KOMPSAT-1 AND KOMPSAT-2 FROM A EUROPEAN PERSPECTIVE

F. P. Kressler [a, *], Y.S. Kim [b], C. Schiller [c], K. Steinnocher [a]

[a] ARC systems research, 1220 Vienna, Austria - (florian.kressler, klaus.steinnocher)@arcs.ac.at
[b] Korea Aerospace Research Institute, Daejeon, Korea, younsoo@kari.re.kr
[c] ARC Seibersdorf research, 2444 Seibersdorf, Austria, christian.schiller@arcs.ac.at

Commission VI, WG VI/4

KEY WORDS: Remote Sensing, KOMPSAT, High resolution, Multispectral, Sensor,

ABSTRACT:

On July, 28th, 2006 the second Korean Mulipurpose Satellite (KOMPSAT-2) was launched. This not only represents an important step on the roadmap of the Korean National Space Development Plan (NSP), it is also an important addition to the already available high-resolution optical sensor. With specifications similar to those of IKONOS-2, it is complementary to the remote sensing systems currently operated by Europe. KOMPSAT-2 is part of a long-term concentrated governmental effort of different Korean agencies to develop, built and operate different space technologies. This long term support allows the gradual built-up of capabilities and know-how, ranging from the design and operation of space sensors to the launch of space vehicles. Cooperations between Korea and Europe on a governmental, research and commercial basis provide an opportunity for both Korean and European researchers to benefit from each others technologies. Panchromatic data of the Electro-Optical Camera onboard KOMPSAT-1, launched in 1999, is already available through the European Space Agency's (ESA) Third-Party-Mission Programme and at the Austrian Research Centers (ARC).

1. INTRODUCTION

The Republic of Korea (see Figure 1) has approximately 48.8 Million inhabitants and covers 98.480 km². The capital Seoul is, with over 10 Million inhabitants in the city area and over 23 Million (Brinkhoff, 2006) in the Seoul metropolitan area, one of the largest megacities in the world. It is also the worlds 10th largest exporter (CIA-Factbook, 2006), mostly due to its large high-technology industry.

Source: https://www.cia.gov/cia/publications/factbook/maps/ks-map.gif

Figure 1. Map of the Republic of Korea

In view of the importance of high technology for the future economic development, the government of Korea drew up a National Technology Road Map in 1995, in which six strategic technologies were selected as critical for the future, space technology being one of them (Choi, 2003). In accordance to this, remote sensing was found to be of prime importance for the national development of high technology. The National Space Development of Korea, established in 1995 and revised in 2005 (NSP, 2005), lays down the roadmap for space development in Korea until 2015. It encompasses, among others, the development of 7 multipurpose, 4 science and 2 geostationary satellites. From an earth observation and monitoring point of view, the multipurpose satellites are of the greatest interest.

Two KOMPSAT (Korean Multipurpose Satellite) satellites have already been launched. KOMPSAT-1, launched in 1999, provides with the EOC (Electro Optical Camera) panchromatic images at a spatial resolution of 6.6 m. While it served as a testbed for further Korean developments, it already provided valuable data and is still in operation at the time of writing. In the course of a cooperation between the Korea Aerospace Research Institute (KARI) and the Austria Research Centers (ARC) datasets covering different European cities were geocoded and made available as well as different applications, using this data, were examined.

On 28th July, 2006 KOMPSAT-2 was launched. With specifications comparable to those of IKONOS-2 it represents a major development step for the Korean space programme as well as an important addition to the already available sensor. Due to the cooperation already established between KARI and

* Corresponding author.

ARC and ties currently being establishes between KARI and the European Space Agency (ESA), European scientist will be able to benefit from this technology.

In the following paper the Korean National Space Program (NSP) will be outlined. This is followed by a more detailed examination of the already available multipurpose satellites, KOMPSAT-1 and 2.

2. KOREAN NATIONAL SPACE PROGRAMME

The Korean National Space Programme was originally initiated in 1995 and revised in the years 2000 (NSP, 2000) and 2005. The objectives of space development in Korea are:

- capability to launch micro satellites indigenously by the year 2005,
- indigenous development of low earth orbit multi-purpose satellite and launcher by the year 2010,
- become one of the worldwide top 10 countries in the space industry by the year 2015.

Special emphasis is put on acquiring the capacity of indigenous space development covering all aspects of space technology. As part of this plan the Korea Space Launch Vehicle-1 (KSLV-1) is currently under development. It is scheduled to be launched in October 2007 from the Korean Space Centre, currently under construction at Oenaro Island, Korea (KSLV, 2006).

According to the revised National Space Programme 13 satellites will be developed and launched by the year 2015, covering 7 multi-purpose satellites, 4 science satellites and 2 geo-stationary satellites. The multi-purpose satellites perform observations of the earth's ocean, the polar regions, the environment and weather and some space physic parameters. The science satellites conduct studies in core technologies related to the development or multi-purpose satellites and space science experiments. The geostationary satellites will cover both communication, broadcasting and meteorological application.

In the following sections an overview of KOMPSAT-1 and 2 will be given. This is followed by a section describing the implication for Europe, with special emphasis of the opportunities available to European scientists.

3. KOMPSAT-1

KOMPSAT-1 was launched on 20th December, 1999 from Vandenberg Air Force Base, USA. It is a joint development between the Korean Aerospace Research Institute (KARI) and TRW Inc. and features three sensors. The Space Physics Sensor (SPS) consists of two instruments, a high energy particle detector and ionosphere measurement sensor. From an earth remote sensing point of view the OSMI (Ocean Scanning Multispectral Imager) and the EOC (Elector Optical Camera) are of primary interest. The objective of the OSMI is to provide measurements for biological oceanography. It collects data in six spectral bands at a ground resolution of 1 km with a swath width of 800 km (see Table 1). The data provide insights into the distribution and fluctuation of dissolved organic matter and phytoplankton, which represents the basis of the marine food chain and is of vital importance in the CO_2 cycling.

Spatial Resolution	1 km
Spectral Resolution	6 bands (0.4-0.9 µm)
Radiometric resolution	11 bit
Swath width	800 km
Orbital period	daily

Table 1. Characteristics of OSMI on KOMPSAT-1

An example of an image collected by OSMI is given in Figure 2. It shows the phytoplankton distribution around the Korean peninsular.

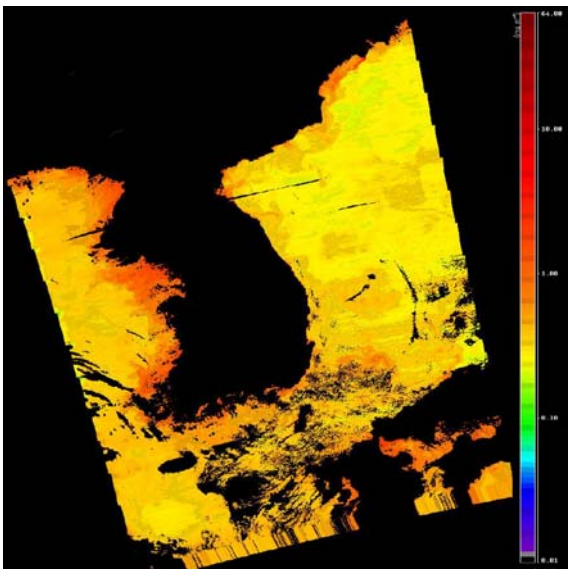

Figure 2. Phytoplankton Distribution measured by the Ocean Scanning Multispectral Imager (OSMI)

The EOC collects panchromatic images at spatial resolution of 6.6 m with a swath with of 17 km. It uses pushbroom scanning and has cross-track pointing capabilities (body pointing) of up to ± 45 °. The characteristics of the sensor are given Table 2.

Spatial Resolution	6.6 m
Spectral Resolution	0.51 – 0.73 µm
Radiometric resolution	8 bit
Swath width	17 km
Orbital period	28 days
Viewing angle	± 45 °

Table 2. Characteristics of EOC on KOMPSAT-1

A sub set of a KOMPSAT-1 scene is shown in Figure 3. It shows the centre of the City of Vienna and it can be seen that the spatial resolution allows the identification of building blocks and major streets.

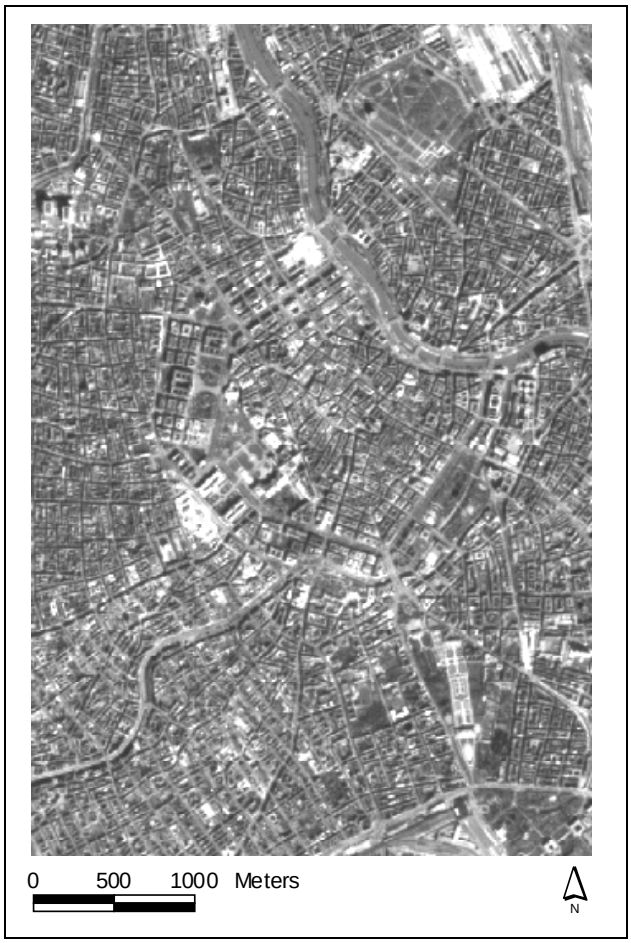

Figure 3. Subset of KOMPSAT-1 scene of center of City of Vienna, Austria

Although designed for three years, at the time of writing (August, 2006) KOMPSAT-1 was still in operation. Nearly 50,000 images were archived covering different areas of the world. This main archives catalogue, located at KARI, can be accessed through the eoPortal (http://catalogues.eoportal.org/eoli.html) operated by ESA. For research purposes KOMPSAT-1 data is available through a third party mission agreement between ESA and KARI (http://eopi.esa.int/esa/esa?cmd=aodetail&aoname=Kompsat). This archive covers uncalibrated data from approximately 50 European cities (see Figure 4). Additional data from the KARI archive can be obtained upon submitting a full Category-1 proposal to ESA.

Since the launch of KOMPSAT-1 numerous applications have been carried out. They range from 3D-modelling derived from stereo images (e.g. Sohn, et al. 2004) to urban land cover mapping (e.g. Kim et al. 2004, Kressler, et al. 2002a), change detection (e.g. Jeong and Kim, 2004) and texture and fusion analysis (e.g. Kressler, et al. 2002b). Object-oriented analysis (Baatz et al. 2003) was also found to be very helpful for the analysis, as this not only allows a classification on the basis of spectral and texture information but also on neighbourhood and shape (e.g. Kressler, et al. 2003).

Source: http://eoli.esa.int/servlets/template/welcome/entryPage2.vm

Figure 4. Location of KOMPSAT-1 image available though ESA

In addition, KOMPSAT-1 images georeferenced by the Austrian Research Centers (ARC) from different European cities can be searched on the eoPortal (http://catalogues.eoportal.org/eoli.html) and are available free of charge upon request for Category-1 users and at a very reasonable price for commercial customers. An online view, order and access interface utilising the SSE Portal (http://services.eoportal.org) will soon be made available by ARC (see Figure 5).

Source: http://services.eoportal.org

Figure 5. Georeferenced KOMPSAT-1 images available from ARC

The receiving station for KOMPSAT data is located at KARI in Daejeon. In 2004 the first KOMPSAT-1 image was down linked in Europe. It is an image recorded of the City of Leipzig, Germany and downloaded at the receiving stations of the DLR (Deutsches Zentrum für Luft- und Raumfahrt) in Neustrelitz and the Dutch National Aerospace Laboratory (NLR).

4. KOMPSAT-2

On 28th July, 2006 KOMPSAT-2 was launched by Eurockot (http://www.eurockot.com) from Plesetsk Cosmodrome, Russia (see Figure 6). The launch vehicle is based on a converted SS-19 ICBM, bringing the satellite to a sun-synchronous orbit at 685 km altitude.

Source:
http://www.eurockot.com/alist.asp?cnt=20040894&main=3

Figure 6. Launch of KOMPSAT-2

The sensor is a joint development between Korea and Israel by KARI and ELOP Ltd. (http://www.el-op.co.il/). It records data in one panchromatic and four multispectral bands at a resolution of 1 m and 4 m respectively (see Table 3). The swath width is 15 km and the radiometric resolution 10 bit. The repeat rate is 28 days which can be lowered to one to three days using body pointing of the satellite bus.

For Korea, the United States and the Middle East image distribution will be performed by KAI Image Inc. (http://www.kaiimage.co.kr). For the rest of the world distribution will be carried out by SPOT IMAGE (http://www.sportimage.fr/). At the time of writing pricing information was not yet available. Data will be downloaded at the control station at KARI in Daejeon. In addition downlink facilities will also be used in Europe as well as on other continents, allowing data collection without interfering with the original mission of KOMPSAT-2 over Korea.

The specifications of KOMPSAT-2 are given in Table 3.

Spatial Resolution	1 m (panchromatic) 4 m (multispectral)
Spectral Resolution	0.5-0.9 µm (panchromatic) 0.45-0.52 µm (blue) 0.52-0.60 µm (green) 0.63-0.69 µm (red) 0.76-0.90 µm (near-infrared)
Radiometric resolution	10 bit
Swath width	15 km
Orbital period	28 days
Viewing angle	± 30 °

Table 3. Characteristics of KOMPSAT-2

The specification of KOMPSAT-2 will allow a wide range of applications (Sakong and Im, 2002). They range from the production of topographical maps, agricultural, environmental, forest and costal monitoring. High-resolution digital elevation models, derived from stereo images can improve the management of water resources. Urban planning and monitoring of urban sprawl, with or without the use of 3-D imagery can be expected to be one of the prime uses of the high resolution data. Another important role will be disaster monitoring, within Korea and outside.

5. FUTURE KOREAN SENSORS

In the coming years a number of new multipurpose satellites are planned (see Table 4).

Year	Sensor	Characteristics
2008	KOMPSAT-5	X-band Synthetic Aperture Radar
2009	KOMPSAT-3	Optical
2010-2015	KOMPSAT-3A KOMPSAT-7 KOMPSAT-6	Not yet decided

Table 4. KOMPSAT sensors planned for the future

In 2008 KOMPSAT-5, a X-band synthetic aperture radar will be launched. A year later, KOMPSAT-3 with specification similar to KOMPSAT-2, but increased spatial resolution, will follow. For final phase of the current Korean space program in 2010 - 2015 three more satellites of the KOMPSAT series are planned. It can be seen that KOMPSAT represents a continuous development and improvement, building upon previous experience.

6. CONCLUSION AND OUTLOOK

The Korean Space Program is an extremely ambitious and long term undertaking. Started in 1995 with a 20 year time line it is still on track, although some revision had to be made. It is part of a large scale program of the Korean government to establish technologies relevant for the future. The long range planning allows the gradual built-up of know-how in Korea, ranging from building and operating satellites to launching them from Korea. Due to the cost-intensity of the technology and the long learning curve associated with it, government support and a long-term commitment is crucial for a successful continuation of such a program. This program resulted, among others, in two multipurpose satellites which are currently in operation. While KOMPSAT-1 only features one panchromatic band with a spatial resolution of 6.6 m, KOMPSAT-2 already has five spectral bands, one panchromatic with 1 m and four multispectral with 4 m spatial resolution. This not only is a major step forward in the technological development, it is also a very welcome addition to the already existing satellite sensors. The specifications of KOMPSAT-2 are complementary to the satellites currently operated by European countries. Future satellites of the KOMPSAT series will bring further improvements in the optical domain as well as new developments in the field of synthetic aperture radar. The ties established between different Korean and European institutions and research facilities will improve the access to data on a scientific level, benefiting both European as well as Korean researchers.

References

Benz, U., Hofmann, P., Willhauck, G., Lingenfelder, I., & Heynen, M., 2004. Multiresolution, object-oriented fuzzy analysis of remote sensing data for GIS-ready information. *ISPRS Journal of Photogrammetry and Remote Sensing*, 58, pp. 239-258.

Brinkhoff, T., 2006. City Population, http://www.citypopulation.de (accessed 11 Aug. 2006)

Choi, Y., 2003. Technology Roadmap in Korea. The Third Generation Foresight and Prioritization in Science and Technology Policy — The Second International Conference on Technology Foresight. Tokyo, 27-28 February 2003 http://www.nistep.go.jp/IC/ic030227/pdf/p5-1.pdf (accessed 11 Aug. 2006).

CIA-Factbook, 2006. The World Factbook, https://www.cia.gov/cia/publications/factbook/geos/ks.html (accessed 11 Aug. 2006).

Jeong, J.J. and Kim, Y.S., 2004. Change Detection using KOMPSAT EOC images. Proceeding of the International Symposium on Remote Sensing, 27.-29. October, 2004, Jeju, Korea, CD-Rom.

Kim Y.S., Jeun, G.H., Lee K.J. and Kim, B.K., 2004. Urban Spatial analysis using multi-temporal KOMPSAT-1 EOC imagery. Proceeding of the International Symposium on Remote Sensing, 27.-29. October, 2004, Jeju, Korea, CD-Rom.

Kressler, F.P., Steinnocher, K. and Kim, Y. S., 2002a. Urban Land Cover Mapping from KOMPSAT EOC Panchromatic Images Using an Object-Oriented Classification Approach. Proceedings of the Third International Symposium Remote Sensing of Urban Areas, June, 11th - 13th, Istanbul, pp. 219-226.

Kressler, F.P., Kim, Y. S. and Steinnocher, K., 2002b. Texture Analysis, Image Fusion and KOMPSAT-1. Proceedings of International Symposium on Remote Sensing 2002, October, 30th - November 1st, Sokcho, pp. 792-797.

Kressler, F.P., Kim, Y.S. and Steinnocher, K. 2003. Segmentation-based urban land cover mapping from KOMPSAT EOC images. Proceedings of the 2003 Joint Spring Meeting, April, 4th, Seoul, pp. 588-595.

KSLV, 2006. Space Launch Vehicle, http://www.kari.re.kr/english/rnd/rnd_03.asp (accessed 8 Aug. 2006).

NSP, 2000. National Space Program, http://krsc.kari.re.kr/eng/sub/center_info/gallery/plan.pdf (accessed 8 Aug. 2006).

Sakong, H.S. and Im, J.H., 2002. Application Fields and Strategy of KOMPSAT-2 Imagery. *Korean Journal of Remote Sensing*, 18(1), pp. 43-52.

Sohn, H.G., Yoo, H.H. and Kim, S.S., 2004. Evaluation of Geometric Modeling for KOMPSAT-1 EOC Imagery Using Ephemeris Data. *ETRI Journal*, 26(3), pp. 218-228.