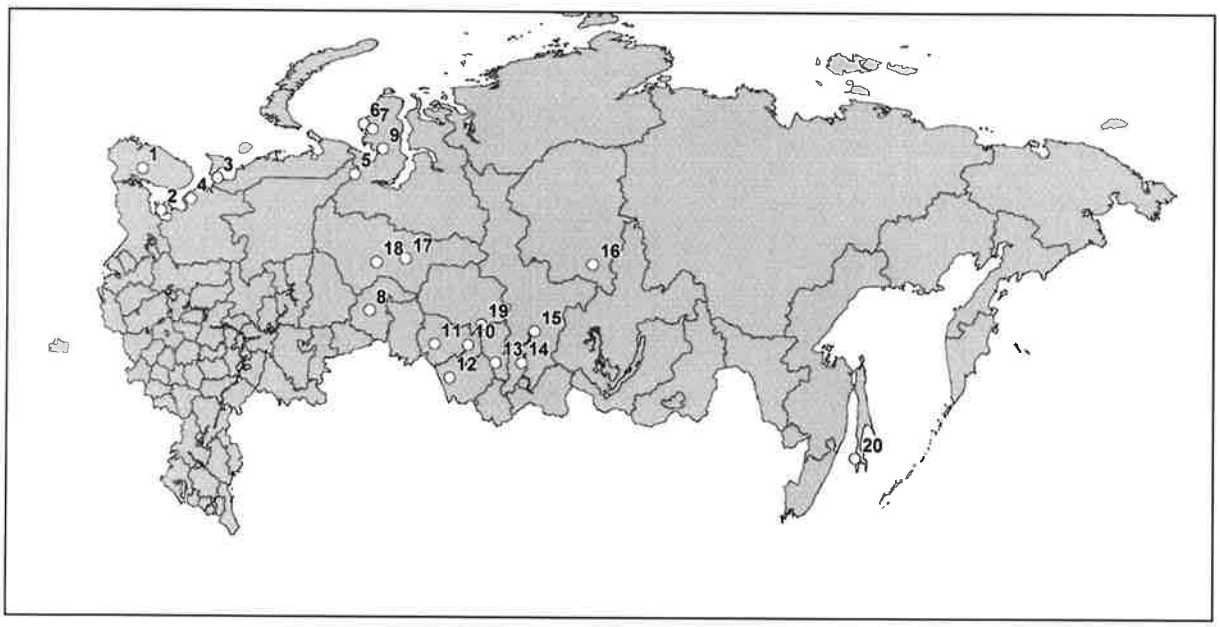


Table 2-1: Summary of the requested ERS SAR data from various locations in Russia. The data has been distributed for demonstration purposes to various users within the Russian Federation.

no	Date	Orbit	Frame	Lat.(N)	Min	Long.(E)	Min	LOCATION
1.	010897	11928	2223 2241	67	40	33	40	Kola Peninsula
	101097	12930	2223 2241					
2.	140695	0777	2295	64	40	36	30	Onega Peninsula
	230797	11799	2295					
3.	070796	06345	2241	67	00	45	00	Kanin Peninsula
	270896	07075	2241					
4.	090697	11169	2277	65	30	41	00	Arkhangel´sk region
5.	170797	11712	2241	67	20	65	40	Polarny Ural
6.	040896	6745	2169	70	58	67	00	Kharasavey
7.	170797	11712	2169 2187	70	36	68	17	Bovanenkovo
8.	240898	17487	1143 1161	57	30	68	00	Tumen
9.	041096	7618	2187 2205	69	10	69	50	Yamal
10.	050798	16764	2475 2493 2511	55	02	82	57	Novosibirsk
	090798	16828	1089 1107					Novosibirsk
11.	020898	17165	2475 2493 2511	55	05	77	50	Chany
12.	060798	16807	2529 2547	52	39	80	09	Altay
13.	140698	16470	1053 1071 1089	53	45	87	07	Novokuznetsk
14.	100798	16842	1071 1089	53	45	91	05	Khakassiya
15.	300598	16255	1107 1125	56	02	93	04	Krasnoyarsk
16.	180698	16520	2367 2385	60	53	101	54	Tunguska
17.	170898	17380	2367 2385	61	15	73	24	Surgut
18.	220798	17008	2367 2385	60	59	69	01	KhantyMansiysk
19.	020798	16721	2457 2475	56	29	84	58	Tomsk
20.	150196	3857	0927 0945	46	57	141	44	Yuzhno Sakhalinsk
	180498	15645	2655 2673					Yuzhno Sakhalinsk

2.3 The User Survey Questionnaire

The philosophy behind the questionnaire development was to obtain very detailed information on the activities of each potential user to be contacted. The reason for demanding such a high level of information from the respondents to the questionnaire was the fact that one expected that most of the information would be obtained through direct interviews with the various potential users. These types of personal interviews would require a significant effort from the project team and hence the information acquisition through the personal interviews could be more extensive than in other types of market surveys, where the contact with the client is more indirect. The final version of the questionnaire (Annex A.2) was developed through an iterative process of the forms in respectively Russian and English versions.

The expected a priori knowledge of the application areas for SAR data in general was expected to be limited among a large part of the potential Russian EO user community. Based on this assumption it was planned that the customer contacts also would contain a significant element of information dissemination on the potential application areas of SAR prior to assembly of the actual information from the users.

The level of information requested from the users through the questionnaire was acquired at three levels;

- the organisation type and its role, included its activity areas, clients, and funding sources
- detailed description of the main information requirements to meet the tasks of the organisation
  - type and sources of information, geographical coverage, frequency and scales of information
  - financial resources and expected development of the activity during the coming years
- assessment of the role of EO data in current as well as future activities of the organisation.
  - use of other types satellite EO data and for what applications,
  - requirements on processing level of EO data and the limiting factors for their use in the organisation.

  In addition the information on the correct address etc. of the organisation and contact persons was included.

Based on the acquired information and impressions obtained during the interview, the project team made an assessment of the potential for respectively future "purchase" and /or "use (application)" of satellite SAR data as an information source for their activities. The evaluation of the respondents was, partly subjectively, ranked "high", "medium", "low" and "unable to evaluate".

The questionnaire is made in an appropriate relational data-base version based on Claris FileMaker Pro 4.0 for the statistical analysis of the information.

In order to obtain a representative survey of the potential Russian clients for synergetic use of ERS and ENVISAT SAR in combination with other EO data, the information retrieval from the users was done subsequently according to the following scheme;

- identification of key organisations - potential EO-data users - using various information sources available: personal contacts and experience of the project partners, various on-going scientific and technical conferences, evaluation of workshop materials, reference-books, etc.;
- a preliminary lists of the potential EO-data users – respondents to be contacted;
- selecting the actual channel/means to get the first contact with the potential EO-data

users: either personal (visits, presentations, interviewing, discussions, workshops, etc.) or indirectly through information distribution via fax, e-mail, mail, etc.;

- distribution of information packages concerning the key application areas for the survey, as well as a cover letter and the questionnaires to be completed;
- acquiring, implementing, organising and processing the information obtained from the users; and
- creation, maintenance and statistical analysis of the acquired information in a central relational data base for the project.

The selection of user organisations has been done on the following principles: (i) relevance; (ii) representativity; (iii) whether organisation is an existing or potential user of satellite data; (iv) possibility to get in contact and to receive an adequate reply.

The completion of the questionnaires was done through both personal interviews and to a minor extent through distribution of the questionnaires and project information to the identified users. The latter approach was evaluated though a group of around 80 organisations in the St. Petersburg region as well as to 112 oil companies and forestry agencies. For this non-personal approach the feedback ratio was very modest, with only responses from those also directly contacted by other means. Personal contacts require much more time, efforts and competence by the interviewer, but at the same time this approach proves to be fruitful and the received information is more relevant, objective and complete. The most efficient way to conduct an interview turned out to be when the responding person fills in the questionnaire and the interviewer make clarifications if necessary. Also additional information was obtained during the interviews, which was taken into account in the evaluation of the information obtained.

2.4 The Regional Survey Activities

The questionnaire survey was conducted by the Project Team in various part of Russia. All information obtained was assembled in a common data. The geographical regions covered are;

- the north and north-western part of Russia
- the St. Petersburg region
- the Moscow region
- the Siberian region
- remaining parts of the Russian Federation

2.4.1 North and North-Western parts of Russia

Prof. V.V. Melentyev (NIESRC) completed a trip to Murmansk, Apatity and Arkhangel'sk (north-western part of Russia) from 6. - 16.10.98, during which interviews were arranged and questionnaires distributed among potential users of EO data. The total number of organisations visited was 47. Through participation in a technical fisheries conference – "Century of the Industrial Fisheries in Russia"- in Murmansk, a large number of organisations involved in fisheries from all over the Russian Federation were informed about SAR applications and interviewed for the market survey.

The northern parts of Russia were covered during Prof. V.V. Melentyev's business trip to Salekhard and Khanty-Mansyisk (28.10. - 11.11.1998). The Committee on Environmental Protection of Yamalo-Nenets Autonomous District (YaNAD) provided efficient assistance and an official letter signed by the Head of YaNAD Environmental Committee (Mr. Ershov)

accompanued the project information sent to 18 oil/gas companies in the region. Interviews and consultations with representatives of 7 large YaNAD companies of various types of field of activities were carried out. In co-operation with YaNAD Committee on Environmental Protection, meetings with regional executive officials were arranged. The total number of visited organisations in Salekhard was 42.

A visit to Khanty-Mansyisk was also arranged with the support of the Regional Committee on Environmental Protection. A number of organisations (mostly oil and gas and mining companies) were visited. Totally 17 organisations were involved in the market survey in the region.

2.4.2 The St. Petersburg region

Dr. O.Eu. Korotkevich, NIERSC, was responsible for the regional survey. After an initial survey by post among 83 organisations in the region, personal meetings and detailed discussions were arranged with leading and business executives of the 31 most relevant organisations. Among these, 23 institutions were identified as having specific interest and requirements for EO data within the four identified and other application areas. The information about the EO-data market survey in the St. Petersburg region is summarised in Table 2-2.

Table 2-2: The market survey of potential EO-data users for different application areas.

Ways of getting information	**Application areas**					
	Ice cover	Forest cover	Env. monitoring	Nature resources	Others	**Total**
Questionnaires sent	10	27	26	8	12	**83**
Organisations visited	6	6	10	5	4	**31**
Replies received	6	2	8	4	3	**23**

2.4.3 The Moscow Region

Dr. A.V. Kouraev (NIERSC) completed during the project period questionnaires for 43 organisations of various types operating in the four specified application areas. Of these 18 questionnaires were completed through direct interviews. Through project participation at a technical seminar on use of satellite data within forestry (in Moscow, 18. November, 1998) additional 13 replies were obtained, from about 30 relevant participants. At the project user demonstration workshop at ESA Office in Moscow, information from additional two participants were obtained. Through personally agreed mail and faxes additional three were reached and by on-ward distribution of questionnaires through prime contact additionally seven replied.

In addition, a direct mail survey was initiated and 112 letters were sent to Russian oil companies and to 12 state forest management bodies all over the Russia. The positive success rate of this survey was as low as around 10%, although the visibility and marketing effect of the project has later turned out to be more significant than the actual number of replies indicates.

2.4.4 The Siberian Region

Prof. G.V. Erokhin (SRCS) performed an in-depth analysis of the state of the EO data market and user requirements within Siberia, which was done through completion of the questionnaire by identified potential users of EO data. More than 50 questionnaires were distributed among the organisations and enterprises of Siberia. About 30 organisations and enterprises from all Siberian regions replied and returned the filled questionnaires (some in duplication with the NIERSC survey).

2.4.5 The Moscow Region and other parts of the Russian Federation

NITs IPR, as a main distributor of Russian EO data, used its current network of around 40 clients as a baseline for completion of the questionnaires. These organisations covered mainly governmental organisations funded through the state budget and some commercial joint-stock companies partly owned by governmental shareholders.

The qualitative and quantitative and analysis of the information content of the questionnaire survey is presented in Ch. 4.1.

2.5 The Regional Thematic Workshops

Based on an initial analysis of the questionnaire survey three locations were selected for the project workshops – St. Petersburg, Moscow and Novosibirsk. In order to obtain the user specific information of relevance for the market survey, it was necessary to include a major part of information about the availability and potential applications of ERS SAR data in the context of the program of the workshops.

For the workshops, all project partners have prepared contributions and shared information material among each other for use in the preparation of the oral presentations. The viewgraphs for the overview presentations given by the Nansen Center in English were partly translated to Russian. The viewgraphs for all the technical presentations, to be given in the Russian language, were made in or translated to the Russian language. Linguistic issues did not introduce any problems in the completion of the workshops and in the information exchange process associated with the workshop completion.

The technical presentation program for the workshops included:

1. *Workshop Background, Objectives and Tasks – NERSC*

   The project organising the workshops is based on the RSA & ESA co-operation in the ICEWATCH project. The history of using ERS SAR in the Northern Sea Route (NSR) for ice navigation since August 1991 was described through major highlights. The combined use of Russian and European satellite data was emphasised, for both navigation, offshore industry and environmental and climate studies in the NSR. The user workshops are a part of a market survey and the objectives and methods for these investigations were presented. An overview of the thematic focus of the workshops, the four main EO application areas, and the expected outcome of the project were given. The aim of ESA to establish an ERS/ENVISAT SAR receiving station in Russia, to stimulate integrated use of both Russian and European EO data as well as definition of the requirements to an EO data supply mechanism concluded the presentation.

2. *The ESA Earth Observation program – NERSC*

   A review of the ESA ERS program, its sensors with focus on the SAR instrument and the global SAR acquisition station network including the current lack of coverage of major

parts of Russia were presented. A review of the three major purposes of the ERS mission; the scientific achievements and applications; the human quality of life and its direct applications; and the competitive industry development from the ERS mission, with focus on the two first were presented. The way forward with ENVISAT was described including the mission overview. Concluding with the METOP and Living Planet (Earth Watch and Earth Explorer) programs was the planned way for the future.

3. *The Russian Earth Observation program – RSA and NITs IPR*

   The main objects of RSA and NITs IPR activity were presented, with respect to the launch history and schedule of the main meteorological, natural resources and environmental monitoring earth observation satellites and sensor systems. The technical parameters of Russian satellites "RESURS-O1" and "OCEAN-O1" were shown for earth observation. The benefits of different data archives were described. Among future RSA plans are the launch of the radar satellite "RESURS-ARKTICA" for Earth observations and improving the availability of archive EO data in standard format via Internet.

4. *Ice navigation applications – NIERSC*

   A technical presentation on the development of use of sea ice information in support for ship navigation in the Northern Sea Route (NSR). Particular focus was given to the opportunities in applications of microwave EO data, particular from SAR, for near real-time use in ship navigation in sea ice. The presentation used the experience of the ICEWATCH project to describe the various elements involved in this type of operational application. A technical description of the key elements from data acquisition and processing to data transmission and onboard applications and analysis was given. The application was demonstrated through analysis of various images from the NSR for navigation and mapping purposes (e.g. pipeline planning). The presentation was completed with the CEC project Arctic Demonstration and Exploratory Voyage (ARCDEV) during which a Finnish tanker was escorted from Murmansk to the Ob estuary in April 1998.

5. *Environmental Mapping and Monitoring – NIERSC*

   The use of satellite data (SPOT and ERS-1, 2) for oil spill monitoring was presented. Main steps of image analysis for water oil spill were presented. The ERS-SAR data application for marine oil pollution monitoring in Norway was presented. Combined use of satellite and ground-based data was shown in the example of the Usinsk (Komi Republic, Russia) pipeline accident. The advantages of ERS-SAR and SPOT data for monitoring of technological (marine pollution) disasters and natural (flood) disasters were presented.

6. *Forest Mapping and Monitoring – NIERSC & International Forest Institute (IFI), Moscow*

   The forest mapping and inventory is one of the main fields for satellite data applications in Russia. The techniques of using different satellites (NOAA, SPOT, RESURS and LANDSAT) for localisation of forest fires, forest clear cutting and forest insects damage detection were presented. GIS applications for forest fire protection were shown on the example of Far East forest fire in 1997-1998 years. The benefits of ERS-SAR data applications for forest monitoring and mapping were shown. Combined use of satellite and ground-based techniques for forest state assessment was presented for test areas in the St. Petersburg and Moscow regions.

7. *Natural Resources – NIERSC*

   The application of ERS data for natural resources monitoring were presented. The benefits of ERS SAR data for studies of lineaments and tectonic structure were shown. The

advantages of combined use of satellite and ground-based data for mineral explorations were discussed. The EO data applications were shown in an example of detection of oil deposits in the coastal areas. The Earth surface deformation measurements were presented by using SAR differential interferometry. The examples of EO data applications for ground displacement monitoring related to extensive coal mining were described.

8. *Practical use of satellite data in Russia – SPOT Image*

   State-of-the-art of the SPOT program was presented. The technical parameters of SPOT-4 were shown. The advantages of SPOT image data access were described. Examples of SPOT images applications for monitoring of Russian territories were presented.

9. *Applications of Russian remote sensing data – NITs IPR*

   The Russian systems for satellite data processing were presented. The benefits of NITs IPR satellite data archives were described. Examples of data from "RESURS" for monitoring of pipelines, river run-off and snow pollution were shown.

10. *Siberian Accord, SRSC (Novosibirsk only)*

    Siberian Accord is an interregional association ("non-governmental amalgamation") of economic cooperation between the 19 territories (states, republics, krais, oblasts, autonomous districts) of the Russian Federation within Siberia. The Siberian region covers 38% of the Russian territory (10.000.000 km^2) with a population of 24.4 mill people. The region is rich in natural resources, such as wood, coal, oil, gas, iron and other minerals. The Siberian Accord has a defined policy to utilise EO data for environmental and resource monitoring due to its geographic structure and large areas. Due to winter darkness and frequent haze and cloud cover the high latitude regions can significantly benefit from use of microwave EO data.

    EO data have been used in the different Siberian Research Institutes and administrative institutions. The scientists from the Ecological Monitoring Institute (Barnaul, Aliay Krai) have been working 12 years in remote sensing.

    The Siberian Space Monitoring Center (Novosibirsk) was established with the main objective to develop regional applications of EO data (RESURS) for ecological monitoring of oil spills in the soil, forest fires, etc.

11. *Workshop discussion and participant contributions – NERSC/NIERSC*

    The discussion deals with the satellite data accessible to users, the applications of satellite data for ship navigation (Arctic Region of Russia); pollution and vegetation monitoring in oil-gas exploration regions, the applications of satellite data for forest management and monitoring. The participants discussed the aspects of image processing and image format standardisation for users and new satellite stations locations.

The three workshops were completed on 9. December in St. Petersburg, 11. December in Moscow and 15. December in Novosibirsk. Invited organisations 44 of 35 participated in St. Petersburg, 31 of 23 in Moscow, and 70 of 50 in Novosibirsk.

Project Staff Participation with presentations at the Workshops:

NERSC:	Mr. Lasse H. Pettersson
NIERSC:	Dr. Leonid P. Bobylev, Prof. Vladimir V. Melentyev, Dr. Lola A. Kotova, Dr. Victoria V. Donchenko, Dr. Oleg Eu. Korotkevich (St.P), Dr. Sergey A. Bartalev, IFI (Moscow), 5 administrative staff in St.P., and Dr. Alexei Kouraev (adm. in Moscow)
SPOT Image:	Mr. Evgéne I. Krivtchenko, (Russia representative) (all)
ESA:	Mr. Alain Fournier-Sicre (Moscow)
NITs IPR:	Dr. Alexey M. Volkov (St.P. and Moscow), Dr. Vitaly I. Khizhinitchenko (all)
SRCS:	Dr. Gennady N. Erockhin (Novosibirsk) and 9 administrative staff.

3. The National Market for Applications of Russian EO Data

This section gives an overview of the existing Russian market for EO data. It contains elements of the official policies, the actual satellite data acquisition and distribution as well as the applications of EO data for various environmental purposes. The information is mainly based on sub-reports from the Russian project partners (see Annexes A.6 to A.8).

3.1 Russian Remote Sensing Data Market - An Overview

The vastness of the territories of the Russian Federation, their frequent remoteness in accessibility, the need for the development of various regions of Russia, have all led to the widespread use of satellite earth observation data for industrial, agricultural and environmental mapping and monitoring. As a result, there exists today a diversified and structured system of Earth Observation (EO) data acquisition, distribution, processing and delivery, including various organisations.

The general Russian EO policy is defined by the following governmental bodies:

- Russian Space Agency (RSA),
- Federal Service for Hydrometeorological and Environmental Monitoring (Roshydromet),
- Federal Service of Geodesy and Cartography (RosKartografia),
- Ministry of Defence and
- State Committee on Ecology.

These organisations and others, including the Russian Academy of Sciences (RAS) have developed a "*Federal Space program up to the year 2000*", in which the current remote sensing policy is reflected. The policy includes EO systems that will:

- provide information to the weather forecasting services,
- improve meteorological and ice monitoring information for the Northern Sea Route,
- reduce costs of geological and agricultural activities,
- provide necessary information for forestry and water resource management,
- give information for harvest forecasting,
- determine and forecast productivity of fishing areas and
- enable pollution monitoring and improve mitigation efforts.

The government of the Russian Federation approved a *Concept for State Space Policy* on 26. May, 1996. This document determines the priorities of the Russian Space Agency in a broad range of areas such as [Efimov and Miller, 1997]:

- creation, modernisation and application of space systems and complexes of social-economic importance,
- provide operational/regular spaceborne EO data to federal agencies, ministries, organisations, regional services and other users,
- appoint the main operator of the "Resurs-O" satellite, and provide regularly the users with data from MSU-E and MSU-SK sensors,
- provide calibrated satellite EO data and derived thematic information products and interpretation,

- provide services for manufacturing and delivery of ground acquisition stations and
- perform pilot demonstration projects for applications of satellite EO data for use in environmental studies.

According to the adaptation of the EO policy and the implementation of necessary technological infrastructure, data are acquired and distributed to the Russian user community. Based on the new knowledge obtained using EO data in support of the decision process a feedback process is adopted to implement relevant changes to the EO policy (Figure 3-1).

The Russian organisations operating within the Earth Observation and Geo-information market can be divided in the following categories [Miller, 1997, Miller, 1998]:

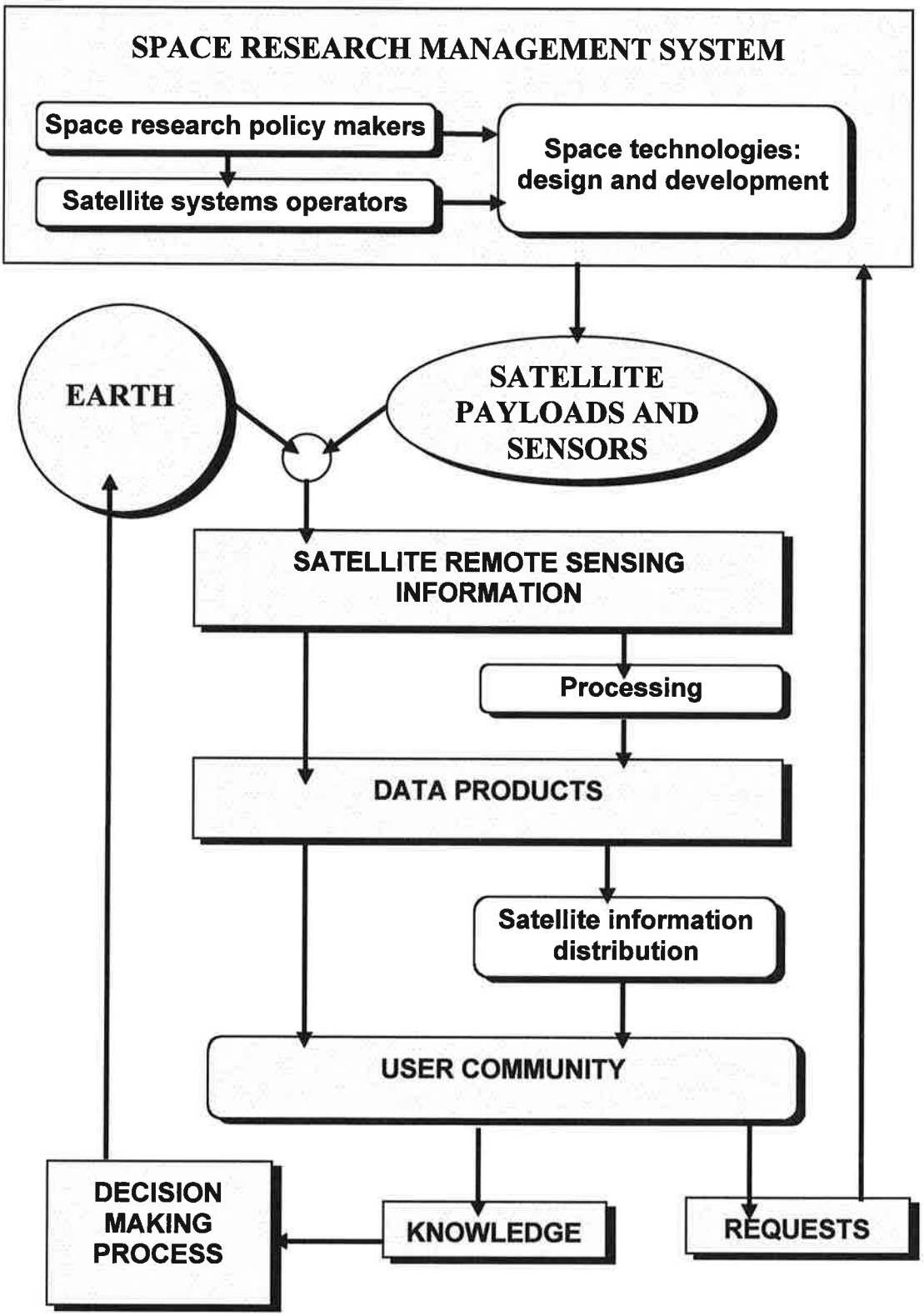
- State management structures
- Remote sensing data providers (acquisition and archiving institutions)
- End-user organisations
- Providers of software for data handling and thematic processing
- Providers of specialised hardware (computer peripherals, ground stations etc.)
- Educational and consulting organisations
- Organisations and companies providing value-added EO based services and products.

At the Federal level the following key organisations are identified as the main users of Earth Observation data:

- Russian Space Agency
- Federal Service for Hydrometeorological and Environmental Monitoring (Roshydromet)
- Federal Service of Geodesy and Cartography (RosKartografia)
- Ministry of Defence
- Ministry of Emergency Situations (MChS / EMERCOM)
- Ministry of Agriculture
- Ministry of Natural Resources (MPR)
- Ministry of Internal Affairs (MVD)
- Federal Security Service (FSB)
- Ministry of Combustible Fuel and Energy (Mintopenergo)
- Ministry of Education
- Ministry of Fisheries
- Gosstroy (Ministry of Construction)
- State Committee of Ecology (Goskomecologiya)
- Federal Forest Service
- State Committee for Land Use (Goskomzem)

A new rapidly growing EO market segment is represented by the regional and local authorities of various regional entities of the Russian Federation (e.g. republics, krais, oblasts, autonomous districts, cities). The traditional market segment exists among commercial companies (value-adding services, shipping companies, users of natural resources, etc.), scientific and scientific-production organisations.

Figure 3-1: The general structure of Russian Earth Observation data system.



3.1.1 An Assessment of the Market for Russian EO data

For the vast territories of the Russian Federation it is necessary to use remote sensing data for environmental monitoring as well as to obtain information about natural resources for their sustainable and cost-effective utilisation. Since the end of the seventies, the use of remote sensing data in Russia has been developed under a free of charge distribution policy. A dedicated implementation policy by the Russian Space Agency has led to a gradual manifestation of the role of remote sensing data as a state-of-the-art source of information for various Russian organisations, as well as the development of new EO information technologies. In general, corresponding expenditures were included in space system costs. In the end of the eighties, GosNITs IPR, as a major national distributor satellite EO data for mapping of natural resources and oceanographic applications, provided data to more than 200 users.

From the beginning of the nineties Russian economy was oriented toward free market development causing a change in the satellite data distribution policy. In spite of the fact that the public budget funds most satellite launches and their use, satellite EO data are now mainly distributed on a commercial basis. During last ten years the Russian economy has been through periods of significant transition. For the development of an EO data market the resources allocated by different departments for purchase of satellite EO data has also decreased.

As a result, during the years from 1996 to 1998, the number of clients of the EO data service of NITs IPR has degraded to only 40. It should be noted that in the previous years users were satisfied, in general, by receiving lower level processed EO data in the form of photo products and applied the data for analyses and interpretation. The current clients demand higher level pre-processed digital data of varying thematic information content. A rather moderate price policy and increased availability of Russian satellite EO data as well as the development of the computer and commercial software market, both contribute to the increase in the number of the new EO data user organisations. For example, some new joint-stock companies were founded with involvement of the ministries, state departments and other public organisations, for carrying out environmental monitoring activities in the public sector for environmental protection, mineral resources exploration, etc. Such establishments are evaluating several options for cost-efficient completion of their tasks, including evaluation of the use of EO data sources.

In 1997 a round table discussion - "*Russian space and remote sensing market*" - was organised [Efimov, 1997]. Around 40 organisations participated in the round table conference, where various issues concerning Russian EO data market were discussed. The conference covered issues related to the main types of EO data, their advantages and limitations for use, user requirements for information and delivery, demands on processing level as well as supportive software tools etc..

According to the survey conducted at the round table, the frequency of use of various EO data were investigated (summarised in Figure 3-2). The most frequently used EO data sources are aerial photography and data from the Resurs-O series, which were used by 22% of the participants. High resolution photographic data (5 meter) from the KFA-1000 sensor and data from the NOAA AVHRR sensors were used by 19%, followed by information from MK-4 and SPOT sensors (16%). The Almaz SAR data are used only by 3 organisations or 9% of the participants, and the KATE-200 images by the same number of users. Other types of remote sensing data were only used only by two organisations, while data from the MIR space station were only used by the Centre for the Preparation of the Astronauts. The use of EO data from

other space agencies were almost absent among the participating organisations, although 6 % of the participants have used data from the ERS satellites.

A ranking of the hampering factors for development of the Russian EO data market identified the following issues [Efimova and Miller, 1997]:

80% - Complicated access to the information on availability, retrieval parameters and quality of EO data for a specified territory;

70% - difficulties to meet the users request for specific territorial data coverage by the Russian providers of EO data;

60% - lack of knowledge on satellite remote sensing possibilities and weak popularisation of satellite retrieval methods for geo-information;

60% - low data quality and consistency of Russian EO data as a commercial product (missing format standardisation, accompanying metadata, full information on survey conditions and sensor characteristics);

60% - lack of widely accessible information on digital thematic and topographic products (GIS products) that can be used in conjunction with the satellite EO data;

50% - lack of consumers demand (open discussions, marketing research) for surveys from Russian satellites and direction of research and design efforts;

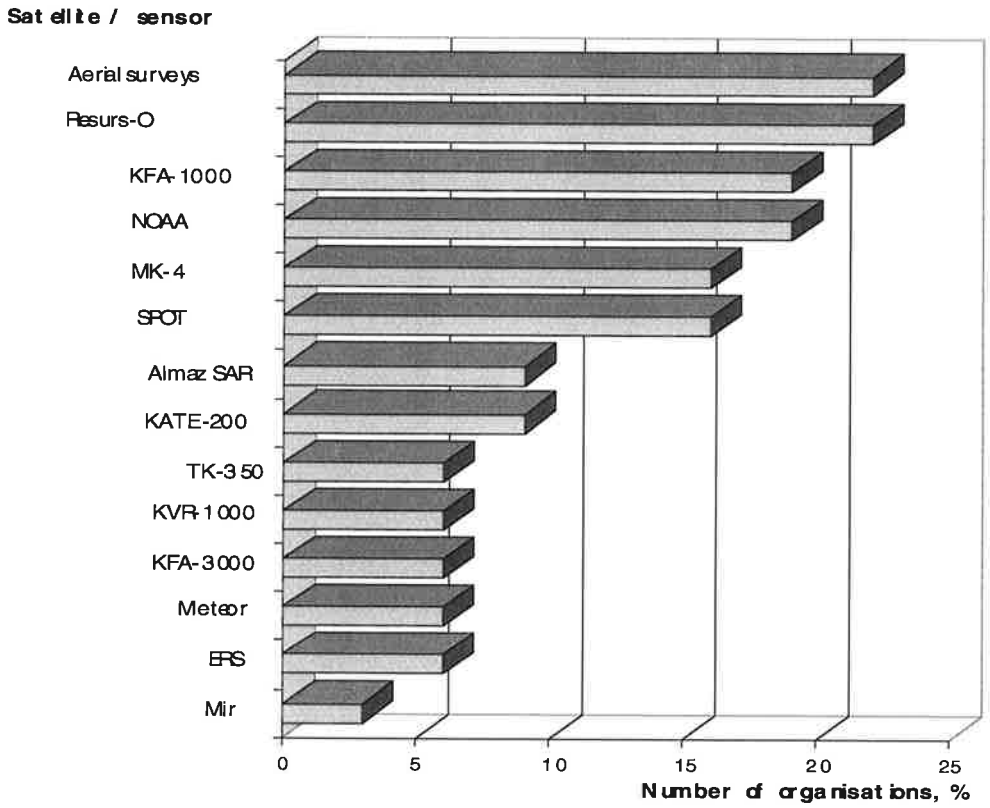
40% - unreasonable strict regime of secrecy concerning use of satellite and cartographic data;

30% - high prices for Russian satellite data;

The majority of the Russian user organisations (94%) use the EO data mainly in the digital format, while a similarly high percent of the users applies data in either raw format (Level-1) or as higher level processed information (81% of respondents). The most frequently used types of data processing routines includes according to Efimov [1997]:

- geometric correction and transformation - 81%
- radiometric correction - 68%
- filtering - 68%
- image quality enhancements- 68%
- original algorithms and methods - 65%
- automatic classification and pattern recognition - 58%
- image mosaicking, production of photographic plans and orthoplans - 45%
- atmospheric correction - 42%
- use of data after thematic processing - 32%
- digital terrain models - 26%
- production of high-quality photographic hard copies - 26%

Figure 3-2: The most frequently used EO data among Russian users [after Efimov, 1997].



The most frequently used image processing software packages in Russia for remote sensing data processing are [Efimov, 1997]:

- Erdas Imagine (19 %);
- ER-Mapper (12 %);
- Original own developed software (9 %);
- XV-HRPT - software developed by Space Research Institute (IKI) of RAS (6 %);
- ScanViewer - software from Engineering and Technological Centre "ScanEx" (3 %);
- Photomod (3 %); and
- IDRISI (3 %)

In general, a limited availability of commercial international image processing and GIS software also hampered the actual use of EO data among these users.

3.2 Overview of the RESURS and OKEAN Satellite Programs

The year 1974 marked the beginning of the era of environmental and natural resources Earth observation sensor satellites in the USSR. In this year the Meteor-18 satellite was launched and it was succeeded by a series of six other satellites, the last one - Meteor-31 - launched in 1981. The payload of these satellites comprised the multi-spectral optical sensors with low (MSU-M) or medium (MSU-S) spatial resolution. This series of EO satellites has been

followed by the launch of the Resurs-O1 satellite, which included the Kosmos-1689 in 1985, Kosmos-1939 in 1988, Resurs-O1 N 3 in 1994 and Resurs-O1 N 4 in 1998. The Resource-O1 series carried already the next generation multi-spectral opto-electronic scanning sensors of higher spatial resolution – the MSU-E - and the multi-spectral opto-mechanical conical scanning sensor of medium spatial resolution – the MSU-SK. At present Resurs-O1 N 3 is operational and Resurs-O1 N 4 satellite undergoes flight tests. Since April 1999 it has not been in operation due to serious technical problems with the data transmission from the satellite. The development of this EO program has mainly contributed to the development of terrestrial and coastal zone application within the Russian Federation and data are currently distributed for use world–wide under international agreements.

During the same period of time also the oceanographic earth observation satellite systems were developed in the Russian Federation. Earliest oceanographic EO satellite was the "Kosmos-1500" (launched in 1983), followed by "Kosmos-1602" (in 1984), "Kosmos-1766" (in 1986), "Kosmos-1869" (in 1987), "Okean-01" (in 1988), "Okean-02" (in 1990), "Okean-03" (in 1991). At present the Okean-O1 No. 7 satellite has been in orbit since 1994. The principal application fields for Okean-O1 satellite series are:

- operational sea-ice status study and estimation in the Polar regions for shipping along the Northern Sea Route and in the Antarctic, and for the Northern Seas offshore operations;
- study and estimation of structure and dynamics of sea ice and ice on large rivers and lakes;
- estimation of the flood-affected areas;
- support of emergency tasks;
- regional and global climate change studies and
- studies of sea surface macro- and meso-scale variability.

The main sensor on board Okean-O1 is the side-looking radar (SLR or RLSBO), which for the first time in the world made it possible to systematically make all-weather observations of land and oceans surface in the microwave range (3.2 cm, VV-polarisation) covering a swath width of 450-480 km. In particular, this sensor made it possible to provide monitoring of the meso-scale sea ice conditions for the entire Arctic seas at a frequency of at least twice per week.

During May 1999, the Okean-O N1 satellite is scheduled to be launched following the series of the Okean-O1 oceanographic satellites. The sensor payload has been considerably extended as compared to the Okean-O1 N7, and the data will be downloaded through a digital link at a rate of 61.44 Mbit/s to dedicated acquisition stations. In particular, the MSU-S optical sensor will be replaced by the more modern scanners MSU-SK and MSU-V. The latter sensor has high ground resolution (50 meter) in the visible and near-infrared (IR) ranges and medium resolution in the middle and far IR ranges. The spectral band locations for the MSU-V sensor is the same as for the Landsat Thematic Mapper (TM), and hence will mainly improve the land surface and coastal zone monitoring applications. Okean-O N1 will also carry another new sensor - the scanning multiband microwave radiometer Delta-2 designed for atmospheric studies. In contrast to earlier Okean satellites, the Okean-O N1 satellite will operate in a sun synchronous orbit and becomes a multi-sensor platform for studies of the atmosphere, natural land resources, as well as the coastal, ocean and ice covered water regions .

During 1999 the Meteor-3M N1 satellite is also due to be launched. The payload is more developed than in the previous Meteor series. The orbit will be sun-synchronous and new

digital data down link will give significant improvements for data distribution. The new sensor payload includes a limb atmosphere sensing sensor - SAGE III, a contribution from USA - designed for the estimation of atmospheric gases content, including ozone, other trace gases, as well as aerosol content.

In a more distant prospect it is planned to launch the radar satellite - Resurs–Arktika. This satellite will follow the Resurs-O1 satellite series, and the sensor payload will include the MSU-SK and MSU-E scanners (the latter with a ground resolution of 22-26 m). Besides, this satellite will carry the MSU-S2 scanner for the mapping of the global vegetation index as well as land surface temperature. The synthetic aperture radar (SAR) "Severyanin" will be operated in several modes providing radar images of medium resolution (130 m) at a swath width of 450-550 km and of high resolution images (30-50 m) at a swath width of 60-80 km. In this respect the characteristics of "Severyanin" are similar to those of the Canadian Radarsat. "Severyanin" also will provide onboard processing of the wide swath (450-500 km) SAR images with a resolution of 300 meter. These images will be downloaded in a HRPT mode (similar to AVHRR) as well as in an APT mode at a one thousand-meter spatial resolution, for direct down-link to small user acquisition stations. The Resurs-Arktika satellite will hence provide high quality EO data in the visible, infrared and microwave spectral ranges that may be used for different applications.

Table 3-1 gives a brief summary of some of the main characteristics of the current Russian EO sensors. For more detailed technical specifications on these and other Russian satellite systems please refer to the Annexes A.6 and A.7 of this report).

Table 3-1: Some main characteristics of current Russian EO satellite sensors.

Sensor	Type	No. of Bands/ Spectral range	Spatial resolution (m)
	Resurs-O1 #3		
MSU-E	Multispectral high resolution scanning sensor	3 * VIS and NIR	45
MSU-SK	Multispectral medium resolution scanning sensor with conical scanning	5 * VIS/NIR/TIR	160 to 600 (TIR)
	Resurs-O1 #4		
MSU-E	Multispectral high resolution scanning sensor	3 * VIS and NIR	30
MSU-SK	Multispectral medium resolution scanning sensor with conical scanning	6 * VIS / NIR / TIR	160 to 700
SRRB	Scanning radiometer for radiation budget	4 * VIS / NIR / TIR	60 km
	Okean-O1 #7		
MSU-S	Multispectral medium resolution scanning sensor	2 * VIS and NIR	500
MSU-M	Multispectral low resolution scanning sensor	4 * VIS and NIR	1200
RLSBO	Side-looking real-aperture radar	3.2 cm (VV)	1300/2500
RM-08	Scanning microwave radiometer	0.8 cm (HH)	15 km

VIS = visible, NIR = near infrared; TIR= thermal infrared spectral range.

The information from the various types of Russian EO satellite data presented above may be used for environmental and natural resources mapping and management. The Russian Federation has launched several EO satellites providing significant flow of remote sensing data, while the number of users capable of adequately using these data are still limited. In some organisations, success has been achieved in using remote sensing data for separate application projects, while in general the situation cannot be considered as very satisfactory.

An evaluation of Russian EO data applications 10 years after the launch of the Resurs-O1 N2 satellite in 1994 one can conclude the following [project report by NITs IPR, Appendix 7];

- the main applications of digital satellite data are within hydrometeorology, geology, ecology and forestry,
- the annual volume of digital data delivered to users peaked at its maximum in 1989 (11.92 Gigabytes), at a time where the data were distributed free of charge to the users,
- a sharp decrease of the data volume occurred with minimum in 1993 (487 Mbytes), which was related to the introduction of cost-recovery for the data,
- a gradual increase of the volume of EO data has occurred since 1993 and
- in 1997 the archives reached a level of 7.65 Gigabytes, of which the purchase of data were only 7.7 % of the total volume acquired.

The most significant achievements of EO data has been made in application areas related to:

- monitoring inundation of river floodplains during spring floods,
- ecological monitoring of land surface pollution near large cities,
- monitoring of forest fires,
- estimation of crops status and harvest forecast,
- sea ice mapping and monitoring,
- mapping geological structures for assessment of mineral resources content and for detection of high risk zones related to mining activities, and
- monitoring coastal zones exposed to significant technogenic influence and pollution.

The Resurs-O1 and Okean-O1 are operational spaceborne EO systems and their data can be used for regular environmental monitoring tasks. The actual monitoring applications can be grouped into some classes differing in their importance, such as:

- forecast, operational control and damage assessment for disasters which originate from natural and anthropogenic phenomena (forest and steppe fires, floods, avalanches, mud flows, oil spills),
- ice monitoring on the seas and inner water bodies of Russia and, in the first place, on the Northern Sea Route and the Arctic shelf region,
- pollution monitoring for coastal waters (e.g. mapping of blue-green algae), of atmospheric pollution (by observing snow cover changes) etc., and
- studies of long term global and regional processes in the environment and their influence on vital human habitat conditions. These processes involve desertification of previously fertile areas, soil erosion, deforestation etc..

3.3 The Infrastructures for EO Data Acquisition and Distribution

The description of the Russian providers and distributors of satellite data is based on the information given in the report in Annex A.6.

3.3.1 Photographic Image Data

From 1974 satellite photographs (except for the materials from military intelligence satellites) obtained from "Kosmos" and "Resurs-F" satellites, manned spacecraft and other space vehicles are stored at and distributed by the State Scientific Research and Production Centre "Priroda".

Up to the middle of 1980-ies the State Centre "Priroda" provided space imagery free of charge for its clients (the number of users of such data in USSR amounted to more than 1000). However, later on acquisition and use of photographic EO materials has changed due to various factors. In 1986 State Centre "Priroda" together with the associations Aerogeodesiya, Kosmokarta and Geodezpribor established the All-Union foreign trade association "Soyuzkarta". "Soyuzkarta" offers commercial photographic satellite images for various parts of the Earth with spatial resolution of down to 5-10 meter. Soyuzkarta has a series of long-term agreements with western companies for distribution of their satellite imagery world-wide.

Commercial distribution of satellite photographic imagery from environmental and earlier military intelligence satellites is being done through the joint-stock company Interbranch association (MA) "Sovinformsputnik" in Moscow. Images of foreign territories with spatial resolution up to 2 m. (for Russian territories up to 4 m.) were unclassified by decree of Russian government dating August 18, 1992, after which "Sovinformsputnik" offered these photographic EO images to the world-wide user community. Significant amounts of aerial photographs and satellite photographic maps are also archived by the Production Geological Union (PGO) "Aerogeologiya".

The following is a brief summary of each of the key Russian organisations involved in distribution of satellite image photographs.

State Scientific Research and Production Centre "Priroda"

State Scientific Research and Production Centre "Priroda" (State Centre "Priroda") was established in 1973 and is a part of the Federal Service of Geodesy and Cartography of Russia. "Priroda" provides EO information from "Resurs-F" and "Kometa" systems ("Priroda" is the main official distributor of KFA-1000 and MK-4 images), as well as photographs from the "Mir" space station module, including EO data from the KFA-3000, KFA-1000, MK-4 and KFA-200 cameras.

Interbranch Association "Sovinformsputnik"

Interbranch Association (MA) "Sovinformsputnik" was created in 1991 by a group of enterprises that were involved in design, development, manufacturing and operation of military-oriented remote sensing systems. "Sovinformsputnik" has exclusive rights for distribution of images from TK-350, KVR-1000 ("Kometa" system); it is also an official distributor of images from KFA-1000 and MK-4 ("Resurs-F1 and -F2 systems) cameras. Its archive contains high-resolution imagery from selected parts of the Earth since 1981.

Production Geological Union "Aerogeologiya"

Production Geological Union for Regional Study of Geological Structure "Aerogeologiya" is a leading organisation in the system of Ministry of Geology for implementation of aerial and satellite geological methods. All-Union Scientific Research Institute of Space and Aerial Geological Methods (VNIIKAM) is a part of the Union.

3.3.2 Multi-spectral EO Data

The information from the first Soviet meteorological satellites of the "Kosmos" and "Meteor-1" series have been received and processed by the Hydrometeorological Centre of the USSR. In 1974 State Scientific-Research Centre of Natural Resources Study (GosNITSIPR) of Hydrometeorological service of the USSR was established in order to design and develop hydrometeorological, environmental and oceanographic space systems. GosNITSIPR was responsible for acquisition, processing and distribution of EO data. The acquisition of multi-spectral sensor data was made by the *Main* Centre of Acquisition and Processing of Satellite Data (GCPOD) in Obninsk (Kaluga region) and at the *Regional* Centres of Acquisition and Processing of Satellite Data (RCPOD) in Tashkent, Novosibirsk and Khabarovsk, respectively. These centres handeled acquisition, processing and distribution of EO data to the users such as organisations of State Hydrometeorological Committee as well as other public organisations such as various Ministries and departments. They also carried out study of user requirements for EO data, studies of the implementation of new data types as well as new methods and technologies of satellite data acquisition, processing and applications.

Up to the middle of 1980's satellite EO information was distributed free-of-charge to the user community, according to the orders of State Hydrometeorological committee of USSR and later on Goskomhydromet. Since January 1, 1985 provision of space based EO information to the users is done on a commercial fee basis, with the exception of use in organisations of the Goskomhydromet and educational institutions under the Ministry of Education of USSR and later the Russian Federation. The users could receive data from central (GCPOD) or the regional (RCPODs) centres of satellite EO data acquisition and distribution. EO data of high and medium resolution were distributed as photo negatives or prints, hydrometeorological information as separate photo images, maps of sea surface temperature and radiation temperature of terrestrial surface, as well as various types of information in the digital form on magnetic media.

The association "Sovzond" was created for commercial distribution of "Resurs-O1" data. It was established as a joint effort of the Russian scientific and research institutes - Electrical Engineering ("Elektromechaniki"), Space Device Engineering, and NPO "Planeta". Until recently data from "Resurs-O1" were transmitted un-encrypted and could be acquired by any organisation in possession of a personal ground station (see also external Appendix A.6, section dedicated to the "Resurs" satellite).

Exclusive rights for distribution of radar imagery from Almaz satellite in Europe and USA were given to the Space Commerce Corp (Houston, Texas, US) and Almaz Corp was created for commercial distribution of these images. Besides, a special trading department was established within NPO "Mashinostroyeniye" for sale of Almaz-1A images. Later an agreement was signed between NPO "Mashinostroyeniye" and Hughes STX (Lanham, Maryland, US) for thematic processing and distribution of radar images. In Russia, data from the Almaz satellite (1991-1992) can be obtained at NITs "Almaz" of NPO "Mashinostroyeniye".

The market survey project has identified the following key distribution organisations for EO data within the Russian Federation;

Scientific and Research Centre for the Study of Natural Resources (NITs IPR)

The State Scientific and Research Centre for the study of natural resources (Gos NITs IPR) was established in 1974 under the auspices of RosHydromet. In 1990 it was transformed into scientific and production association (NPO) "Planeta". In 1997 NPO "Planeta" was divided into NITs IPR and NITs "Planeta". NITs IPR is located in Dolgoprudny (Moscow region), while acquisition of satellite information is being

done in Obninsk (Kaluga region) by NITs "Planeta". The acquired digital satellite EO data are transmitted via radio relay link to the NITs IPR in Dolgoprudny, where main EO data archive is maintained. In a Board decision of April 23. 1999, RosHydromet re-merged NITs IPR under the organisation of NITs Planeta.

Scientific Research Centre of Satellite Hydrometeorology - NITs Planeta

Scientific Research Centre of Satellite Hydrometeorology "NITs Planeta" was founded in 1997 separated from the former NPO "Planeta", founded in 1974. "Planeta" is a leading Russian organisation for the exploitation and development of national Earth observation satellite systems for hydrometeorological ("Meteor", GOMS), oceanographic ("Okean") and environmental ("Resurs") purposes, as well as operational acquisition of data from the western satellites (NOAA, METEOSAT, GMS, SPOT etc.).

Engineering and Technological Centre (ITTs) "ScanEx"

Engineering and Technological Centre "ScanEx" was formed in 1989 in order to develop and implement innovative technologies for access to environmental, ecological and meteorological information. In August 1996 "ScanEx" started acquisition of data from "Resurs-O1" satellite on a personal ground station (PGS), that was designed and developed by orders from the Russian Space Agency. Currently 12 PGSs "ScanEr" staions for receiving "Resurs-O1" data within the radio frequency are in operation (Table 3-3 and Figure 3-3).

Siberian Remote Sensing Centre (SRSC)

Siberian Remote Sensing Centre was created in 1997 as a non-profit non-governmental scientific organisation, by the integration of efforts of the three state organisations. These were (i) The Regional Data Acquisition Centre (RCPOD) of Western Siberia, (ii) The Regional Association "Siberian Agreement" and (iii) the Institute of Computational Mathematics and Mathematical Geophysics of the Siberian Branch of the Russian Academy of Sciences. The purpose of SRSC is to provide interested departments and organisations in Siberia with satellite data for various purposes of environmental monitoring and management (further information is given in Ch. 3.4 and Annex A.8).

3.3.3 Regional Russian EO Acquisition Infrastructure

The three main Russian regional EO data acquisition centres are located in Obninsk, Novosibirsk and Khabarovsk. In addition there are a number of personal ground stations (PGS) providing access to download satellite images from the "Resurs-O1" satellite series. Currently 12 such "ScanER" PGS stations, delivered by the Engineering and Technological Centre "ScanEx", are in operation (see Table 3-2, Table 3-3 and Figure 3-3). These PC-based stations are well suited for use at research and education institutions and regional environmental monitoring centres etc. to provide real-time access to satellite EO data.

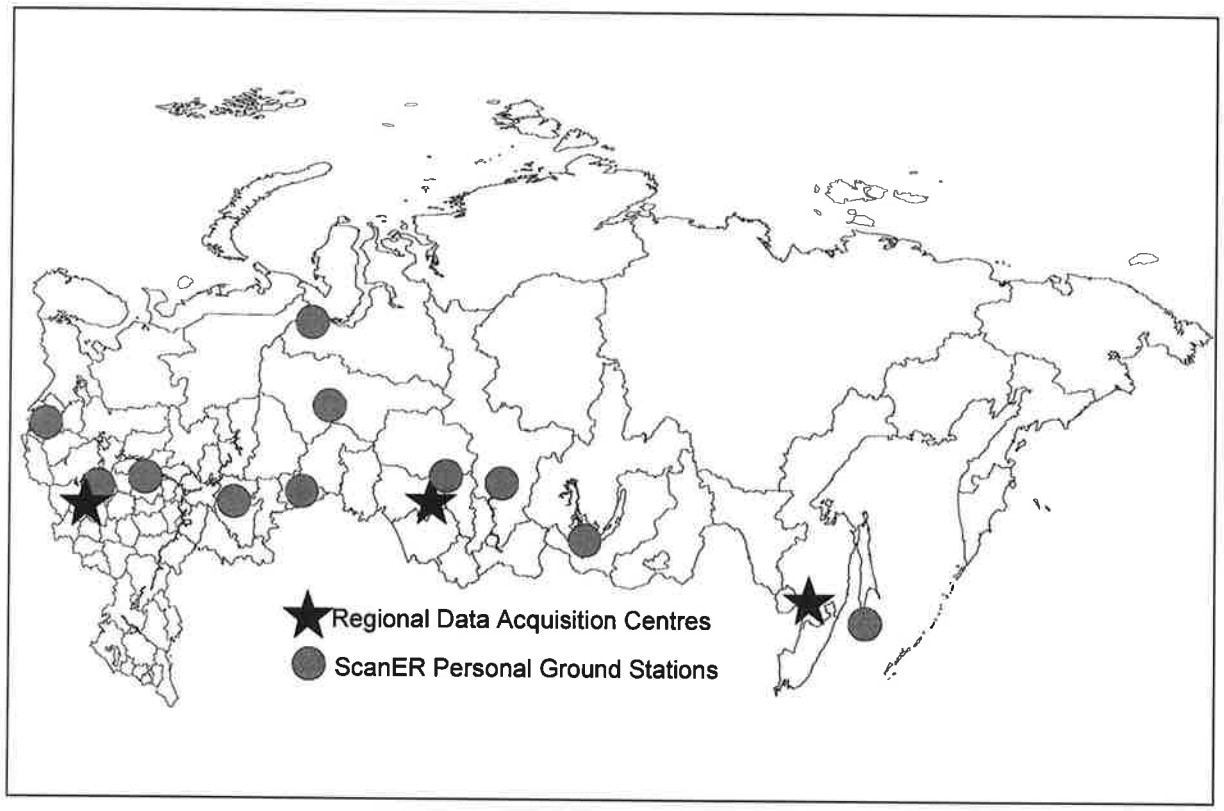
Table 3-2: The technical specifications of the ScanER station [Source: ScanEx Web site].

Antenna type	parabolic dish
Dish diameter	1.6 m.
Polarisation	circular, right-hand
RF input frequency	8175-8225 MHz
LNA noise temperature	55 K
Data rate	7.68 Mbps
Positioning accuracy	0.1º
Operational (survival) wind speed	15 (40) mps
Working temperature range	-50ºC - 50ºC
Antenna system weight	70 kg

Table 3-3: List of current ScanER PGS users [Source: ScanEx Web site].

ORGANISATION	**Location**
Engineering and Technological Centre ScanEx	Moscow
Regional Committee for ecology	Kurgan
Nature Protection Committee of Yamal-Nenets Autonomous District	Salekhard
Krasnoyarsk Scientific Centre	Krasnoyarsk
Ministry of environmental protection and natural resources of Khanty-Mansiysky Autonomous district	Khanty-Mansiysk
Tomsk State University in cooperation with NPO "Sibgeoinformatika"	Tomsk
Tomsk physics and technical institute	Tomsk
Architecture academy, cadaster faculty	Nizhniy Novgorod
Ecological problems institute	Ufa
Scientific and Research Institute of Space and Aerial Geology Methods (VNIIKAM)	Saint Petersburg
Dal'geoinform	Yuzhno-Sakhalinsk
Baikal RIKTs	Irkutsk

Figure 3-3: Location of some satellite EO acquisition stations in the Russian Federation



3.4 An Example of Regional Co-ordination

3.4.1 The "Siberian Accord"

The interregional association of economic co-operation SIBERIAN ACCORD is a non-governmental co-ordination of the 19 territories of Siberia. These are the republics - Altai, Buryatia, Khakasia, Tyva; the krais - Altai, Krasnoyarsk; the oblasts - Irkutsk, Chita, Kemerovo, Novosibirsk, Omsk, Tomsk and Tyumen; and the autonomous districts - Aginsk Buryat, Evenk, Khanty-Mansi, Taimyr, Ust-Ordynsk Buryat and Yamalo-Nenetsk.

Siberia, with its territory of 10,000,000 sq. km (i.e. 38 % of the territory of Russia) and a population of 24.4 million people. The territory of Siberia is similar in size to Canada. 25 % of the global wood deposits and 27 % (161 billion tons) of its coal are located in Siberia. 32 % of the world's gas deposits is to be found here. The deposits of iron ore amount to 7.1 billion tons and there are 98.5 million tons deposits of manganese ore. 82 % of Russia's aluminium, and 61 % of its refined copper is produced in Siberia. 60 % of the world's peat supplies are also found here.

According to the latest estimate, the value of the main natural resources of Russia amounts to US$ 30 trillion. Siberia is one of the richest parts of Russia with respect to natural resources and almost half of these natural resources of the Russian Federation are located in Siberia.

The Siberian industry is represented by 9,000 industrial enterprises. The Siberian Branch of Russian Academy of Science and its headquarter in Novosibirsk - Akademgorodok (Academic township) are known all over the world.

The supreme representative body of the association is the Council, which consists of Heads of the 19 territories of Siberia, as well as leaders of legislative bodies of these territories. The 19 Leaders of these territories are also members (senators) of the Federal Council – the highest chamber of the Russian Parliament. The Chairman of the Council is Mr. Vitaly Mukha, the Governor of Novosibirsk Oblast. The Director General of the Executive Board is Vladimir Ivankov, who is also Deputy Chairman of the Association Council.

The Council examines the most urgent regional problems. As a rule, the representatives of the President, the Government and the Parliament take part in the work of the Council, which indicates the significance of problems of Siberia to the whole of Russia and offers the possibility of solving regional and state problems quickly and efficiently.

The association considers important questions of economic policy, which affects one third of Russia's territory. It is therefore directly concerned with investment, effective and sensible use of natural resources (tenders, rental payments etc.), foreign economic relations, science and technology policies, agricultural machinery, conversion and industrial policies, construction transport development, crime prevention policies and the public health service. Economic and social programmes are developed by special committees called Co-ordinating Councils.

Co-ordinating Councils are working structures of the SIBERIAN ACCORD, which include the representatives of local authorities, the Government of Russia, scientists and experts. The ideas, proposals and documents are worked out by the working groups of the Co-ordinating Councils.

Ministers of the Russian Federation, heads of Siberian Republics, governors of Siberian territories, directors of major companies, scientists, bankers and financiers, sociologists and politicians, all take part in the work of the Co-ordinating Councils. As a rule the Co-ordinating Councils are headed by the governor or chairman of the legislative body of one of the Siberian territories.

Co-ordinating Councils are established according to economic and social programmes of the SIBERIAN ACCORD. The leaders of Co-ordinating Councils are members of Federal Ministries Collegium and represent the interests of Siberia in the Russian Government.

The Executive Board is responsible for creating new systems of interregional business contacts, contacts with other regions of Russia, with the Government, the Parliament and the President of the Russian Federation, as well as with the world community, international economic organisations and companies. It provides all the members of the SIBERIAN ACCORD with current economic data and details of problems to be solved, as well as helping to implement the adopted decisions.

Together with the federal authorities, the association is working out new methods of management of Russia´s and Siberia´s economy in conditions of decentralisation and market relations and is making a contribution to overcome the economic crisis.

The SIBERIAN ACCORD is concerned with legislation and with establishing and developing new external economic trade and business relations. The association actively collaborates with foreign embassies in Russia, with representatives of companies and international economic organisations and takes part in the work of these organisations in Russia and abroad.

SIBERIAN ACCORD is working out new forms of economic management: it creates corporations, which include industrial plants, trading companies and research institutes.

Substantial results have already been achieved. The first of these is the agricultural corporation "Agrosib" aimed at solving one of the main challenges facing Russia - efficient utilisation of agricultural products. With the assistance of the corporation the achievements of latest technology and global experience are introduced into the creation of new agricultural complexes. The corporation is also engaged in manufacturing of agricultural machinery, in the building and maintenance of miniplants and automated lines for agricultural processing.

3.4.2 The EO Activities under the Siberian Accord

The Siberian Remote Sensing Centre (SRSC) was formed in 1997 by a decision of the Executive Board of the SIBERIAN ACCORD with the purpose of providing satellite data to organisations and departments in Siberia. The founders of the centre are the Institute of Computational Mathematics and Mathematical Geophysics of RAS, the Regional Centre for Acquisition and Processing of Satellite Data of RosGidroMet (RCPOD) and the Regional Association Siberian Accord (represented by the Information Centre EcolMASS). The Novosibirsk ground station for EO data acquisition has been receiving satellite data from the Russian Resurs-O1 satellite since 1989. Professor Gennady Erokhin is the General Director of the Siberian Remote Sensing Centre.

Realizing the imporatnce of joining forces to implement up-to-date space technologies, the Russian Space Agency (RSA) and Interregional Association SIBERIAN ACCORD (IASA) have concluded an agreement on scientific and technical co-operation in the field of outer space investigation and use. The agreement was signed on December 9, 1998 in Moscow. This agreement focuses on the development and realisation of co-operative and regional programs (projects), considering priority directions for science and technology development. The intention is to provide all interested authorities and institutions of Siberia with satellite EO data, which would allow them to meet the social and economic needs in their organisation for environmental monitoring and creation of a space network of telecommunication, television, radio and navigation.

In the framework of the present Agreement between RSA and IASA the following activities are included:

- work out and co-ordinate regional programs and projects on the development of telecommunication systems and natural resources and ecological monitoring of Siberia;
- take joint decisions on finding ways and means to initiate co-operative programs and projects;
- carry out joint meetings to settle the problems in providing the Siberian region as a whole and parts of the Russian Federation, belonging to the IASA, with space information;
- exchange regularly scientific and technical information on the problems of mutual interest; and
- develope expertise through scientific and technological projects relating to the launching of modern space information technologies in the Siberian region and parts of RF belonging to IASA.

To realise the program on space monitoring of Siberia on the basis of modern space information technologies IASA established the Co-ordination Council on Space Monitoring of Siberia (CC SMS). Its first meeting was held on April 8, 1999 in Khanty-Mansijsk. At this meeting the Council panel as well as CC SMS work-plan for 1999 were approved.

The Council panel consists of 45 expert members and includes the head of Khanty-Mansijsk Autonomous Region Administration, Mr. A.V. Filipenko as its chairman, the head of the Earth Remote Sensing Department of RSA (Dr. G.M. Polischuk) and the General Director of Siberian Remote Sensing Center (Prof. G.H. Erokhin) as vice-chairmen. In addition leading officials from state and regional committees, administrative departments and scientific centres from all of Siberia and RF are members of the Council. Among non-Siberian scientific organisations which are members of the Council panel, are the Nansen International Environmental and Remote Sensing Center in St. Petersburg and International Forest Institute in Moscow.

CC SMS strategy covers tracing the state-of-the-art on environmental monitoring in Siberia and fulfilment of the Council tasks; organisation of regional space monitoring centres working together with Siberian GIS centres on remote sensing data application; working out a concept for development of a Siberian space monitoring system.

3.4.3 Siberian Infra-structures for EO Data Acquisition

Regional Data Acquisition Center in Novosibirsk

During the market survey the location of a receiving station near Novosibirsk at the premises of the Regional Data Acquisition Center (RCPOD) was suggested. Without further evaluation the proposal is based on the following facts:

- RCPOD has in operation the basic antenna equipment, to be used in support of the ESA acquisition station for ERS SAR data;
- Competent scientific and operational personnel area available in Novosibirsk to support acquisition of the ERS SAR data and regional use of the data through thematic interpretation and dissemination;
- Communication and data distribution can be made through high-speed external Internet-relay channels linking Novosibirsk with the rest of the world (space link 1 Mbit/s Novosibirsk - Germany, dedicated line 2 Mbit/s Novosibirsk- Moscow -Finland).
- In the framework of the Regional Association SIBERIAN ACCORD a broad co-operation between all interested users of satellite information from various regions of Siberia was established. The co-ordination of space monitoring activities is being done through the Co-ordination Council on Space Monitoring of Siberia, organised by the SIBERIAN ACCORD.
- There is political resolution by the administrative leaders of the regions and the Regional Association SIBERIAN ACCORD, including 19 regions of the Russian Federation, to implement a program for space monitoring of Siberia.

YaNAD State Committee on Environmental Protection - Salekhard.

Yamal-Nenets Autonomous District (YaNAD) covers 750,3 thousands sq.km. More than 50% of its territory is north of the Arctic Circle. Salekhard, the district administrative center, founded in 1595, has a population of 30.400 people. Since 1993 under the new Constitution of the Russian Federation Yamal-Nenets Autonomous District has been related to as the subject of the Russian Federation. The region is an important node in the regional communication network, involving the Northern Sea Route, road and rail road communication and an international airport.

The natural gas deposits of the region are unique and have reserves sufficient to satisfy both

the national needs, and for export. Actually up to 90 % of all the recoverable natural gas reserves in Russia is concentrated in Yamalo-Nenets Autonomous District. Approximately 35 % of the potential oil reserves of Western Siberian oil-and-gas province are located in Yamalo-Nenets district, 174 natural gas, oil and oil-and-gas-condensed deposits have been explored. The region is also rich on wide range of other minerals and natural resources. Due to the extensive exploration of the natural resources a high level of regional concern and efforts are mate within environmental monitoring of the extent and effects of these activities.

In order to perform such monitoring activities the State Committee on Environmental Protection of the Yamal-Nenetz Autonomous District in Salekhard, has since 1996 operated a regional service for acquisition and processing of EO data from the satellites NOAA, METEOR and Resurs-O. At present the service is equipped with two satellite data receiving stations.

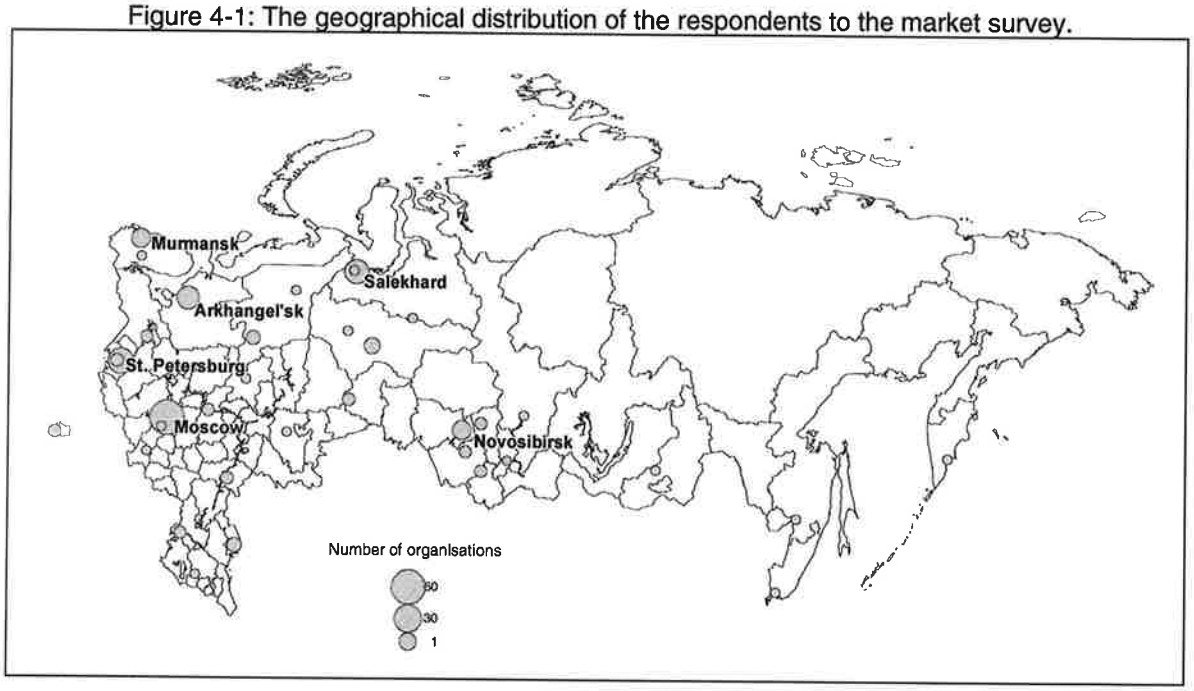
A strong regional interest has been expressed in order to accommodate an ERS SAR receiving station in Salekhard. The local applications will be multiple among other maintain the control of the oil transportation and other shipping activities in the Kara Sea and through the Northern Sea Route. Local and regional use of SAR data for planning and environmental monitoring related to the oil and gas exploration activities, planning of infrastructures such as roads and rail-roads, and flood monitoring. The center is also linked to high speed data communication networks which allows to disseminate data and processed information products to a wide range of users within Siberia, the rest of the RF and abroad. In this respect it is suggested to use the antenna and infrastructure of the existing "Orbita" receiving station near Salekhard. For digital data transmission from Salekhard to Nametkinskaya station (Moscow), the use high-speed channels of the communications satellite "Yamal-100" is suggested.

4. Assessment of the Russian EO Market

4.1 The User Survey

Totally 189 Russian public organisations, institutes and private enterprises responded with adequate information to be included in the market survey database. The geographical distributions of respondents covered most of the territories of the Russian Federation, although with a focus on the European western and northern parts, central and southern Russia, west and central Siberia and only to minor extent the east Siberia and the Far East (Figure 4-1). Some overlap occurred between information obtained from the various organisations in the project team. The gathered information concerned the needs to meet their main mission including their requirements for possible use of EO data in this connection. Requirements for EO data and their delivery, information content, coverage, frequency etc. for potential application of SAR data from the ERS and ENVISAT satellites, in combination with information from other satellite sensor systems, were gathered. Further details on the survey approach are given in Ch. 2.3 and Questionnaire forms in report Annex A.2.

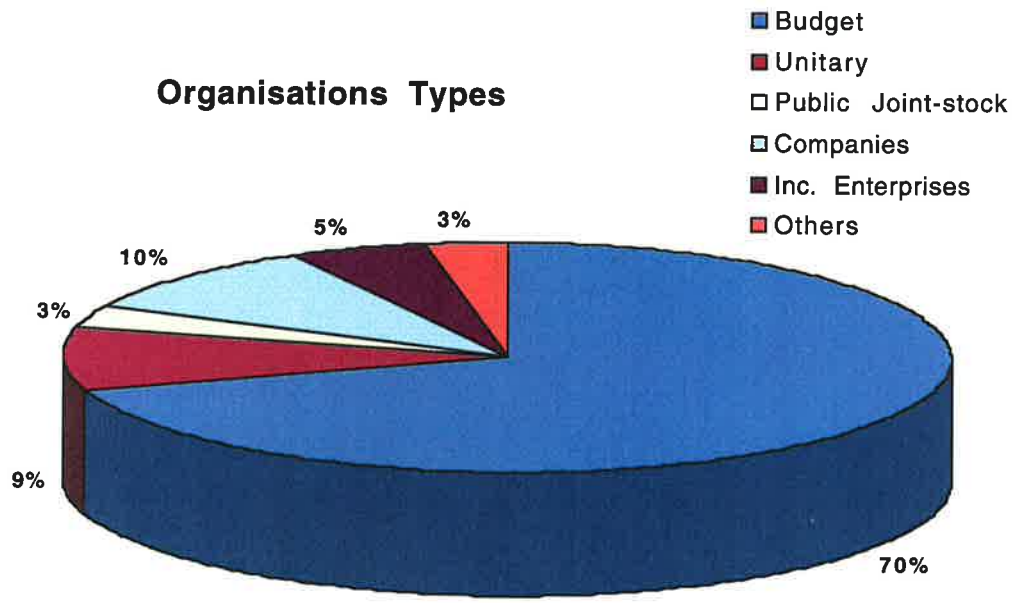
Figure 4-1: The geographical distribution of the respondents to the market survey.



Organisations Types and Funding Sources: 82 % of the respondents were from organisations, which were wholly or predominantly state-owned (see Figure 4-2). This proportion is very large, although it reflects the fact that by tradition many Russian organisations are under public or semi-public administration. During the recent years a transition of organisations to private companies and organisations has occurred, leading to various joint-sector subsidiary organisations. The funding agencies and clients for EO related activities within the contacted organisations are to a very large extent supported from public budgets. In general the survey shows that most of the organisations obtain some kind of public funds, from regional authorities (65%), federal agencies (40%) and from international organisations (24%). In addition 43 % of the public organisations indicated commercial

clients within the oil and gas industry, from other organisations – large industries (22%), smaller industries (24%), consulting companies (16%), Universities (45 %) and educational institutions (19%). In general, the funding sources for each organisation are quite diverse and complex, involving several source types and client categories. It was impossible to obtain any quantitative information on the actual volume or significance of the different funding sources for the institutions. Lack of this type of information makes it difficult to perform a quantitative assessment of the importance of the various funding sources initiating the EO relevant activities. However, this reflects also the fact that the public sector in Russia today depends (considerably) on commercial and other non-public sources to fund its activities.

Figure 4-2: The distribution of the main Russian organisation types covered by the market survey. The Budget, Unitary and Public Joint-Stock is under the public sector and the latter in the joint sector, while the private commercial sector is covered by Companies, Incorporated enterprises and others.



The private sector, including voluntary organisations and international organisations, accounted for only 18% of the survey responses. A large proportion of these organisations (71 %) obtained funding from the oil and gas industry, 47% from minor industry, 24% from private organisations and 35% from other sources. For the incorporated enterprises these figures were even higher, among which e.g. 83 % received funding from the oil and gas industry. This shows that such companies are established in order to serve their parent companies and that to a large extent the EO relevant activities are contracted to this type of subsidiary organisations. Such companies are usually established in order to undertake specific tasks related to the overall consortium activities. Also among the private sector the public funds from regional, national and international authorities are indicated as relevant sources by respectively 53%, 24% and 18% of the responding organisations. This indicates that public sources are also of importance for the private industry. The lack of quantification of budget proportions for each sector makes it difficult to assess the quantitative importance of the various sources relative to the total activity of the organisations. The private market is in general also quite mixed involving various sources of funds for the activities related to exploration and use of EO data and derived information.

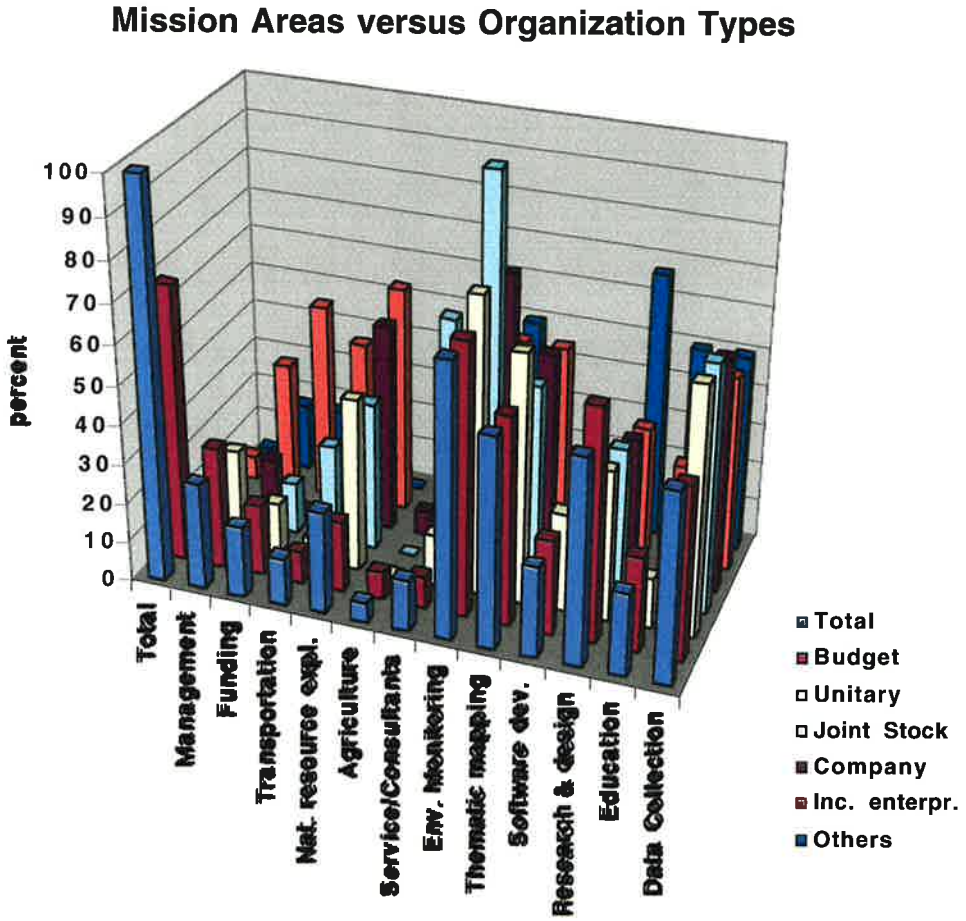
Mission areas: The responses on mission foci cover several application areas for EO data. A wide range of funding agencies, authorities, industry, information providers and users, research and development groups, and educational institutions have been contacted (see Table 4-1 and Figure 4-3). In summary, the mission areas covered all *a priori* indicated areas except for fields such as manufacturing, energy (except oil and gas) and infrastructure maintenance, which are neglected due to the low number of responses. EO applications are relevant within these categories, e.g. hydro-electric power plants, and users could have been identified, although these mission areas were not covered by the survey.

For all institution categories more than 50 % (up to 69%) of the organisations have main mission goals related to "environmental monitoring" and "thematic mapping". Also, around 50% are engaged in "data collection" and "research and design". The survey has, to a large extent, been among organisations involved in the process of generating information used for environmental monitoring, i.e. the value-adding sectors of the EO data use. Organisations responsible for public administration (31%) and direct funding agencies (18%) have been contacted, which are among the end-user categories of EO-based information products. Within the private sector the focus is also mainly on "environmental monitoring", although the exploration of "natural resources" is among the mission goals for over 50% in this category. The so called end-users of the information within management (27%) and funding agencies (18%) have also been contacted through the survey. The survey information is hence adequate and include all major *a priori* defined mission areas within the EO related activities.

Table 4-1: A summary of the responses (in %) to each of the main mission foci, shown for the entire survey, as well as for the various types of organisations contacted. The numbers discussed in the report are high lighted.

		Public			Private		
Main Mission Area	Total	Budget	Unitary	Joint Stock	Company	Inc. enter-prices	Others
No of respondents	189	131	15	8	17	12	6
in %	100	70	8	4	9	6	3
Management	27	31	25	0	12	33	17
Funding	18	18	13	13	0	50	17
Transportation	12	8	6	25	12	42	33
Nat. resource expl.	26	18	44	38	53	58	0
Agriculture	5	7	0	0	6	0	0
Service/Consultants	13	8	13	63	12	42	17
Envir. Monitoring	69	69	75	100	71	50	50
Thematic mapping	53	53	63	50	53	50	17
Software developm.	23	24	25	13	29	25	17
Research & design	52	59	38	38	35	33	67
Education	21	24	13	0	12	25	50
Data Collection	48	44	63	63	59	50	50

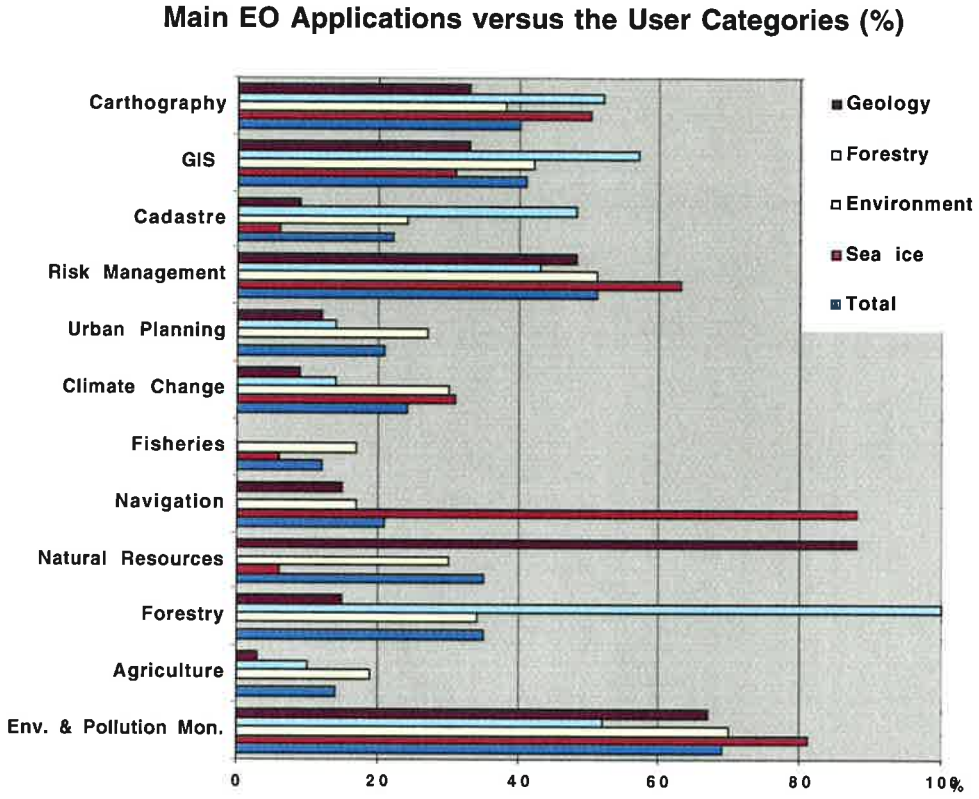
Figure 4-3: A summary of the responses (in %) to each of the main mission foci, shown for the entire survey, as well as for the various types of organisations contacted. The information content is similar as shown in Table 4-1.



EO Application Areas: The responses with respect to the EO applications cover all major areas (Figure 4-4). The application areas related to monitoring of "environmental pollution" (69%) are of concern to a large proportion of the contacted organisations. Related activities such as "risk management", "GIS" and "cartography" are hence also within the application areas of many of the responding organisations. Also in the user categories such as sea ice navigation there is a high level of concern for these issues. This implies that a particular user may have several application areas of SAR data in case these are being used within the organisation. The responses from basic and applied research institutions indicate that each of them covers a wide range of EO relevant application areas and hence they respond to several application areas. Taking into consideration the fact that 77% of the respondents have had experience in use of EO data, the role and use of EO data seems important for a large proportion of the contacted organisations. Except for agriculture and fisheries all application areas have been indicated by over 20 % of respondents. The application areas with greatest development potential seems to be within sea ice monitoring, where the users have identified a significant benefit in use of SAR data compared to the current observation methods. As mentioned above, "environmental monitoring" is among the tasks for many of the users and particularly at high latitudes SAR data has advantages compared to other EO based information sources. "Risk management" is an application of general and high concern to all application areas and hence a field of potential development. The integrated use of EO data in "GIS" and "cartography" applications is also a field where SAR data will have a significant

impact. Within mapping of natural resources various parts of the exploration industry has identified their strong interest in using EO data provided that the application methods are well documented and are able to support their main mission and goals.

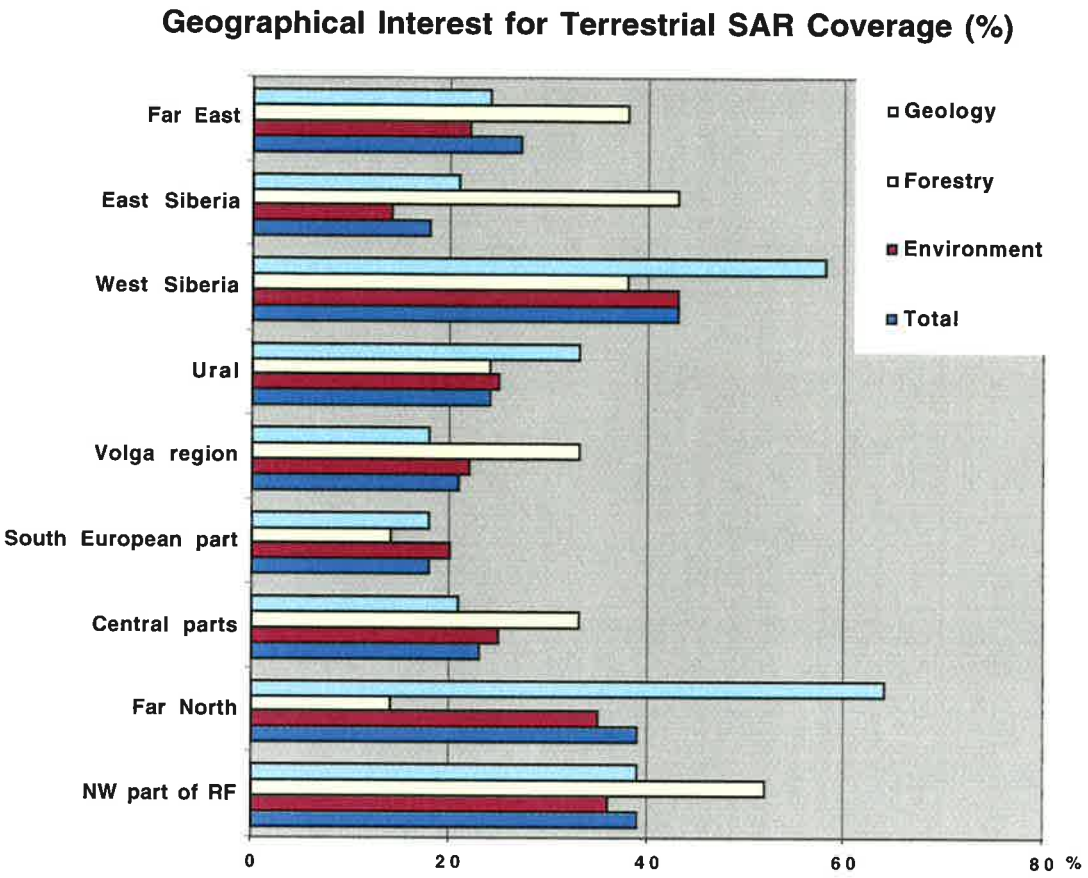
Figure 4-4: The distribution of responses for various EO applications shown for the total survey and for each category of the main user groups – Sea ice navigation, Environmental monitoring, Forest mapping and Natural resources (geology).



EO Data Coverage: The requirements on geographical SAR data coverage extends over all the main parts of the Russian Federation. For land areas the focus is in west Siberia (43%) and the northern and north-western regions (39%) of the Russian Federation (see Figure 4-5). Also the Far East is of interest to 27%, although very few of the contacted institutions are located in this part of the RF. For "environmental monitoring" the geographical distribution of interest is quite homogeneous all over the RF, although with a stronger focus on western Siberia. For "forestry applications" the NW and central parts and Siberia are of the prime interest. Geographical interest of the private sector is slightly higher in the far northern region, Ural, and Siberian parts of the RF, which is primarily due to the fact that these are the regions containing major natural resources.

In general, the areas of primary geographical interest are to a large extent covered by the existing ESA stations in Europe as well as through a new proposed station in the northern areas of the central or eastern parts of the RF, e.g. Salekhard or Yakustsk.

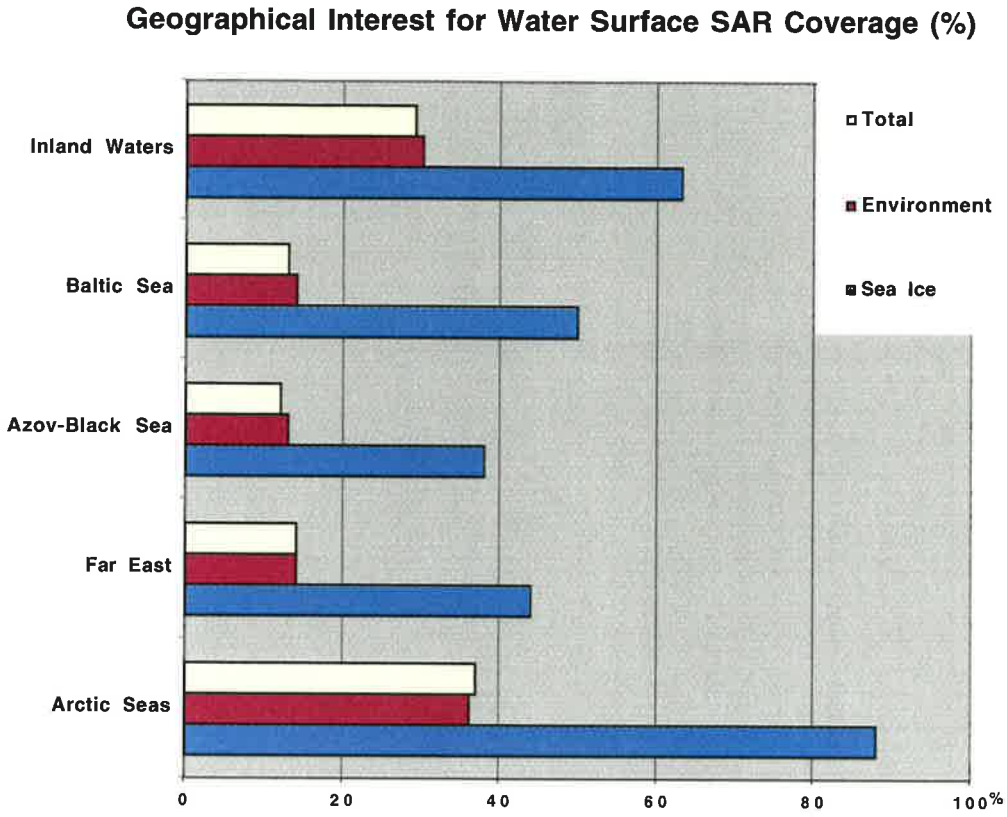
Figure 4-5 The geographical distribution for desired terrestrial SAR data coverage for the total survey and the land application areas.



For water areas the general focus in on the Arctic Seas (37%), and roughly equal (≈14%) on the water regions of the Baltic, Black, Caspian and Far East seas (Figure 4-6). For sea ice applications 88% are interested in the Arctic waters, 50 % in the Baltic sea, and 44% in the far east seas. 63% of the respondents also indicated interest in use of SAR data for inland water bodies, although the geographical requirements for these were not investigated further. From the workshop responses, the great lakes such as Baikal, Aral sea, Ladoga and Onega as well as the river/channel water way systems (including Volga) are of prime interest.

In order to cover the data demand for the major parts of the Arctic and Far East seas a station located in the Yakutsk region is desired in combination with the existing ERS stations. A station located in the Moscow region will cover the Caspian Sea, Black and Baltic Seas as well as some of the major inland water bodies (see also further discussion in Ch. 4.4).

Figure 4-6: The geographical distribution of water coverage for the total and the relevant application areas.



Seasonal Coverage: Year round SAR data coverage are required by 53% (Figure 4-7), with increased interest for sea ice applications during the winter season (44%) and for forestry applications during growth season (43%). This clearly states that there is a requirement for SAR data coverage throughout the year, although with some seasonal preferences for the various applications. One concludes that an ESA ERS/Envisat SAR station in the Russian Federation should allow for year around operations.

In general the observation frequency for SAR data coverage are requests on an "event" (55%) or "one-off" (31%) basis, although on average 19% will prefer a daily data coverage (Figure 4-8). The same level of respondents will also like to have SAR data coverage on a weekly, monthly and annual basis, although with some discrepancies between the various application areas. The main deviation from this general SAR data coverage requirements is that 50% of the sea ice monitoring users would like to have a daily coverage of SAR data in order to meet their mission requirements. In general one may expect that most users of SAR data will order data on an event to event basis connected to particular environmental situations or monitoring tasks undertaken by the organisations.

Figure 4-7: The seasonal distribution of SAR data request.

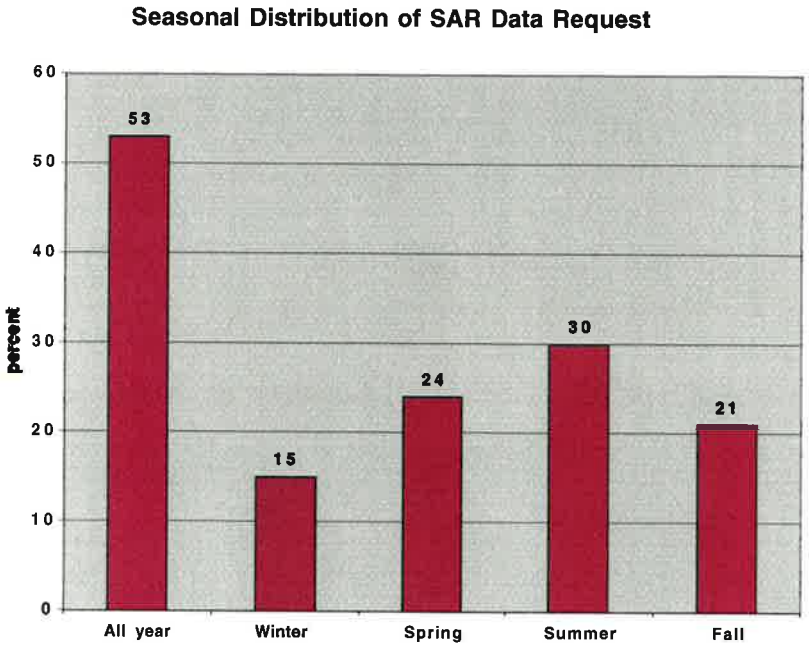
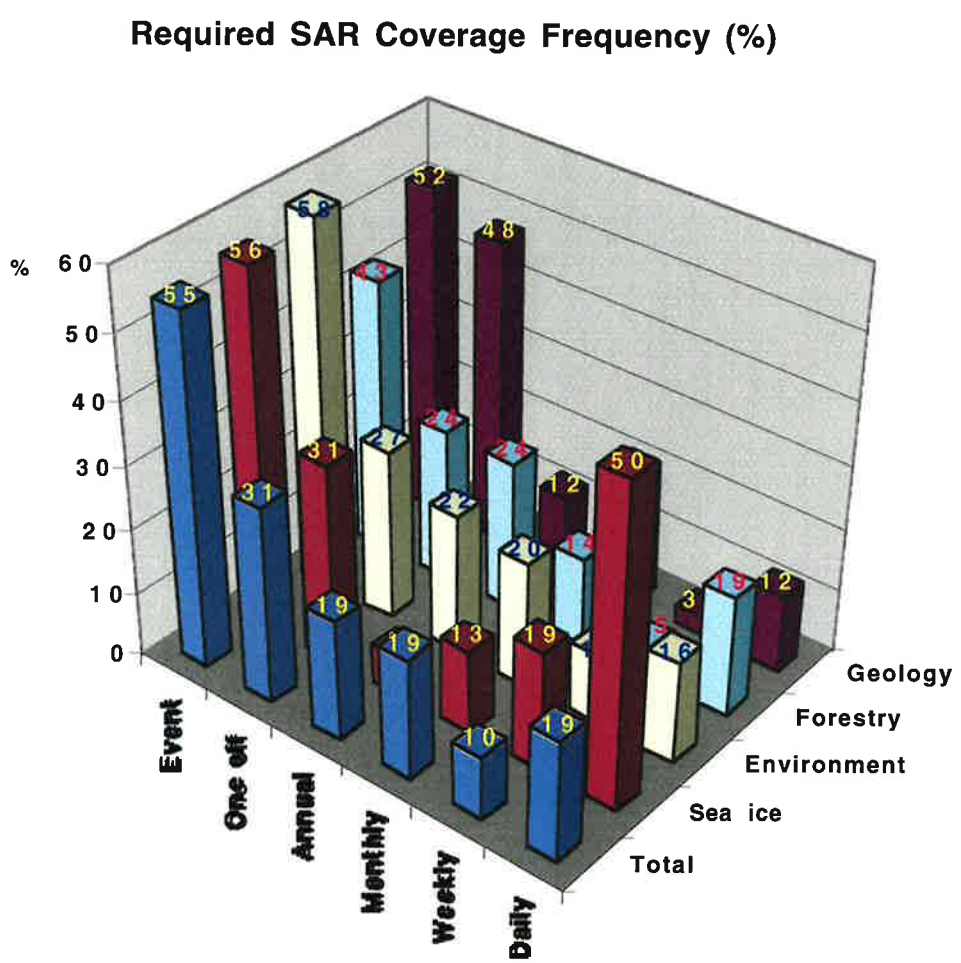


Figure 4-8: The observation frequency distribution for SAR data coverage within the overall and four application areas.

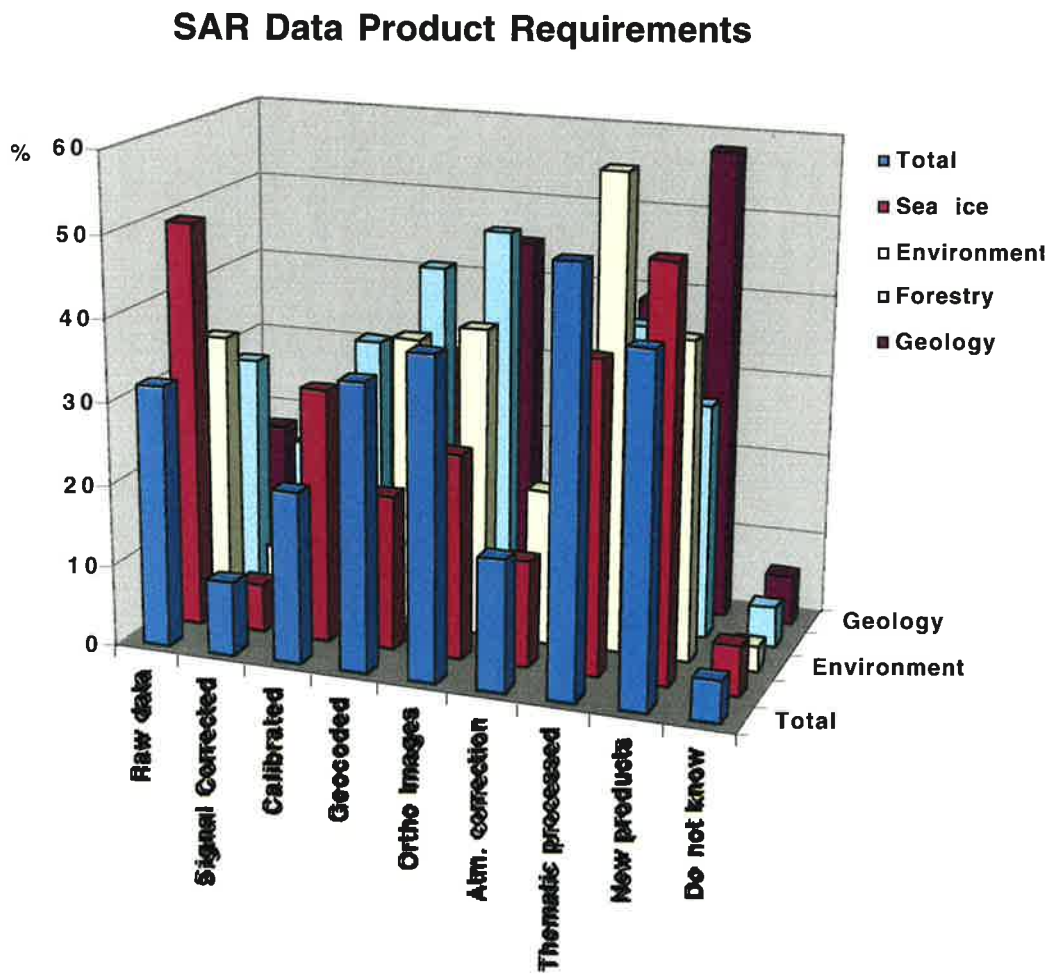


Requirements on SAR Data Products: In general 32% of the respondents would require the basic level image products (Level-1B types) (Figure 4-9). For the sea ice applications as many as 50% are able to use the basic image products or a calibrated product (31%). The lower response may be due to a lack of understanding of the product differentiation causing a lower response to these categories.

The fact that most of the Russian users are acquainted with optical EO data from e.g. the Resurs satellites is also reflected in their responses on SAR data product requirements. Geo-coded and Ortho images were requested by 35% and 39% of the respondents, respectively. For a large part (51%) thematic products are also requested, which implies that there is a need for a value –adding service provider between the data provided by the space agency and the end user of the EO information. As much as 42% also indicated a need for "New Products", which indicates that the many of the users have a prime interest in the derived information products and not necessarily the EO data itself. This fact is more marked in the geology application area (58%) and for sea ice applications (50%). From the workshops one can conclude that within these categories particularly, but also in the other categories, there is a profound need for documented value-added information products in order to stimulate a wider use of EO data sources for information retrieval.

Most of the survey responded had well defined requirements to EO data and the derived data products, supporting the conclusion that the contacted institutions are quite well educated or experienced in the use of EO data.

Figure 4-9: The distribution of the required level of data processing for SAR products required by the users in total, and for each of the four categories of application.



EO Data Experiences: The respondents to the survey were in general very well acquainted with the use of EO data within their field of expertise (see Figure 4-10). 77% of the respondents were already acquainted with the use of EO data within their organisation, the remaining (23%) had never used EO data or did not respond to the question (6%). The main EO data sources used among the respondents were optical sensor data, mainly from Russian satellites and primarily the Resurs satellite series (58%). Among non-Russian satellites the NOAA AVHRR data was the most commonly used data source (22%). With respect to use of microwave satellite radar data, Almaz data had been used by 11%, ERS SAR data by 14% and Radarsat data by 5%. The survey also indicates that the respondents expect future use of SAR data to increase significantly from current level. However, this may not be representative due to the thematic bias/focus of the survey, e.g. for ERS SAR an increase from 14% to 73 % (for future use), as well as for SPOT data (from 12 to 49%). Based on an integrated evaluation of the responses from each contact the project team has performed its own (subjective) assessment of the probability that they will purchase or use EO data in the future. Figure 4-11 summarises the overall assessment for future use and purchase of EO data and the probability for purchase (Figure 4-12) and for future use (Figure 4-13) in the four prime application areas.

Figure 4-10: The frequency of respectively current and future use of satellite EO data among the participating Russian organisation in the market survey.

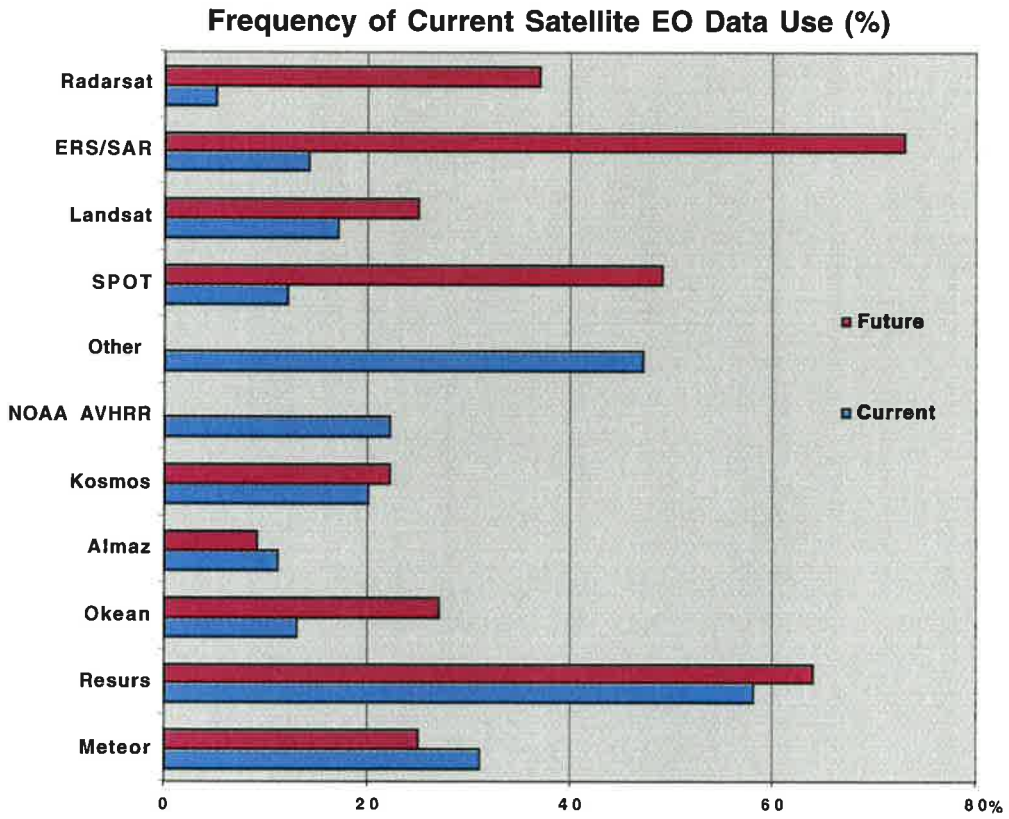


Figure 4-11: The project overall assessment of the probability that the contacted organisation will purchase or use ERS/Envisat SAR data in the future, ranked in High, Medium probability, Unlikely and unable to evaluate.

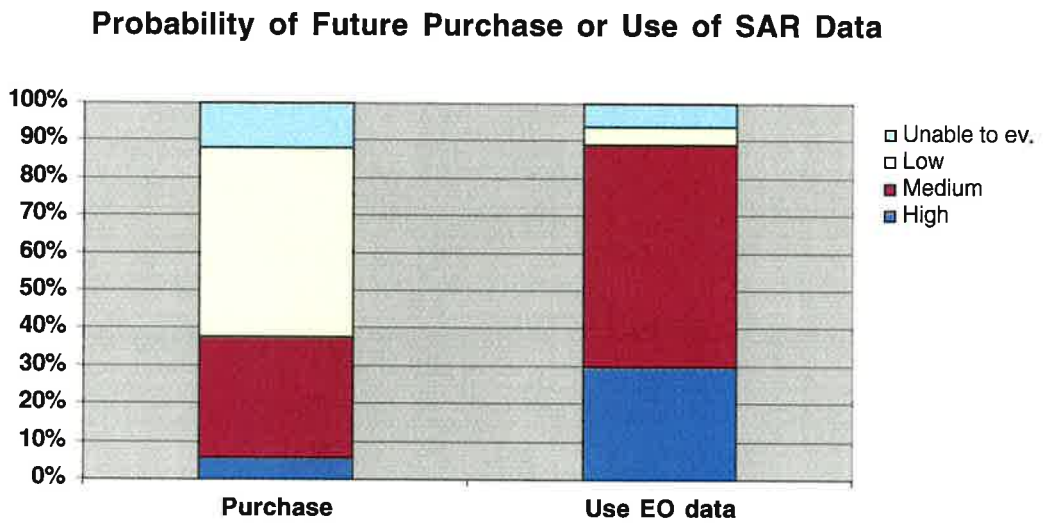


Figure 4-12: The project assessment of the probability that the contacted organisation will purchase ERS/Envisat SAR data in the future, ranked in High, Medium probability, Unlikely and unable to evaluate. The total assessment (same as in Figure 4-11) and for each user category are shown.

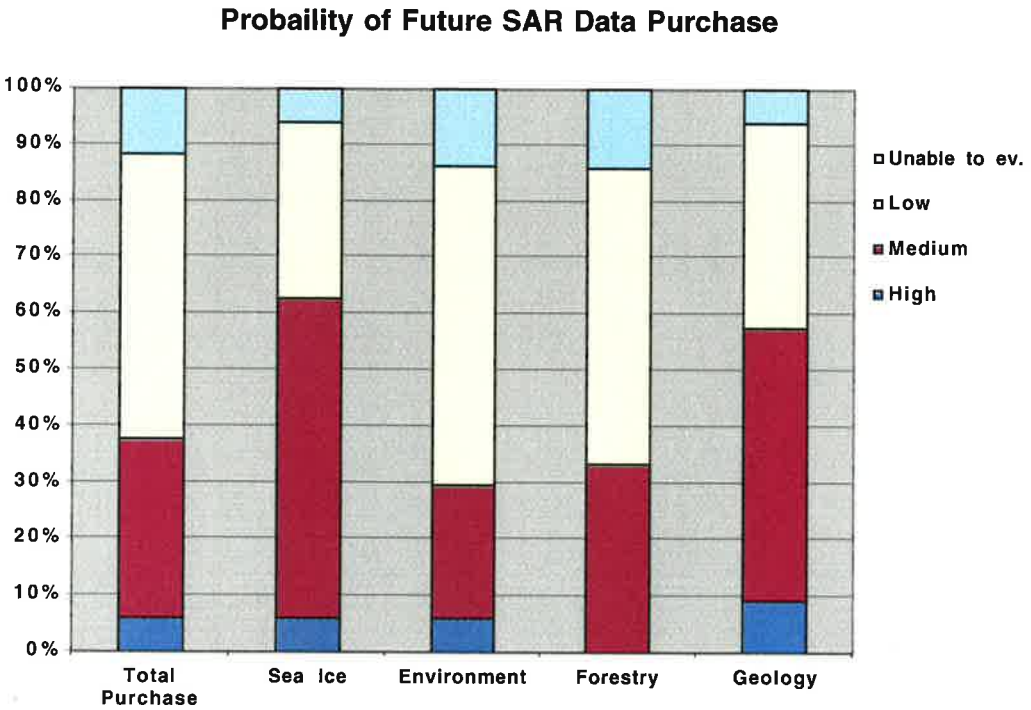
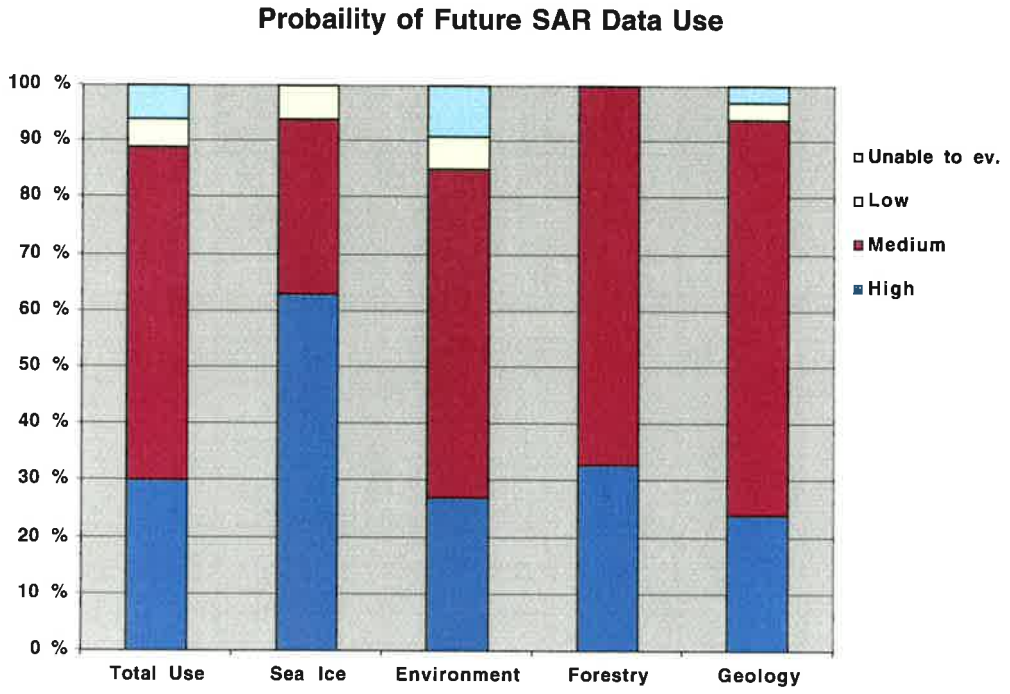


Figure 4-13: The project assessment of the probability that the contacted organisation will use ERS/Envisat SAR data in the future, ranked in High, Medium probability, Unlikely and unable to evaluate. The total assessment (same as in Figure 4-11) and for each user category are shown.



4.1.1 The Regional Workshops

The technical program for the three workshops included the following topics (see also Ch. 2.5) that were presented by the Project team:

- Workshop Background, Objectives and Tasks – NERSC
- The ESA Earth Observation program – NERSC
- The Russian Earth Observation program – RSA and NITs IPR
- Ice navigation applications – NIERSC
- Environmental Monitoring – NIERSC
- Forest Mapping and Monitoring – NIERSC and Int. Forest Institute, Moscow
- Natural Resources – NIERSC
- Practical use of satellite data in Russia – SPOT Image
- Applications of Russian remote sensing data – NITs IPR
- Interregional Association "Siberian Accord", SRSC *(Novosibirsk only)*
- Workshop discussion and participant contributions – NERSC/NIERSC

The discussions and user responses obtained during the three workshops are summarised below.

Saint Petersburg

Leading managers, technical staff and experts in the fields of geology, forestry, cartography,

ice navigation and oil exploration from different organisations, institutes and companies took part in the workshop. The participants noted that Earth Observation (EO) data applications were well established among them and other Russian user organisations. The main experiences of EO applications were with optical EO sensor system and their usefulness for different applications areas were highly acknowledged. It was emphasised that active microwave data were regarded as very relevant for ice navigation and pollution monitoring in the dark winter season as well as under the frequent cloud and haze conditions at the high northern latitudes.

In order to stimulate the use of EO data within the oil exploration industry it is necessary to define in detail the end information product that will be of use for their activity, which must be developed in co-operation between the industry and the EO expert providers. Sea ice mapping is one such field since the Arctic offshore oil exploration and transportation activity is increasing in Russia. The fact that Murmansk Shipping Company now is 51% owned by Lukoil indicates the increased interest in this direction.

It was also pointed out that synergetic use of aerial photography and EO data could be useful for forest mapping and monitoring in the north-western Russia. Planning of aerial surveys were difficult due to the changing weather conditions and satellite SAR data could be complementary information source. Participants emphasised the advantages of SAR data for production of digital bathymetry maps in shallow waters. The combined use of EO information (image information) in vessel traffic control systems (VTS) for both on-board and land based centres for marine traffic monitoring, was of significant interest to one participant.

The lack of basic information on the ESA EO program and sensors, lead to some questions on the satellite sensors technical specifications and how to obtain EO data from European and Russian Space Agencies.

The representative from the Yamal-Nenetz Ecological Committee presented their operational use of Resurs-O data in monitoring areas of their oil exploration fields. The activities included applications on terrestrial oil pollution, vegetation cover and snow pollution mapping.

In summary, the participants expressed a significant need for more information on ESA sensors and their potential applications. More imagery, faster data delivery, easier data ordering and access, validation and thematic image analysis, and integration of EO data in "one" system for users would be desirable.

Moscow

The specialists in emergency and hazard management from EMERCOM, forestry, gas/oil exploration industry and radar technology, different organisations and institutes, Russian (GazProm) and international (Statoil) oil companies took part in the workshop.

The participants emphasised that EO data had its most prospective applications within or monitoring of natural and technogenic disasters and hazards. EMERCOM gave examples of the international exchange of EO data under the STREAM program. In hazard monitoring the emergency authorities are in need of frequent and near real-time access to EO data, which put particular operational constraints on the EO data delivery chain. The participant from GAZPROM was interested in using EO data for monitoring of gas released during pipeline accidents, vegetation cover of oil/gas exploration regions and non-petroleum oil on the water surface, as well as in support of the increased activities in the Arctic shelf region. A concern of international oil companies was related to the actual regulations and demands put on their exploration activities by the Russian authorities, which will be a main guideline for their initiatives. Documented benfits of EO data sources could be included in their offers of supporting initiatives - i.e. improved sea ice monitoring and marine oil spill pollution using

SAR, the latter after a system used in Norway.

The forest inventory specialists asked questions concerning the EO data applications for forest fire monitoring, clear cutting and forest insects detection. It was especially noted that satellite images could be relevant for production of forest digital maps – thematic and topographic. The discussion became quite detailed on specific technical issues of EO technology and data processing for forest applications.

Participants also discussed the issues concerning the location of a new Russian Satellite Receiving Station, image processing techniques, as well as the techniques for validation of satellite retrieval and ground-based data sources. In the higher level educational system gaps were identified in the general training of students, and it was hence suggested that the specialists in Earth Observation data processing and image interpretation should be more active in providing lectures for students within various fields of the higher educational system.

Novosibirsk

The discussion focused on the accessibility of satellite EO data for Siberian users. The participants addressed the aspects of an ERS/SAR receiving satellite station located in the Novosibirsk region. It was noted that EO data were extremely important for the Siberian region, which was difficult to monitor by other means. In particular in the northern regions, where lack of daylight, clouds and haze are frequent, the use of microwave radar technology is particularly favourable for monitoring applications. The applications of satellite EO data for pollution and vegetation monitoring in oil-gas exploration regions were discussed. The degradation of the areas under influence of permafrost due to the greenhouse warming is of significant concern. The issue has both technical impacts on man-made constructions (buildings, roads, railway, pipelines etc.) in the areas, but is also of general environmental concern due to the increased release of methane gas. The use of high resolution EO data to detect hits of meteors was presented. The "SIBNET" (developed in Novosibirsk) a structure for the distribution of EO data within Siberia was presented.

During the discussion, the Ecological Monitoring Institute in Barnaul and Sun and Earth Physics Institute in Irkutsk presented various projects, involving use of EO data sources. The specialists from Ecological Monitoring Institute extensively used RESURS images and aerial photography data as well as in-situ measurements for soil studies. They developed the models that connected the soil moisture and brightness temperatures in themicrowave band as well as spectral reflectivity of soils with their type and humus content in optical band. The specialists from Sun and Earth Physics Institute presented the application of NOAA/AHVRR image applications for forest fire detection for Sakhalin and Khabarovsk regions in Autumn 1998. The results of using NOAA/AHVRR data for monitoring the Lake Baikal ice conditions and water temperature were also reported. These issues are of significant local concern, and future use of EO data that can improve the use of the lake were discussed (determination of circulation pattern, pollution, algae blooming, ice freezing and melting period, water level etc.).

At the end of the workshop a resolution was formulated by the regional participants, in which among other things they decided to address the Russian Federation Government for granting a financial support for the development of Siberian Space Monitoring Centre in Novosibirsk.

4.2 Assessment of the Total Russian User Potential

An assessment of the total number of organisations in the RF operating within the four main

application areas has been done. This assessment does not evaluate the probability that that the organisations directly will use satellite based EO information. An extensive list of most of the organisations included is given in Annex A.5.

4.2.1 Sea Ice Navigation

The major interest for sea ice mapping applications using SAR data in the Russian Federation is related to the shipping activities in the Northern Sea Route (NSR) and the major Siberian rivers. Under the Northern Sea Route Administration the following governmental bodies participate: RosHydromet (Arctic, Antarctic and Marine Administration), Ministry of Transport, Ministry of Natural Resources (Sea and Inland water administrations), Ministry of Fisheries, and the Hydrography Committee of the Navy. A total of 166 major entities are identified.

SAR-based ice information for ship navigation on inland lakes and rivers, the White, Caspian, Bering as well as the Okhotsk Seas, are also of relevance to the authorities and shipping industry. For the NSR the Northern Sea Route Administration is responsible for the management of all civilian ship operations in the region. The State Commission for Arctic Affairs consists of six Ministries and State Committees. In addition sea ice information is of use for sectors such as fisheries, natural resource exploration, mapping authorities, environmental agencies, educational institutions, as well as the HydroMeteorological Services. The key end users in this respect will ultimately be the ship captains and/or ice pilots on board the ship in operation or the escorting ice breaker service and their on shore management. Other active users are the authorities at various levels to monitor and enforce regulations for the shipping activity, at federal level to the local port authorities responsible for the local activity in their area. Along the NSR and in the main Siberian rivers around 16 ports are in operation for major parts of the year (see Figure 4-14).

MANAGEMENT BODIES OF FEDERAL LEVEL	
Ministries and State Committees	11
Committees and Management Bodies at Regional and Republic level	71
Industrial and Scientific - Industrial Enterprises	21
Scientific and Research Institutions	15
Federal Training and Educational Institutions	6
ORGANISATIONS OF REGIONAL SUBORDINATION:	
Shipping Companies – operating in ice covered waters	13
Arctic Port Administrations (with ice cover 23)	16
Regional Training and Educational Institutions	3
Shelf Oil and Gas Companies	7
Scientific and Consulting Companies	3

4.2.2 Regional Environmental Monitoring

Environmental monitoring in Russian Federation is managed under the State Committee for Ecology and its subsidiary regional committees for ecology (89, one for each of the

constituent entities of Russian Federation), thus adding up to 90 organisations at the federal level. These regional environmental monitoring bodies operate under a high level of regional independence, since several obtain their sources of funding through direct local taxation of the industry using the natural resources in the region. A significant number of organisations and bodies deal with ecological monitoring and nature protection at the local levels (level of city, sub-region, town, village, etc.), but this number is difficult to determine.

Figure 4-14: The main ports in the Russian Arctic and Far East, in which the shipping activities are hampered by the ice conditions.

4.2.3 Forestry

Total number of various types of organisations within the system of Federal Forest Service of Russian Federation (RF) is 213, of which there are 86 forest management bodies at a federal level and 127 subsidiary organisations locally.

Source: Directory of office phones of workers of federal forestry service of Russia (on state at 1 January 1998) /Federal forestry service of Russia, Moscow, 1998, 66 pp.

MANAGEMENT BODIES OF FEDERAL LEVEL	
Federal Forest Service of Russia	1
Forestry management bodies in the republics of the RF	21
Forestry management bodies in Krai, Oblast and autonomous formations of the RF	64
ORGANISATIONS OF DIRECT SUBORDINATION:	
National parks	4
National parks subordinated to forestry management bodies in constituent entities of the RF	29
State Forest Management Enterprises	12
Scientific and Research Organisations	14
Institutes for qualification improvement	2
Other organisations of direct subordination (including 26 airbases and forest museum, forest information services etc.)	32
Special education organisations of the federal forestry service	21
Forest technical schools	4
Other organisations (such as magazines, banks, joint stock companies etc)	9

4.2.4 Natural Resources

Among organisations dealing with management, exploration, transportation etc. of natural resources, information was obtained for several systems or types of organisations: Russian Geological Service (1132), Russian Service for Water Management (159), and Russian oil and gas companies (259).

A) Within the Russian Geological Service total number of 1132 organisation was identified, of which:

FEDERAL LEVEL OF SUBORDINATION	
Ministries and State Committees	76
Industrial and Scientific-industrial enterprises	24
Scientific and Research Institutions	47
REGIONAL LEVEL OF SUBORDINATION:	
Institution and enterprises	948

Source: Directory of enterprises and organisations (on 1 July 1997). Book 1. Geological service of Russia (Federal level of management). /Ministry of natural resources of Russia, 1997

B) The system of Russian Service for Water Resource Management comprises the following 159 organisations:

Regional basin water management services	23
Directions of water reserves under constructions	7
Scientific organisations	13
Various organisations subordinating to the regional water management services	116

Source: Directory of enterprises and organisations (on 1 July 1997). Book 3. Water industry management service of Russia /Ministry of natural resources of Russia, 1997.

C) Total number of Russian oil and gas companies operating within the Russian Federation is 259. No distinction between federal/regional levels can be made from the data available.

Source: Golden fund of oil business, 1998. Section: Oil and gas extraction enterprises. Russian federation.

4.3 Key EO Application Areas of Concern for Russia

Analysis of the information acquired during the project implementation shows that satellite EO data coverage are requested for large parts of all over the Russian Federation. Both high spatial resolution and frequent coverage is necessary for many industrial organisations and authorities within various application areas. Various issues in application of EO information are described below for each of the main application areas.

4.3.1 Sea Ice and Marine Applications

Sea ice information for Navigation support

Of relevance to all marine activities is information on the ice edge and distribution, ice type (age), thickness, concentration and ice kinematics. Satellite data on ice cover, sea ice features and thickness obtained in the near-real time mode are necessary for safe and efficient ship routing during winter conditions. In addition, sea ice information is essential for off-shore oil and gas exploration activities, pipeline constructions in land and water areas, marine insurance companies etc.

Studies of marine resources

Of direct importance for fishery operations are hydrological conditions, such as location of ocean fronts, boundaries of cold and warm water masses, eddies and rings, internal waves and up-welling zones. Other important issues are operational mapping of sea surface temperature and the spatial distribution of phytoplankton, organic matter and marine pollutants including oil contamination. Sea bottom relief and assessment of coast line changes will be useful for coastal management and analysis of marine pollution effects.

4.3.2 Environmental Monitoring Applications

Oil and gas contamination

One of the most important issues for ecological monitoring is related to the intensive oil and gas production activity, mainly in the northern territories of the Russian Federation. The pollution issue is related to both monitoring of the terrestrial and marine contamination of the

environment. Pollution sources are associated with drill sites, the extensive network of oil and gas pipelines, and land and waterway transportation of oil and gas. For instance over two thousands cases of oil pipeline leakages occur annually in Siberia. In assessing hazardous situations along the oil pipelines and at oil and gas exploration sites, remote sensing will be very useful in determining the risk factors based on remoteness and natural condition of the territory. Until recently damage assessment from terrestrial oil pollution has been based on the use of EO data from the Landsat and SPOT satellite sensors, and only to a minor degree on the use of SAR data. Due to the frequent haze and cloud cover over large areas of Russian territory, the use of active microwave EO imagery is very promising.

Extent of the Permafrost area

Mapping of climatic changes in the geographical extent of permafrost conditions is essential. The information is related to the general issues of the release of methane gas to the atmosphere as well as to the significant change it will have on man-made constructions and activity in the area of changing frost conditions (movements of pipelines, roads, railway lines, dams, buildings etc.).

Floods

River flooding is an important problem of concern in various parts of Russia. Information related to the water equivalent in the snow cover, the melting process, critical ice barriers in rivers and lakes is of significant importance for forecasting spring-floods.

Erosion, landslides and avalanches

Both riverbed and ravine erosion caused by floods due to snow melting or extremely high precipitation activity, are important issues for many regional authorities. Estimates of the excessive soil moisture content, localisation of landslides or mudflows, snow avalanches, and risk assessment for these factors are also of paramount importance for many regions of Russia.

Other natural hazards

The detection of areas with changes of surface relief as a result of earthquakes can be used in seismic zoning and earthquakes prediction. In order to acquire multi-year data set for land use, such factors as albedo and reflective properties of Earth surface should also be studied.

In addition the survey also identified interests in use of EO data for monitoring of storms, drought, avalanches, mudflows, industrial risks and volcanoes.

4.3.3 Forest Application Areas

The control of the water protection boundaries during forest logging

Monitoring of the boundaries of the water protection zones along the rivers (typically 100-150 m extension) is a critical issue with respect to the actual logging activity. Areas of forest logging currently often severely affect areas of the water protection.

Forest management activities

There is a lack of thematic classification of both type and condition of forest areas for vast areas. A combined use of medium (40 m resolution) and high (10 m) resolution EO data for forest management activities in forest-abundant and unexplored areas may improve the management and exploitation efficiency. It will result in saving of significant financial and human resources as compared to traditional field mapping, and will significantly increase knowledge base in areas where it is difficult to organise operational aerial surveys.

Evaluation of forest restoration quality

EO images of high- and medium resolution allow evaluation of the actual state of forests that by its age should be classified as exploitable areas. Forests are classified in 3 groups. Usually for forests classified in the 3rd group (without economic importance) and sometimes in forests classified in the 1st and 2nd groups (better quality forests) are reclassified based on their age and not on an actual examination of areas and their development. As a result, significant areas that exist only on paper are classified into forested area and from that point are considered as valuable forest of the relevant age. For many forest enterprises it results in distortion of the baseline data on available forest resource structure, perhaps hiding unfavourable tendencies, which hence may contribute to incorrect decisions in the management of forest resources.

Assessment of surfaces and location of areas with natural ecosystems in the regions damaged from previous clear cutting

In many forest regions of Russia logging was previously done by clearing huge areas of several hundreds hectares. Boundaries of such clear cut areas, preserved natural areas or significantly deteriorated secondary vegetation is clearly visible on images even at 150-meter resolution. EO-based information could be used for planning of nature protection and for correction boundaries of planned protected territories, their protected zones as well as water-protection zones. The application of EO data for environmental purposes, by providing information on the spatial distribution and structures, is sometimes more informative than use of common types of land- and forest management information.

Evaluation of the actual boundaries and state of areas of near-tundra forests

Discrimination of the regions of near-tundra forests, where logging is prohibited, was conducted long time ago and currently available information does not correspond to the actual situation. The Federal authorities have particular interest in use of EO data to effectively control logging activities in the forest region near the tundra and improve the management of the current operating regulations.

Forest fire detection, combat and loss assessment

Satellite imagery may be very efficiently applied for monitoring of forest fires, particularly for assessment of forest fire danger (forecasting) and early warning and localisation of actual forest fires, assessment of their dynamics and potential development under various meteorological conditions. Damage assessment and mitigation is essential also for the possible use of the remaining timber resources in areas of previous forest fires.

4.3.4 Geologic Applications

Satellite images with resolution better than 100 m may provide relevant information for:

- Detection of regional geological structures such as lineaments, ruptures, jointing, zones of the newest activation, faults;
- Revealing of structural-tectonic elements;
- Discrimination of age and genetic types of newest sediments, elements of geomorphology, local class tectonics.

This information can be used for the study of tectonic beds and detection of regions of geological activity. In this case additional remote sensing information on surface temperature and Earth surface albedo is necessary.

The vastness and remoteness of the Russian Federation also stimulates the application of EO-based methods for assessment of possible location of various natural resources deposits.

4.3.5 Agriculture Application Areas

Inventory of cultivated land areas

Discrimination and identification of areas occupied by various crop types. Crop types, classified by satellite data, have to be validated by field observations and merged with the other public data bases and information on the structure of the cultivated areas. The need for information is both identified by public management and commercial agricultural enterprises.

Agricultural hydrology

The following main application areas are of importance: (i) analysis of precipitation rate and frequency, (ii) studies of soil moisture capacity and (iii) studies of water and watering regimes of arable lands.

Land use

In several regions there is a need for the detection of the changes in landscape topography and the detection of changes in terrestrial land cover type and condition due to natural and anthropogenic impact. Of specific concern are such issues as harvest forecasting as well as assessment of insect pests and protection measures against them.

4.3.6 Hydrology Applications

Control of water resources entails monitoring of snow and ice cover, assessment of sources of ground water, and monitoring of floods.

Monitoring of snow and ice cover is aimed at:

- Monitoring of fresh water reservoirs,
- Assessment of area and thickness of snow cover,
- Warning of possible floods resulting from intense snow melting.

4.3.7 Cadastre and Mapping Applications

Topographic mapping provides scientific research and applied programs that study environmental changes with topographic data and data on Earth surface characteristics, such as:

- Vegetation;
- Open ground
- Snow or ice covers
- Construction
- Infrastructure
- Agricultural areas
- Water bodies

It is also expedient to use high-resolution radar imagery for the studies of geomorphological phenomena such as:

- Landslides
- Deluvial and proluvial cones
- River valleys
- River deltas
- Changes in coastal line
- Mud flows
- Volcanic forms

The information acquired is used for land planning, detection of water flow channels and areas of potential flooding and for the study of soil erosion. In coastal areas topographical information is necessary for the detection of changes in slope of coastal morphology and forecasting of floods.

4.3.8 Urban applications

For the urban territories of Russia, especially for large cities, specific concerns are related to mapping, monitoring and management of urban territories, assessment of the state of transport networks, study of industrial and domestic heat losses etc.

4.4 An Assessment of Geographical Location of a ERS/Envisat SAR Acquisition Station

Recommendations for the possible location of an ERS/ENVISAT SAR data acquisition station within the Russian Federation is done on the basis of the user requirements for geographic data coverage. A baseline for the assessment is a requirement for complete SAR data coverage of the territories of the Russian Federation. The technical and practical implications, or the installations and operations of such a SAR acquisition station are considered to be outside the scope of this project. The current official ESA stations partly covering the RF are located in Kiruna (Sweden) and Fucino (Italy). In addition several national stations are covering various parts of the RF. For consideration of a station location within the RF three sites are considered i.e. Moscow region, Novosibirsk in Siberia and Yakutsk in the central eastern part. Figure 4-15 shows the approximate geographical coverage (the radio-visibility zones) for the three locations.

In addition to the Yakutsk location the city of Tiksi located at approximately the same longitude along the Arctic coastline is an other option. In comparing these two locations the Tiksi location will provide better coverage of the Arctic waters than Yakutsk. A station located in Tiksi will be using the antenna system of the "Orbita-2" receiving station. Such antennae installations are also available at several other locations within the RF. This implies that several other locations may be relevant and based on the project information on the user applications one such location may be Salekhard located in at the Arctic circle around 65° east. The following arguments are identified for the various locations (4-5) with respect to the four main identified application areas.

4.4.1 Ice Monitoring

For an optimal coverage of the Russian Arctic sector the receiving station could be located in Yakutsk or Tiksi. The Yakutsk location will provide adequate SAR coverage of the currently "uncovered" central parts of the Northern Sea Route (Laptev sea) in which the main economic shipping activities occur, and 88% of the responses to the survey indicate prime interest to sea navigation applications in this region. In combination with the current European and Alaska stations the entire NSR will then be covered. Shipping activities in this central part of the NSR are, however, currently limited to the "summer period" and mainly for regional transportation, with only a very limited ship transportation through the entire NSR. Also the Salekhard location will cover these remaining uncovered central parts of the NSR. The Yakutsk location will also cover the Far East seas of interest to Russia, including the Sea of Okhotsk and parts of the Sea of Japan, although parts of the Bering Sea will not be covered. In this region 44% of the respondents indicated the use of data for sea ice navigation support.

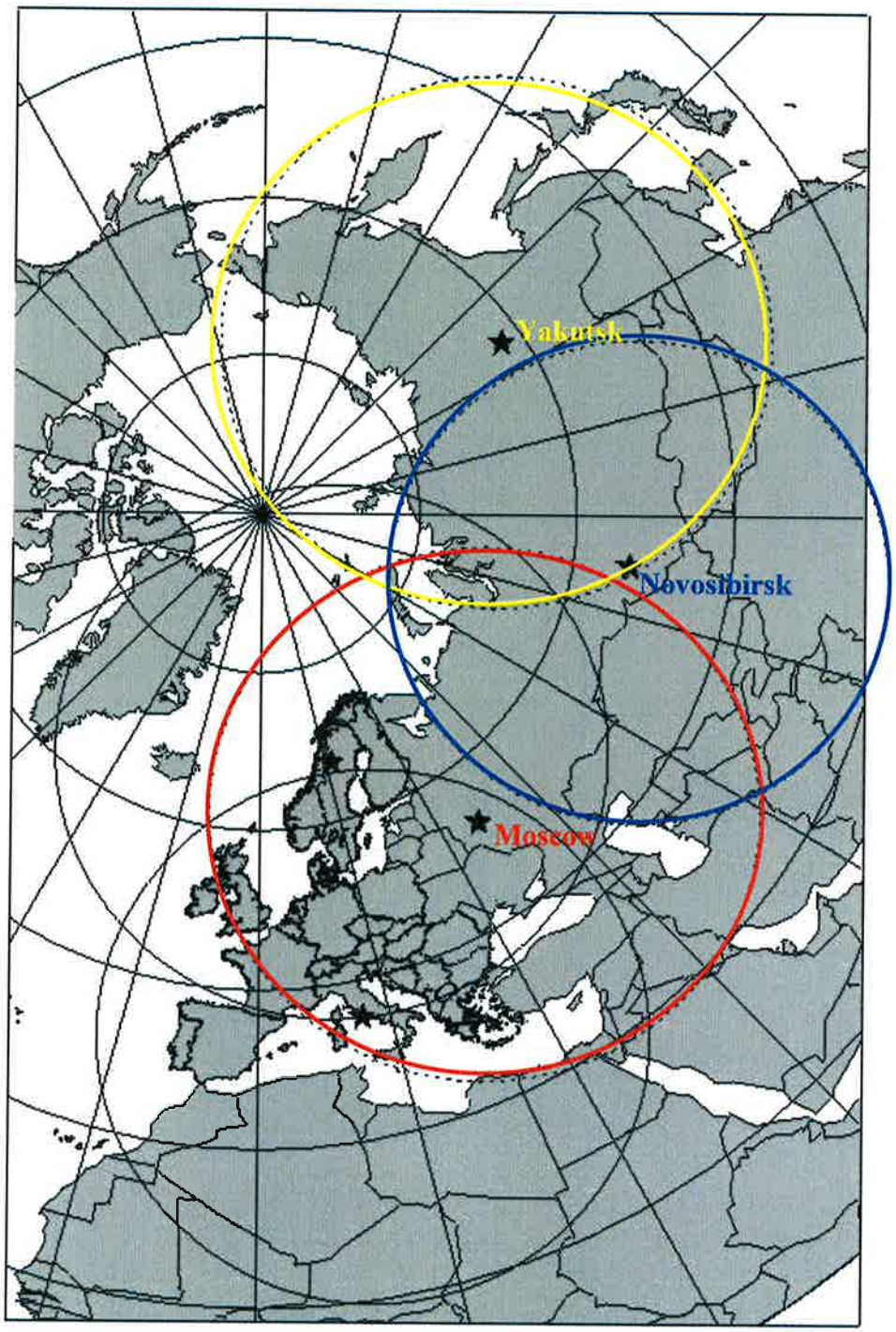
Half of the respondents also indicated a need for sea ice information for the Baltic Sea, which is covered by both ESA stations and from a station located in the Moscow region.

Also in the lower Volga and northern Caucasus including the northern part of the Caspian Sea are hampered by ice cover which cause concern to the oil and gas exploration and shipping activities of the region. A station located in the Moscow region will uniquely cover these

areas and in addition overlap the coverage of the European stations with respect to the southern Barents, Petchora and the western Kara Seas.

The Novosibirsk station location will not provide any additional coverage of the NSR and only partly cover the Caspian Sea.

Figure 4-15: An indication of three possible locations for ERS SAR receiving stations within the Russian Federation – in Moscow, Novosibirsk and Yakutsk. The radio visibility zones of each location as well as for the current ESA stations in Kiruna and Fucino are indicated.



4.4.2 Environmental Monitoring and Hazards

The main oil exploration activities within the Russian Federation are located on the land territories of northern Siberia, off-shore in the Barents, Pechora and Kara Seas and in the shelf region of Far East seas (Sea of Okhotsk, Sakhalin shelf and the Kamchatka region). The majority of the respondents to the survey indicated a prime interest in the regions including Siberia and westward as well as the Caspian Sea, which contains significant oil and gas resources. A station located in the Moscow region will, partly in overlap with the current ESA stations (Kiruna and Norwegian Tromsø stations), cover the greater part of the oil fields of the northern parts of Russia and uniquely provide coverage of the Caspian Sea region.

The Novosibirsk location will also cover the main parts of the exploration areas of interest, with the exception of parts of the Barents Sea and parts of the marine transportation routes.

The Yakutsk station location will cover both the main marine transportation routes in the Arctic and the Bering Sea, the Sea of Okhotsk and the Sea of Japan including the area of the Sakhalin shelf as well as the transportation routes to Japan and the south-east Asian countries. In addition parts of the land-based oil fields of the Yamal region (north of Salekhard) will be covered. In this respect the Tiksi location will not provide additional coverage. Around 25% of the respondents within environmental monitoring had interests in the Far East land regions and 15% in the ocean areas of the Far East.

The Moscow station location covers the parts where more that 80% of the population of the Russian Federation lives and in addition major parts of the surrounding countries such as Belarussia, the Ukraine, Kazakhstan, Turkmenistan and the Transcaucasian countries. These are the most populated and economically developed areas of the above countries in which monitoring of hazards such as floods, forest fires, ecological disasters etc. are of increased significance and impact for the population. The remote and difficult to access areas of Central Siberia and the far eastern parts of the Russian Federation are covered by the station locations in Novosibirsk and Yakutsk respectively.

4.4.3 Forest Management

The Novosibirsk station location will cover more than half of the total forests of the Russian Federation. The forest resources in Siberia are estimated to be 25% of the global timber resources. The geographical interests among the contacted organisations within forestry applications were mainly in the north-western parts of the RF (52%), central region (33%), and western (33%) and eastern (43%) Siberia and the Far East (38%), which supports a general strong interest in data coverage of the entire Russian Federation. According to other sources more than 60% of current logging activity takes place in the western parts of Siberia. The Yakutsk station location covers the forests of the Far East and, in particular, the Primorski Krai Territory where unique tree species grow and special control measures are put into force to monitor and preserve the forests and their use. The three main receiving station locations are complementary from the forest monitoring perspective. The Tiksi location in this respect is inferior to Yakutsk, due to limited coverage of parts of the forests in East Siberia and on Sakhalin.

4.4.4 Natural Resources (Geology)

The survey among the groups interested in geological mapping reveals a strong geographical focus towards the far northern parts (64%) of the RF as well as the mountain areas (e.g. Ural 33%) and the western Siberia (58%). This picture is consistent with the distribution of the natural (geological) resources within the RF. The mountain areas in south east Siberia (24%)

are also of interest with respect to terrain mapping and geological applications. The Altai region towards the Mongolian border was in this respect pronounced. A station location in Novosibirsk and Yakutsk will cover the main areas of interest in combination with existing station locations.

4.4.5 Agriculture

The Moscow station location covers more than 70% of the fields of wheat and rye crops cultivated within the RF. The Novosibirsk station location, which covers more than 60% of the agricultural fields, do not cover the most fertile lands of the central and southern European parts of the RF. The Yakutsk and Tiksi locations are in this respect less optimal in this respect. The survey did not specifically address the agricultural applications and the prime regions of interests are not investigated in detail. The data coverage of the ESA stations and the Novosibirsk location will cover main parts of the areas of interest for agricultural applications within the RF.

5. A Brief Overview of the Non-Russian Market Segments

Two major sectors of the international market for EO data covering the territories of the Russian Federation have been briefly investigated in this market survey. The first sectors covers are a limited number of international companies and organisations involved in activities of use of EO for the territories of the RF. Secondly, a review of the current Announcement of Opportunity (AO) projects within the framework of the ERS-1 and 2 missions, requesting EO data from the territories of the RF has been undertaken. The AO project evaluated has been on those requesting SAR data including both Russian and non-Russian project scientists.

5.1 International EO relevant activities within the Russian Federation

A series of telephone and personal interviews has been conducted with the help of a set of discussion guideline to assess to what degree non-Russian companies or organisations have currently some projects, commercially or research oriented covering the Russian territories. A total of about 20 organisations involved in the four main application areas have been contacted. It was not intended to perform an comprehensive survey, because of the lack of time and resources, but rather to have the opinion of some organisations which could have activities in Russia, or which could have information on the situation in Russia. This information from non-Russian users was collected with the objective to complete the qualitative and quantitative analysis, based mainly with information coming from Russian users, on the market situation for EO data in Russia. The information obtained from this part of the project is mainly of qualitative nature.

The four main application areas defined in the market survey were covered by interviews completed including shipping companies in sea ice navigation, geology (oil, gas or mineral exploration), forestry, and environmental studies. The information obtained illustrates the fact that none of the companies we have contacted currently have important or significant activities in Russia that involves use of EO data. However, some of the companies contacted do have activities in which EO data could be used, mainly in the field of oil and gas exploration and within Arctic shipping. Some project activities within other fields were also established, however most of the projects are pending or has been terminated. Several western companies recognise a significant interest in the Russian natural resources within forestry or in non-renewable resources. The reasons and explanations given on the fact that so few activities are running for their organisation in Russia point to the unstable economic situation, the current economic crisis, as well as the legal regulations for international involvement in e.g. exploitation of natural resources. However, almost all persons contacted regard the need for geographic information as essential. Therefore the use of EO data is regarded as a potential important source of information, due to the complex infrastructure and vast distances within the RF. New project activities, mainly founded by international agencies like the World Bank, are currently being set up; however the process to establish such activities generally takes a long time.

At any rate, the discussions confirm the interest of western organisations in use of EO data within all the four application areas. Within geology, forestry and environment, none of the contacted persons have expressed a strong requirement for use of radar data, but are more familiar with the use of optical EO data, which for some have had well-established application procedures.

The oil and gas resources within the Russian Federation are significant at a global scale. The proven reserves at the end of 1998 were estimated at 65.4 thousand million barrels of oil, and the oil production in 1998 (304.5 million tonnes) was twice as high as for Norway (BP Amoco, 1999). The proven gas reserves at end of 1998 are estimated to 56.7 trillion cubic meters or approximately one-third of the known global resources. The oil and gas exploration industry, with its related shipping and off-shore activities in ice-covered waters, may hence be regarded as the most promising potential field for development of SAR and other EO data applications in the future. Within the time frame of this market survey (≈5 years), three main regions have current and a potential for development of the oil and gas exploration activities. These are the Caspian Sea, Western Siberia (Barents, Timan-Pechora and Kara Seas, land areas in NW Siberia, including the Yamal and Ob region) and the Sakhalin area in the Far East. The main Russian oil and gas companies are LukOil and Gazprom, which both have established collaborative efforts with several international oil companies such as BP Amoco, Conoco, Texaco, Exxon, Norsk Hydro, Statoil and ELF. LukOil has expressed their strong perspectives of the future Arctic operations through, for example, their purchase of Murmansk Shipping Company in 1999. The exploration of the potential hydrocarbon resources in the central and eastern northern parts of Siberia and the Sea of Okhotsk will most likely not be developed extensively within the time frame of this market survey (<5 years). All the three regions have sea ice cover during parts of the year, which influences the operations. Ship transportation of the resources from the region to the consumer market is relevant except for the Caspian Sea where a pipeline network has/is being developed. However, there are only a very limited number of vessels available for year-round transportation of oil and gas in the Arctic waters and significant development of the ships to be used is needed in order to develop cost-effective operations. For the NW Siberia region, additional expenses for ice design and operations of both exploration platforms and for the transportation imply significant additional costs, which limits the profitability of such operations.

The known resources of hydrocarbon in this region are estimated as significant – for gas condensate at the same level as in the Middle East. For the off-shore operations in the Barents, Timan-Pechora and Kara Seas, shuttle transportation using ice-going tankers are needed for the transportation from the platforms to either reloading terminals or transportation to the European market. For the land-based sources, specially-designed and -operated loading terminals must be established, and the current infrastructure is far from capable of serving the operational needs. In both the design, location and operations of such loading terminals EO data may become a significant source of information. It is also the impression that pipelines over land will not substitute the need for additional ship transportation, due to both strategic and practical reasons. The main factor hampering a more extensive involvement of the international oil and gas industry in the exploration and exploitation activities within the RF is the process in obtaining clear and firm licences for their operation conditions in the exploitation phase. The use of "compulsory" information sources and measures, such as e.g. a national Russian ice service, may also impact the decisions of the companies in their use of e.g. EO data in support of their activities in the RF. The fluctuation in the prices for oil and gas products at the world market may also impose a more strict cost-effectiveness evaluation by the companies in their implementation of measures needed for their operations, including use of EO data in support of their operations.

The domestic ship transport within the northern parts of the former Soviet Union was considerable and very important for the regional activities. The total cargo volume was estimated to 7 million tons/year at its peak period, however the current volume of regional cargo transportation was reduced to a level of below 2 million tons in 1998. There is, however, a growing regional interest within the RF in shipping their natural resources directly

to the markets using ship transportation along parts of the Northern Sea Route and within the major Siberian Rivers. In this respect, the area west of the river Yenisei is of year-round interest, while the areas further east are restricted to "summer" operations. The port of Dudinka, serving the mining activities of Norilsk, is the main cargo port of the northern Russia. This kind of domestic and export transport is today mainly served by Russian cargo vessels and shipping companies. Except for transportation of hydrocarbon resources, the project has not been able to identify a significant international interest from the shipping industry in serving the transportation market in this region. However, since the need for ice classified vessels is limited to the winter period in e.g. the European waters the non-Russian shipping companies with ice-class vessels may envisage a market to be served during the summer season.

When the Northern Sea Route (NSR) was opened in July 1991 for the international shipping industry, there was great optimism about the utilisation of this route between Europe and Asia. The saving of around 50% sailing time compared to the traditional routes through the Suez or Panama canals was envisaged to initiate significant shipping activities in the NSR. However, the optimists in 1991 have failed in their short-term expectations and there is still very little international presence in the NSR. The International Northern Sea Route Programme (INSROP) was established to extensively study the challenges in developing the international ship traffic in the NSR. INSROP concludes that the NSR still has a potential for profitable shipping, though there remain obstacles related to "lack of a predictable and competitive tariff regime, reliable NSR infrastructure, due to the current political and economic instability of Russia". Further research on design of environmentally safe and ice-classified ships, in order to lower the investments costs for vessels capable to operate in this harsh environment, will also contribute to increased interest from the international shipping for this region.

In order to investigate the actual conditions of year-round operations of a tanker vessel in the western parts of the Russian Arctic waters, European industry, CEC, Russian authorities and institutions implemented the project "Arctic Demonstration and Exploratory Voyage – ARCDEV" in 1998. The project was co-ordinated by Fortum Oil and Gas (formerly Neste Shipping) in Finland and the objectives were to investigate the practical conditions, regulations for and economy in year-round ship transportation of hydrocarbons from NW Siberia to the European market. The conclusions of ARCDEV indicate that today it is not economic profitable to transport gas condensate from this region to Europe. However, with changes related to the Russian infrastructure, such as customs port clearance, icebreaker support fees and operations as well as increased loading speed at the port terminals, ship transportation of gas condensate to the European market will become profitable. ARCDEV also identified several tasks for further development, covering the range from the actual ship design to the support operations of ship navigation in sea ice, including use of EO data for more efficient ship operations in sea ice.

The above opinions reflect to a large extent the general trend for many western companies involved in the RF. However it could be that other organisation in Europe, US or Japan have more extensive activities in Russia involving use of EO data, but information on this subject has not been indicated from the persons we have contacted. One exception is the Siberia project, which is an European Union project (CEO project) which will use significant amount of ERS and JERS SAR data on Siberia, but not on a commercial basis. The project has also performed a search on the Internet to try to localise some companies having projects in Russia involving use of EO data, but no information has been found. Discussions with some Sales Area Managers of Spot Image also did not identify companies having purchased EO data over Russia.

The general conclusion is that the market for EO data over the Russian territory seems low for non-Russian users, even if the potential needs for information are very large. The market will firstly be developed when the economic situation and infrastructure will significantly improve and stabilise, and when western companies or organisation will start to invest significantly in the use of the resources available within the Russian Federation.

5.2 The ERS AO Projects

The Announcement of Opportunity (AO) Calls is the prime mechanism to stimulate development of applications and scientific research using the ESA satellite data. In the first four ESA ERS AO Calls (AO-1, AO-2, AO-Libreville, AO-Tandem) Russian Principal Investigators have been completely absent. Some projects, however, involved co-operations with Russian Co-PI´s. A few Russian scientific institutions have also purchased a very limited number of ERS SAR scenes in connection with their scientific project activities, although not to our knowledge from areas within the Russian Federation. Through these four first AO calls around 69 non-Russian PI´s have requested ERS SAR data from locations within the Russian Federation, although only a few (<10 projects) were focused on objectives specifically requiring SAR data from the territories of the Russian Federation. During the first three ERS Symposia only one paper on SAR applications were, to our knowledge, given by a Russian scientist.

After the ERS AO-3 Call the situation has changed drastically and 16 Russian scientists have become ERS PI´s requesting ERS sensor data from the territories NIS countries as well as other geographical parts of the world. 14 of these PI´s have requested SAR data alone or in combination with other ERS sensor data (Table 5-1). Altogether 31 PI´s (both Russian and non-Russian) have requested ERS SAR data from the territories of the Russian Federation, including 6 projects requesting data from the Arctic sector. The non-Russian PI´s are mainly from European countries (16 projects) and USA (5 projects) (Table 5-2). The application areas cover the land surface, ice covered and open ocean areas of the Russian Federation from the Baltic Sea to the Far East as well as from the Arctic to the southern countries of the NIS.

The increased number of Russian PI´s is both due to better awareness of the AO data possibilities as well as current lack of any SAR sensors on Russian satellites. In addition the increased international scientific co-operation has also increased the awareness and fostered co-operation such as required in AO announcements.

Table 5-1: Summary of the registered Russian PI´s under the ERS-2 AO3 announcement.

Code	PI	Institution	Title	Application
AO-172	Litovchenko, Konstantin, Ph. D.	Space Research Institute of Russian Academy of Science	Study of phenomena in the surface layer of inland seas and large lakes	Inland Waters
AO-174	Yuri M. Timofeyev, Dr., Prof.	St. Petersburg State University	GOME measurements validation, and the higher level products development	Validation
AO-188	Sharkov Eugene, Prof.	Space Research Institute	SAR remote sensing for monitoring and investigation of hydrogeological and hydrophysical processes the Caspian Sea basin.	Coastal Zone
AO-216	Trokhimovski Yuri, Ph.D.	Space Research Institute of Russian Academy of Sciences	Development of techiques for search of submarine fresh water springs on the Crimean shelf by the use of the satellite data	Ocean Features
AO-219	Pereslegin, Sergey V.Dr.	Institute of Oceanology, Russian Academy of Sciences	Experimental Verification of the Method for Restoration Mesoscale Ocean Current Velocity Fields Using ERS Synthetic Aperture Radar Data	Circulation
AO-224	Lavrova Olga, Ph.D.	Space Research Institute of Russian Academy of Sciences	Investigation of perturbing action of atmospheric and internal oceanic processes on the waved sea surface using ocean remote sensing data	Sea-Air Interaction
AO-246	Zakharov Alexander	Institute of Radio-engineering and Electronics, RAS	The ecological consequences of the accident at the Chernobyl power plant in 1986 based on the analysis of ERS archival data.	Forestry
AO-248	Romanov Alexey, Prof.	Rus. Fed. Research Inst. of Fisheries and Oceanography	Use of high resolution SAR data in fishery regions monitoring	Fishery
AO-276	Kucheryavenkova, Irina	Institute of Radioengineering and Electronics, RAS	Observation of flooding of Caspian sea shore process based on the analysis of ERS-1 and ERS-2 data.	Flooding
AO-343	Zakharov Alexander	Institute of Radio-engineering and Electronics, RAS	Research and development of highly efficient calibration techniques for spaceborne SAR systems on the base of ground based reflector antennas.	Methods
AO-401	Mitnik, Leonid Dr.Sci.	Pacific Oceanological Institute	Mesoscale oceanic and atmospheric phenomena in the coastal area of Japan and Okhotsk seas: study and monitoring with ERS SAR	Coastal Zone
AO-403	Bobylev Leonid P, Dr	Nansen International Environmental And Remote Sens	Retrieving UV irradiances from GOME Level 1 data	UV Radiation
AO-428	Alexandrov, Vitali, Dr.	Nansen International Environmental And Remote Sens	Synergestic use of ERS (SAR and ATSR) and other satellite data for ice studies	Sea ice
AO-429	Dashi D. Darizhapov	Dpt of Physical Problems, Siberian Branch, RAS	On establishing the regional system of ecological monitoring of natural objects in Lake Baikal basin	Environment
AO-431	Bobylev, Leonid P. Dr.	Nansen International Environmental And Remote Sens	The study of Siberian boreal forests current state using ERS-2 data	Forestry
AO-440	Melentyev Vladimir V., Dr. Prof.	Nansen International Environmental And Remote Sens	Application of ERS SAR Data for Studying Migration of White Sea Population of Greenland Seals	Sea-Ice

Table 5-2: Summary of the registered non-Russian PI´s under the ERS-2 AO3 announcement requesting data coverage from the territories of the Russian Federation.

Code	PI	Institution	Country	Title	Application
AO-118	Zebker, Howard A., Prof.	Stanford University	USA	Distributions of atmospheric phase artifacts in radar interferograms	Methods
AO-120	Schmullius, Christiane, Dr.	DLR NE-HF	Germany	SIBERIA - Sar Imaging for Boreal Ecology and Radar Interferometry Applications	Forestry
AO-124	Pampaloni Paolo Dr.	IROE/CNR	Italy	Multisensor Microwave data for global scale monitoring of soil and vegetation	Vegetation
AO-202	De Grandi Franco Dr.	Joint Research Centre/SAI/MTV	Italy	Regional scale mapping of a boreal wetland area by ERS tandem data	Wetlands
AO-270	Simpson, George, Dr.	EOS	UK	Use of ERS Archive Data in Facility Design and Siting Studies on the Yenisey River	Sea-Ice
AO-317	Kasischke, Eric S., PhD	Earth Sciences Group, ERIM International	USA	Monitoring Fire-disturbed Boreal Forests Along the Baikal-Amur Mainline Railroad, Siberia using Multi-temporal ERS SAR Imagery	Forest Fire
AO-334	Bodechtel, Johann, Prof.Dr.	Teledata	Italy	A planning and monitoring system for oil and gas pipelines from Siberia to Europe with ERS radar and optical satellite data in connection with GIS - a pilot project in cooperation with GAZPROM and ROSNYEFT, Russia	Subsidence
AO-348	Ori, Gian Gabriele, Prof.	Dipartimento di Scienze - Universita' d'Annunzio	Italy	Quaternary climatic variations and hydrological implications in arid enviroments using SAR images	Geology
AO-370	Smith, Laurence C. Dr. Assistant Professor	University of California, Los Angeles (UCLA)	USA	Precise flood inundation mapping from ERS interferometric phase coherence	Flooding
AO-382	Johannessen, Ola M, Prof.	Nansen Environmental and Remote Sensing Center	Norway	Detection of changes in Arctic and Antarctic sea ice using ERS SAR and other microwave data	Sea-ice
AO-398	Schrum Corinna Dr.	University of Hamburg	Germany	Limnological studies in Lake Baikal	Inland Waters
AO-411	Stolz, Roswitha	Institute of Geography	Germany	The Utilisation of ERS Data for Environmental Monitoring in the Remote Areas of the Altai Mountains and the Ob-Plateau (southwest Sibiria)	Environment
AO-415	Hartmann, Rolf, Dr.	Jena-Optronik GmbH (DJO)	Germany	AGRO-EAST:2ERS-SAR data for the Agrologistic and Landuse of Eastern European Countries	Agriculture
AO-416	Zimmermann, Reiner, Dr.	Lehrstuhl fur Pflanzenoekologie	Germany	TRANSECT - SAR Imaging and Interferometry for the IGBP-NES Boreal Transect Study	Forestry
AO-423	Muller, Jan-Peter, Professor	University College London	UK	AIRMAP: PM10 atmospheric particulate air pollution maps from ATSR2 over 10 world cities.	Pollution
AO-426	Mann, Paul, Dr.	UT Institute for Geophysics	USA	Investigating Surface Change on Kamchatka Peninsula Though Thematic and Interferometic Studies of ERS-1/2 Radar Data	Volcanoes
AO-435	Ranson Jon K. Dr.	Biospheric Sciences Branch - Code 923,Goddard SFC	USA	Mapping Siberian Landscapes: Natural and Anthropogenic Factors Affecting Carbon Balance	Forestry

6. Conclusions and Recommendations

During the project around 450 Russian institutions have been contacted, informed and asked about their needs for EO based information, in particular SAR data to solve their main missions. The result is that 189 institutions has responded with useful information to be included in the project relational database concerning their requirements to and use of EO based information products. All together round 100 individuals attended the three project workshops organised in St. Petersburg, Moscow and Novosibirsk at which further information was obtained on integrated use of SAR data within the Russian Federation.

The study concludes that a wide range of SAR applications has been developed for use within the Russian Federation. The Market segments needs to SAR data are well defined within several sectors, however the commercial applications are limited due to the current financial situation in the RF. The scientific sector has a large potential to contribute to development of SAR applications and their request for data has been increasing over the last years. Hence a data demand is well defined, however with limited commercial ability to purchase SAR data. The international market for SAR applications for the territories of the RF are in situation of awaiting changes in the Russian economy before implementing new initiatives in this respect. The need for one or more SAR receiving station within the Russian Federation are documented to serve the users needs with respect to both SAR data coverage and facilitate the user access to actual data. The necessary infrastructure and local initiatives to meet the operational needs of such stations are identified, however this was outside the main scope of this project to investigate.

The project has analysed the retrieved information concerning the Russian awareness and use of SAR based EO data according to the following conclusive statements:

State-of-the–art

- Optical and infrared EO data have for many years been operationally used within areas such as:
    - Sea ice monitoring;
    - forest fire detection and damage assessment;
    - weather forecasts;
    - pollution monitoring and assessment;
    - river flooding monitoring;
    - ecological mapping;
    - crop status monitoring;
    - coastal zone monitoring;
    - geology and natural resources mapping, and others.
- A national network of EO acquisition stations has been established in order to serve the regional needs for data and information from the Russian and earlier Soviet Union EO satellites.
- Russian experience with spaceborne radar systems has been established by various Russian institutions under the Almaz SAR program.
- Use of Russian EO data has declined over the last decade, but an increase is again observed over the last years, despite the current financial problems in Russian economy.
- Lack of information on state-of-the-art SAR application areas limits the actual use to be

considered by "non-expert" EO users.

- Regional authorities (environment, natural resources and industry) of the Russian Federation are currently using EO information sources.
- Regional Authorities have shown willingness to further explore EO data as major source of information.
- Regional environmental authorities cover part of their budgets through local taxes from the industry involved in exploration of natural resources.
- The use and awareness of EO data are more limited in the private sector, than in the public sector.
- No respondent to the market survey has provided information on the financial aspects of their activities (current budget, costs of services etc.). Accordingly the expected future outlook for development has been impossible to assess from their responses to the survey.

Awareness and Requirements

- A high level of awareness for use of EO data is established in a wide range of public and semi-public organisations – in particular at scientific research institutions.
- Despite a general high level of awareness most user groups need information and routines for generation of value added products. In particular the knowledge of non-Russian EO data and sensor systems are very limited.
- The forest authorities and industry, as well as the oil companies and mining industry, are in general sceptical about the benefit of SAR until their direct applications are better validated and demonstrated within their own fields of operation.
- Tailored and dedicated information on state-of-the–art applications for SAR data are very much needed in order to develop new application areas and to stimulate the increased use and further development of EO data.
- User training and documentation of application algorithms and methods are needed in order to increase the awareness in a large section of the Russian user community.
- Near real-time applications and year around operations are identified within all the user categories.
- An increased demand for ERS SAR data for the territories of the Russian Federation is identified among Russian scientific users, regional authorities and partly among the international user community involved in activities in the RF.
- In order to meet the identified user requirements for SAR coverage of the RF, a combination of three station locations are required - in Moscow, Novosibirsk and in Yakutsk.
- One or more ground station located within the Russian Federation will significantly facilitate the access to and promotion of use of SAR data for the Russian user community.
- To serve the data needs of the Russian and international PI's under the Third ERS Announcement of Opportunity (AO3) a station located in Novosibirsk is required.
- The Yakutsk station location will *uniquely* cover the eastern part of the Northern Sea Route (Laptev Sea) as well as land areas of the Far East of RF. The Far East seas will also be covered in partly overlap with other existing station locations.
- The SAR data costs are a significant and limiting factor for application development within all application areas.
- The market survey has contributed to an increased awareness of Russian SAR application forming a basis for future market and application development.

Application Areas

- SAR data has its particular benefit among EO information sources in the high latitude regions of the Russian Federation, due to the frequent occurrence of cloud, haze and winter darkness.
- The basic industrial use and exploration of natural resources are located mainly in the northern regions of the Russian Federation.
- Regional authorities have indicated significant benefit in the use of EO data, including SAR, within environmental mapping for planning of new activities and installations (roads, railroads, pipe lines etc.) and environmental monitoring and assessment of impact from existing installations.
- Regional authorities envisage EO data to become a prime source of information within mapping and monitoring of natural phenomena such as sea ice, flooding including ice blocking in rivers, forest state and damage as well as forest fires.
- SAR applications in support of ship navigation in ice covered areas is the most developed application area, although, wide spread commercial use is currently limited by the data costs, due to limited geographical coverage of the current ERS SAR sensor (100 km swath) and the current financial situation in Russia. Despite the technical limitations SAR data has proven significant value when available.
- Ship detection is of interest to local authorities in order to monitor illegal fisheries particular in the Far East seas.
- The oil exploration industry operates often through intermediate companies, providing environmental assessment and other services in which EO data can be used as an integrated source of information. These end-users do not regard EO data alone as a source of information, but require integrated retrieval of the information content as essential to increase the use of EO data.
- Previous forest monitoring was mainly done using aerial surveys. However this has declined significantly over the recent years due to the budget situation. A cost-efficient substitute or complement could be obtained through use of satellite SAR data in combination with other information sources.

Future Development

- An increasing interest in the Russian and international scientific community for SAR data from the territories of the Russian Federation is observed through the increased number of projects in response to the later ERS AO calls.
- The Russian scientific community has expertise in existing and future thematic application areas of SAR data, which will be of benefit to the Russian and international user communities.
- Within mapping and monitoring of terrestrial pollution, forestry and natural resources (geology) exploration, SAR data have a significant national potential of development provided that the application methods well demonstrated and validated.
- Within the oil exploration industry, partly shipping industry, forestry (industry and authorities) and mining companies there are financial resources and willingness to invest in use of *documented and beneficial applications* of EO data.
- Increased availability and access to ERS SAR data within the RF will foster research and application development. Furthermore this will stimulate the development of future operational applications and the market for ENVISAT SAR data from year 2001.

The non-Russian Market

The most significant interest in the possible use of EO data for the Russian territories is identified within the sector of exploration of hydrocarbon resources. Related to these activities is also the support of shipping and off-shore operations in ice covered waters as well as planning of pipeline structures. Within international research programs for monitoring of the forest resource there is also a pronounced interest for EO data coverage of the forested parts of the RF. Most of the relevant international activities within the RF are depending on non-Russian funding of its activities, however many companies regards their presence to day as were important for a more active future activity in the Russian market.

The general conclusion through the limited number of contacts is that the non-Russian market for EO data over the Russian territory seems low, even if the potential needs for information are very large. The market will firstly be developed when the economic situation and infrastructure will significantly improve and stabilise, and when western companies or organisation will start to invest significantly in the use of the resources available within the Russian Federation.

A SAR Receiving Station Location

An assessment of the importance of the suggested station locations for ERS/Envisat SAR station within the Russian Federation has been made (Table 6-1) under the assumptions of the current network of stations and the requirements for data coverage within each application area obtained through the survey. Each application area has different priorities with respect to geographical coverage although requirements for coverage of the entire Russian Federation is required. Year around operation of the SAR data acquisition is required for most application areas, however with some seasonal preferences for the different applications.

Table 6-1: An assessment of the importance (ranked from 1 to 4) of the various ERS/ENVISAT SAR station locations for each application area. The coverage of the existing ESA stations is taken into consideration when ranking the station locations. N/A: not applicable compared to the higher priorities or other current stations.

Application area		Moscow	Novosibirsk	Salekhard	Yakutsk	Tiksi
Ice Monitoring		4 [1)]	N/A	3	1	2
Env. Monitoring & Hazards	marine	2	N/A	1	3	3
	land	1	2	3	3	N/A
Forest management		1	2	3	3	N/A
Natural Resources (Geology)		3	1	3	2	N/A
Agriculture		1	2	3	(3)	N/A

1) area covered entirely by the Tromsø & Kiruna stations.

SAR Use Assessment

The project team has assessed the probability that the contacted users in future will purchase or use SAR data within their mission areas (see Figure 4-11 to Figure 4-13). The conclusion of this assessment is that with an acceptable level of confidence around 1/3 of the contacted organisations will to some extent be purchasing SAR data in the future. Around the same number will also be using data in the future with a very high level of confidence. As much as close to 90 % of the contacted organisations will use SAR data in their mission areas,

provided that they are offered at a free-of-charge basis.

The Russian market for SAR data has a large potential of development, but in the current financial state it is difficult to obtain both quantitative commitments or firm figures on its development. In order to become commercial viable the market will need both information and training to adopt use of SAR data at a regular basis.

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