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Review

Application Fields and Strategy of KOMPSAT-2 Imagery

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Abstract : KOMPSAT-2 satellite is being developed to be launched in 2004 expectingly. This paper is investigating application status of satellite imagery data using various domestic and foreign references such as journals and dissertations and seeing status of policy making and project implementation. In order to promote the application of KOMPSAT-2 imagery, its application ways in each field are presented. In addition, this paper suggests strategies to induce application of KOMPSAT-2 imagery.

Key Words : KOMPSAT-2 Satellite, Application Fields, Satellite Imagery.

1. Introduction

World powers are increasing their effort to develop the high-resolution satellite imagery since Space Imaging Co. successfully launched the world first commercial high-resolution satellite in 1999. The reason is that they would like not only to make a display of power of defense and technology but also to foresee the phenomenal expansion of high-resolution imagery market. According to the long-term program of Space Development of Korea, KOMPSAT-1 was launched successfully in 1999 and KOMPSAT-2 is being developed to be launched in year 2004 expectingly. Multi-Spectral Camera (MSC) will be loaded in the KOMPSAT-2 satellite and it will collect the 1m panchromatic and 4m multi-spectral imagery data.

The development objectives of KOMPSAT-2 satellite include: (1) to satisfy the real-demand of satellite imagery for the application to the wide variety of fields including national territory management, agriculture, vegetation, environment, and ocean monitoring and (2) to secure independent development ability of multi-spectral high resolution satellite as a future high value-added technology from a standpoint of national technology strategy. High precision satellite technology is obtained in the process of developing the satellite body and the camera, but the satellite imagery continues to be produced during the satellite's life.

KOMPSAT-1 has been collecting the data for 2 years; nevertheless, the application of the data is insignificant. This is because we have lacked application strategy and supporting program. In order to become the strong powerful nation at the satellite field, it is important not only to have nation-owned satellite but also to develop the application technology of satellite imagery (Lee, 2000). The government will have to set

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up the well-balanced strategic policy of satellite production and technology development of application as well as will propel this policy consistently (Ministry of Science & Technology, 2001).

Under these backgrounds, this paper is investigating the application fields and ways of KOMPSAT-2 imagery and suggesting the programs and strategies on the level of the government to promote the application of KOMPSAT-2 satellite imagery.

2. Application Status of Satellite Imagery Data

1) Study Outline

The study attempted to classify the application fields and types of satellite images and the camera sensor types mainly used in Korea based on dissertations and thesis reported on academic journals. The dissertations used in this study are from 50 master's and doctoral theses with regard to the application of satellite imagery published between 1998 and 2000. A total of 100 articles related to the application of satellite imagery published from 1998 to 2000 in Journal of the Korea Society of Remote Sensing, The Journal of Geographic Information System Association of Korea, and Journal of Society of Geodesy, Photogrammetry and Cartography were selected for the purpose of this study. In addition, Photogrammetric Engineering & Remote Sensing, Remote Sensing of Environment, and International Journal of Remote Sensing were selected to compare the application status of satellite imagery in Korea with that in the advanced countries: 180 articles, published in 2000, have been analyzed.

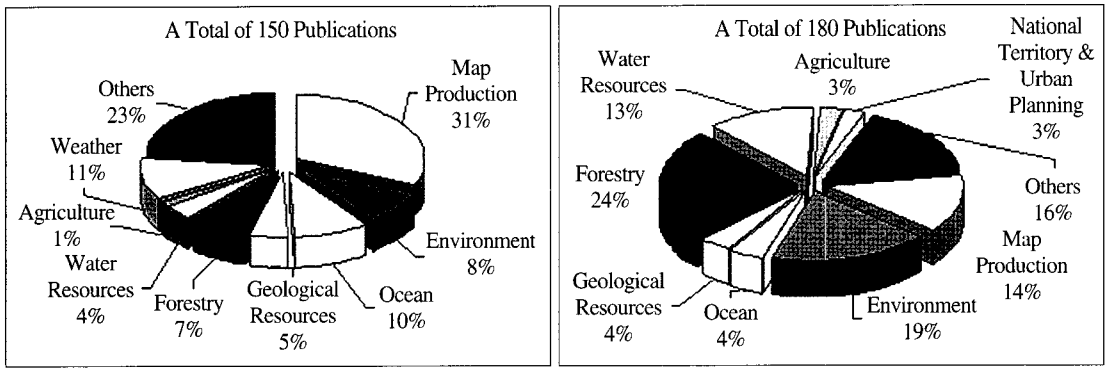
2) Application Status

(1) Satellite Imagery Application Field

Compared to Korea, where application field is limited to the map production and the like, other countries are studying evenly the different areas of the application. In Korea, it is observed that satellite imagery data is used in the field of map production (31%) most frequently followed by weather (11%), maritime (10%), environmental (8%), and forestry (7%). In foreign countries, forestry (24%) takes up the largest part followed by environment (19%), map production (14%), and water resources (13%). The part worthy of note is that in Korea, the study on the field of water resources is not as advanced as other countries.

(2) Application Status per Camera Sensor Types

The ratio of optical sensor usage is relatively high in Korea, but in foreign studies even application of optical,



Domestic Foreign

Fig. 1. Application ratio of satellite imagery in each field.

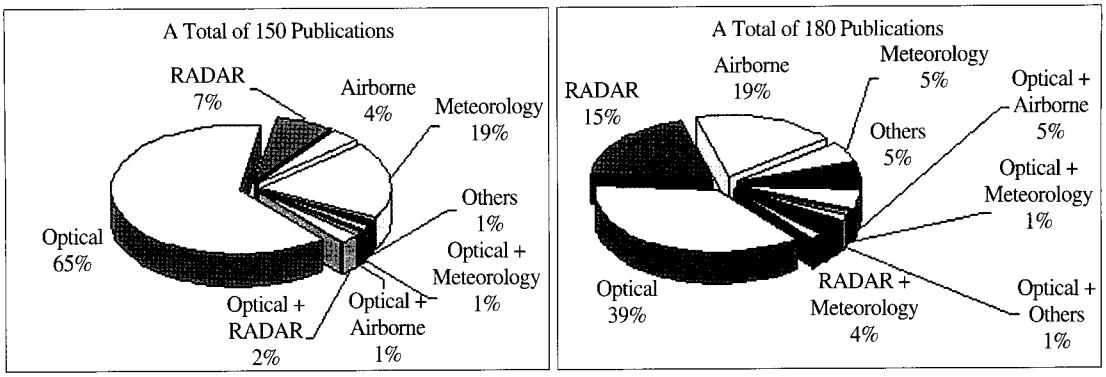


Fig. 2. Application ratio of satellite imagery per camera sensor types.

RADAR, aerial photographs, etc. is apparent. In Korea, optical sensor takes up 65% of the entire camera sensor types followed by the order of meteorology (19%), Radar (7%), and Airborne (4%). In foreign cases also, optical sensors are used the most at 39% but not as much as Korea, and the order is followed by Radar, Airborne (19%), and meteorological sensor (5%).

(3) Application Status of Satellite Imagery based on Degree of Resolution

In Korea, low-resolution (30 m ≤ spatial resolution at nadir) imagery (53%) is used most frequently followed by mid-resolution (5 m ≤ spatial resolution at nadir < 30 m) imagery (42%) as produced by SPOT Satellite and high-resolution (spatial resolution at nadir < 5m) imagery (5%). In other countries, the usage ratio of mid-resolution imagery (11%) is lower than the usage ratio of high resolution imagery (11%) and low-resolution imagery (78%). The study attributes the reason of high usage ratio of high resolution imagery of other countries to unrestricted usage of aerial photographs.

(4) Application Status of Satellite Imagery to the Map Production

In Korea, SPOT Satellite imagery (41%) is used most frequently to produce maps, which would rather usually produce ortho-rectified imagery than produce maps such as topographical maps directly (Park, 1991; Cho, 1991). The Landsat Satellite imagery (31%) is usually used to produce thematic maps such as land-use status map and

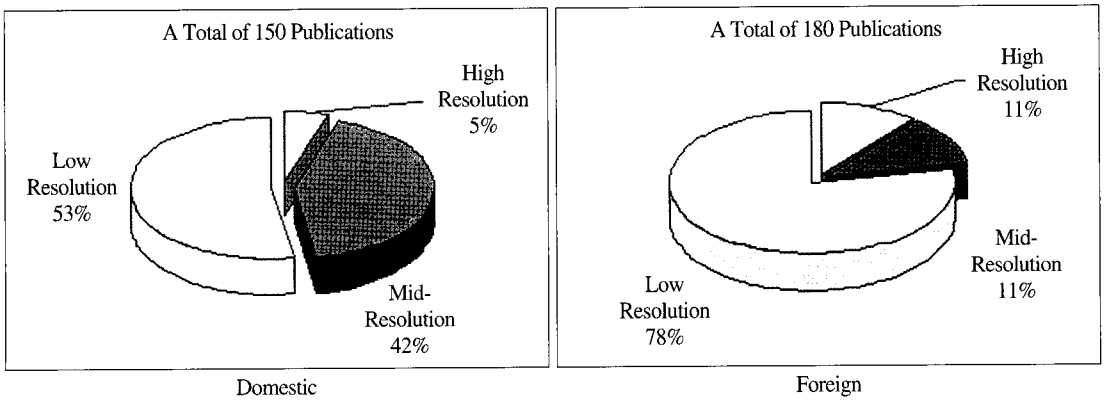
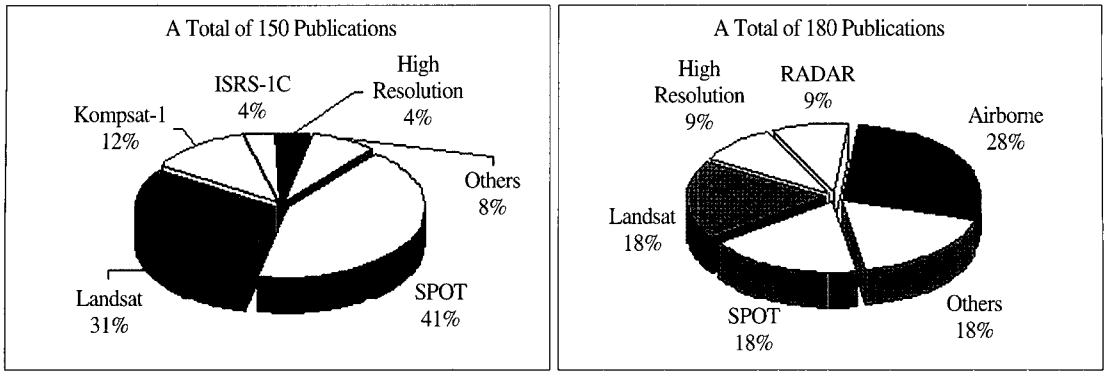


Fig. 3. Application ratio of satellite imagery based on degree of spatial resolution.



Domestic Foreign

Fig. 4. Application ratio of satellite imagery used to produce maps.

vegetation map. Recently, the application of high-resolution imagery including KOMPSAT-1, Russian Satellite imagery such as KVR-1000 and Alternative, and IKONOS (Space Imaging, U.S.) is increasing. In other countries, aerial photographs (28%) are used most frequently to the map production, followed by SPOT (18%), Landsat (18%), and RADAR and high-resolution imagery (each 9%).

2) Status of Policy Making and Project Implementation

In order to comprehend the application level of satellite imagery in Korea, the research and projects implemented using satellite imagery by central government and public organizations have been studied. The study was conducted in 9 areas including map production, forestry, environment, maritime, agriculture, geological resources, weather, national territory and urban planning, and water resources.

The study showed that the most active application of satellite imagery was in map production and in the fields of agriculture and national territory and urban planning, satellite imagery was not applied much. The most frequently applied imagery was Landsat imagery and

Table 1. Application Status of Satellite Images in Fields.

Application Field	KVR-1000 IKONOS	IRS Pan KOMPSAT-1 SPOT Pan	IRS LISS SPOT XS	Landsat MSS, TM	Radar Imagery	NOAA SeaWiFS OSMI
Map Production	○	●	○	◎	○	
Forestry	○	◎	○	●		○
Environment	○	○	◎	●		◎
Agriculture	○	○	○	◎	○	
Ocean	○	○	○	●	○	◎
Weather	○	○	○	◎		◐
Geological Resources	○	◎	◎	●	◎	○
National Territory and Urban Planning	○	◎	○	●		
Water Resources	○	○	◎	●		○

● : Applied the Most, ◎ : Applied a Lot, ○ : Applied in Part

Radar imagery was applied the least. It is worthy of note that Landsat TM imagery was applied covering a wide range of areas including forestry, environment, maritime, geological resources, and water resources (Table 1).

The application frequency of high-resolution imagery, whose spatial resolution is less than 5m, was observed to be very low. It is because its application period was short, since IKONOS imagery was obtained from April 2000, and Russian KVR-1000 and Alternative imagery has not been supplied smoothly.

The application level of satellite imagery in Korea is in the beginning stage: the usage of mid- and low-resolution imagery is restricted to obtain basic information such as land-use status analysis by land cover classification and high-resolution imagery is currently used to obtain information by interpretation with naked eyes.

3. Ways to Apply the KOMPSAT-2 Imagery in each Field

1) Characteristics of KOMPSAT-2 Satellite

The sensor loaded in KOMPSAT-2 satellite is high resolution Multi-Spectral Camera (MSC). The spatial resolution and spectral range of KOMPSAT-2 satellite imagery nearly correspond with those of IKONOS and are closely related to those of Landsat ETM+ (Table 2). From this standpoint, the application fields of KOMPSAT-2 imagery agree with those of IKONOS, and it is expecting to analyze the current studies with Landsat ETM+ more accurately and precisely.

2) A Search for Ways to Apply the Imagery in each Field

One more new field of application had been added to the 9 application fields of high resolution imagery of KOMPSAT-2, i.e., the field of everyday life added to prior fields of map production, forestry, environment, agriculture, ocean, weather, geological resources, national territory and urban planning, and water resources. IKONOS, whose characteristics are very similar to those of KOMPSAT-2, is currently used actively in those fields.

(1) Map Production

So far, aerial photographs have been usually used to produce digital topographical maps (Kang, 1988; Yun, 1991). But, as high-resolution satellite imagery has been commonly used, its role of map production, as the substitute for aerial photographs, is studied actively. Whether satellite imagery can replace aerial photographs in the field of map production depends on the accuracy of

Table 2. Comparison among KOMPSAT-2, IKONOS, and Landsat imagery.

	Orbit	Spatial Resolution (m) at Naidr	Swath Width	Revisit	spectral resolution (nm)				
					1	2	3	4	Pan
KOMPSAT-2 (≥8bits)	685km, Sun-synchronous	≤4 m (1~4) ≤1 m (pan)	15 km		450~520	520~600	630~690	760~900	500~900
IKONOS (11bits)	681km, Sun-synchronous Equatorial crossing 10-11am	4 m (1~4) 1 m (pan)	11 km	<3days	445~516	506~595	632~698	757~853	450~900
Landsat ETM+ (8bits)	750km, Sun-synchronous Equatorial crossing 10am ± 15min.	30 m (1~5, 7) 15 m (pan) 60 m (6)	185 km	16days	450~515	525~605	630~690	750~900	520~900

map production and economical efficiency. The spectral characteristics of KOMPSAT-2 are proper for detailed land cover classification and change detection and the high-resolution imagery enable to update the existing maps effectively by extracting roads and buildings.

(2) Forestry

KOMPSAT-2 imagery will be applied to detailed forest vegetation classification. Also, high-resolution imagery can be used very efficiently to estimate damage caused by disease and harmful insects quickly as well as to establish disaster measures. It enables to capture the situation of forest fires repeated annually and to monitor their restoration processes. However, in order to apply high-resolution imagery to forestry smoothly, the treatment of atmospheric effects by rugged mountainous area and the radiometric correction technique of shadow area must be secured in advance.

(3) Environment

The status analysis of environmental resources typically consists of land cover and land use classification, change detection, and vegetation classification. High-resolution imagery like KOMPSAT-2 enables those analyses more accurately and minutely. According to the Ministry of Environment, we can usually classify land cover with 7 items using Landsat imagery, with 23 items using Landsat and IRS1-C imagery together, and with 48 items using IKONOS imagery. In addition, KOMPSAT-2 imagery can be used for environmental modeling and monitoring and environmental impact assessment.

(4) Agriculture

In agricultural field, high-resolution imagery will be used effectively for the crop analysis, the estimation of agricultural disaster, and the establishment of agricultural resources information. In Korea, except several large plains, most farmlands are small and cultivate various kinds of crop. Mid- and low-resolution satellite imagery has been utilized only for large-scale farmlands. However, high-resolution satellite imagery can help to cultivate crops in small-scale farmlands efficiently: it can cut down a lot of expense on farming by monitoring crop growth and damage from disease and harmful insects. In addition, we can grasp the area of farmlands, the margin of farmlands, and drought situation accurately as well as manage farm crops estimates, monitoring techniques for irrigation, and damage of crops by weather condition more effectively through the application of high resolution imagery.

(5) Ocean

The weather or ocean satellite imagery such as NOAA AVHRR and SeaWiFS has been usually applied to the ocean field (Bigg, 1997). But, high-resolution imagery like KOMPSAT-2 can be used efficiently for coastline, coastal fishery information, and coastal environmental management. Southwestern coast in Korea has very wide tidal flats, which make it difficult to extract the exact coastal line and to detect the coastal change. KOMPSAT-2 is expecting to solve this problem for its high spatial resolution. We have had a hard time in the fishing ground management for investigating fishing ground distribution, the scale of facilities, and their positions with naked eyes. Actually, the results to analyze fishery farm in Shinan-Gun, Jeollanamdo showed that the permitted area did not accord with the actual cultivated area. In addition, excessive fishery farm has made the water quality of the ocean worse. KOMPSAT-2 imagery will be utilized to grasp the coastal fishery information.

(6) Weather

In weather field, KOMPSAT-2 imagery can be used for the forecasting and monitoring weather. In order to observe weather, we usually use weather satellite imagery that can analyze weather information on wide area with real time. KOMPSAT-2 imagery does not

proper to observe weather because its observation width is narrow and its observation period is long. KOMPSAT-2 can be used only to collect the local data for weather forecast monitoring. In addition, we can use it to grasp the degree of disaster by abnormal weather quickly. Recently, we have been suffered from the flood damage by local heavy rain, which is called guerrilla rain. To forecast this local flood damage, high precision DEM(Digital Elevation Model) is needed, which can be produced by using KOMPSAT-2 stereo imagery.

(7) Geological Resources

In the field of geological resources, KOMPSAT-2 imagery will be applied to the areas such as resources exploration and utilization, geological disaster management and monitoring, and geological survey. Moreover, we expect to use KOMPSAT-2 imagery to the environmental impact assessment of mines that are currently used or closed. Studying water pollution and pattern analysis of soil pollution around the mining area, we can establish detailed environmental pollution management system. For geological disaster and monitoring, we can apply KOMPSAT-2 imagery to establish the integrated geological disaster management system by developing the existing landslide forecast and management technique. Especially, because the small-scale landslides usually take place in Korea, KOMPSAT-2 imagery will be applied more efficiently to grasp the exact position of the landslides and to estimate their damage.

(8) National Territory and Urban Planning

So far, the application of satellite imagery in the field of urban planning has not been active because the information needed in urban planning has not been extracted easily from satellite imagery. But, since high-resolution imagery like KOMPSAT-2 is able to interpret the topography and geographical features to the building unit, its application in the field of urban planning can increase rapidly. It is forecasted that application will increase in the field of spatial planning in each level such as metropolitan planning, urban planning, urban design, and district planning. The application of 3-D imagery will bring about the epoch-making change to the determination of road route and the analysis of available land. The techniques to produce 3-D imagery maps and to be applied practically in the spatial planning process must be studied. In order to apply KOMPSAT-2 imagery effectively in the field of urban planning, the techniques to transform raster data analyzed from satellite imagery into vector data and to extract the shape and characteristics of geographical features automatically or semi-automatically are required.

(9) Water Resources

The application of KOMPSAT-2 imagery in the field of water resources is as follows: the establishment of water resources information, water quality management, watershed management, and flood monitoring. Precision DEM will be produced using KOMPSAT-2 stereo imagery, which enables to estimate their watersheds and the contained water volume when constructing dams. Multi-spectral high-resolution imagery will be applied to water quality management by analyzing the characteristics of spectral reflectance of water quality indicators and developing their algorithms.

Analysis of high-resolution imagery with forest resources and soil information enables to calculate the surface efflux volume when it rains, which can be applied to the flood modeling. Especially, as the impermeable surface in the urban area is increasing, the submerged area is increasing when it rains heavily. High-resolution imagery will help to estimate the submerged area and to take disaster measures quickly.

(10) Everyday Life

The everyday life is a field receiving the limelight as high-resolution satellite imagery came into being and its

role is to increase the convenience of peoples lifestyles in a scientific manner. KOMPSAT-2 imagery can be applied to the everyday life including real estates, information communication, 3-D simulation, tourism, and education. In the field of real estates, a customer can capture the environment of the spot from guide service system using high resolution imagery, not going to the spot in person. In the field of information communication, we can use high-resolution imagery to the analysis of electric wave range and position analysis of base stations. Precision DEM extracted from high resolution imagery will raise the efficiency of the base station selection and the accuracy of cell planning algorithm. In addition, it can be a help to select the position of a high-voltage transmission pylon. Orthorectified imagery enables 3-D flying and simulation using commercial software. Moreover, its integration technology with information technology such as 3-D graphic, hardware acceleration, image compression, and progressive transmission is under implementation.

Table 3 sums up ways to apply the KOMPSAT-2 imagery in each field. The application field of KOMPSAT-2 satellite imagery had been classified into two levels according to the area of operation. In the second level 3 ~ 4, categories have been listed according to purpose, technology, impression types, etc.

4. Strategies to Induce Application of KOMPSAT-2 Imagery

1) Prior Formulation of Foundation for Application

The formulation of a foundation through prior study is crucial for inducing KOMPSAT-2 Imagery application. It has been a year since high-resolution imagery had been used, starting with IKONOS, but there are yet many tasks to be tackled (Table 4). It is necessary to find out

Table 3. Application fields of KOMPSAT-2 satellite imagery.

Level I	Level II	
Map Production	• 2-D Map Production • 3-D Map Production	• Thematic Map Production • Change Detection
Forestry	• Forest Vegetation Classification • Management of Forest Usage	• Forest Catastrophe Management & Monitoring
Environment	• Analysis on Environmental Resource Status • Environmental Impact Assessment	• Environmental Modeling & Monitoring
Agriculture	• Crop Analysis • Disaster Forecast	• Agriculture Resource Information
Ocean	• Coastal Infromation • Coastal Environment Management	• Infromation on Coast and Fisheries
Weather	• Atmospheric & Topographic Correction	• Forecasting and Monitoring Weather & Climate
Geological Resources	• Resource Exploration & Management • Geological Survey	• Geological Disaster Control & Monitoring
National Territory and Urban Planning	• Urban & Regional Planning and Management	• Facility Management • Civil Works & Construction
Water Resources	• Establishment of Water Resources • Water Quality Management	• Watersheds Management • Flood Watch
Everyday Life	• Real Estate • 3-D Simulation • Information Communication	• Tourism • Education

Table 4. Prior Research Projects.

	Projects	Contents
Pre-Processing	Radiometric Calibration	Calibration of the errors of pixel values by sensor sensitivity
	Satellite Orbit/Position Modeling	Precision modeling of satellite orbit and position
	Camera Sensor Correction	Correction of the position errors of pixels by the characteristics of satellite optical camera
	Intelligent Sensor Model	Precision modeling of high resolution satellite sensor
	Automatized Imagery Correction	Automatization of each process in the image correction (Image to Image, Image to Map)
Processing · Post-Processing	Geometric Correction	Standard geometric correction using ephemeris data and precision geometric correction using GCP
	Topographic Distortion Correction	Standard ortho-rectification using DEM and ephemeris data and precision ortho-rectification using DEM and GCP
	Image Enhancement	Enhancement treatment to detect imagery distinctly
	Color Calibration	Natural color treatment of false color imagery
	Data Fusion	1m multi-spectral imagery production through spectral fusion between 1m panchromatic and 4m multi-spectral bands
	Mosaic	Mosaicking of a large number of imagery data (Image matching, Overlap function)
	Information Losing Area Treatment	Treatment of the area that loses its information
Information Extract	Topographic Information Extraction	DEM production technology using stereo imagery
	Thematic Information Extraction	Supervised/unsupervised classification technology and various index transformation technology
Import/Export of Satellite Imagery		Import/Export of various satellite imagery
Coordinate Transformation of Satellite Imagery		Transformation between various coordinate systems

these tasks and be prepared in advance. In addition, it is important to prepare a system in advance to store and search the necessary imagery (Ministry of Information & Communication *et al.*, 2000).

2) Establishment of a Policy for Balance between Satellite Development and Application

In the national mid- and long-term plan for outer space development, a detailed plan for Satellite development until 2015 is provided. It is forecasted that the development of KOMPSAT, which is an earth observation satellite, will be the main project. However, there is no mention of utilizing the satellite imagery produced by satellite development. Satisfying the national demand of satellite imagery application is one of the important goals for earth observation satellite. Then, it is necessary to establish and promote a policy that would create a balance between production and application of satellite imagery. In other words, application technology such as satellite imagery processing software and analysis algorithm needs to be continually developed from the time of development. It is important that we have our own national satellites in order to grow as an advanced country, but it is equally important to acquire the satellite imagery application technology.

3) Post Management and Establishment of Operating Strategy

A systematic post management and operating strategy is necessary for KOMPSAT-2. We can easily be led to think as if a business has been successfully completed

when we succeed in designing and launching the satellite into space. But strictly speaking, we must realize that we are only half way to success. The remaining half of the success depends on the ability of the satellite to function until the end of the machines life and on the profitability of satellite imagery application. From this standpoint, systematic and detailed satellite imagery application plans need to be formulated and implemented.

4) Promotion and Formulation of Marketing Strategy

Socio-economic conditions and system that can induce application of KOMPSAT-2 imagery need to be continuously improved. Moreover, the level of security needs to be improved to induce application by the private sector and the industries, and a more aggressive promotion on outer space development project needs to be implemented to gain the support and positive response from not only the experts but the entire citizens. While announcing to the world of our technical level by applying marketing strategy here and abroad, we need to search for ways to acquire economic feasibility through profitable projects. For smooth implementation of these tasks there is a need to search for ways to train professionals.

5. Conclusions

According to the national mid- and long-term plan for outer space development, we have the plans to construct a launching vehicle and a launching site in 2005 and to develop a total of 19 satellites in 2015. Seven of these satellites are KOMPSAT series, which are earth observation satellites. In order to become an advanced country in the field of space development, the government will invest a total of 4800 billion won in those plans.

In order to implement the earth observation satellite development policy successfully, the application of the satellite imagery as well as the satellite development technology should be settled. As mentioned above, the thorough preparation such as investigating ways to apply satellite imagery in each field and securing essential technology in advance is very important to the application of satellite imagery. The government should continue to invest in technology development such as satellite imagery software to promote the application of satellite imagery.

References

Bigg, G. R., 1997. *The oceans and climate*, Cambridge University Press, Cambridge, p 266.

Cho, Gi-Sung, 1991. A Study on the determination of exterior orientation of SPOT imagery, Doctoral Dissertation, Yonsei University.

Kang, Young-Ok, 1988. *A Comprehensive Study on Construction of Digital Orthophoto using airphoto in Seoul*, Seoul Development Institute, pp10-25.

Lee, Sang-Mok, 2000. Policy Direction of Space Development Projects in Korea, National Territory, Vol. 224.

Ministry of Information & Communication, National Computerizational Agency, and Korea Research Institute for Human Settlements, 2000. A Study on the Detailed Plan Making of Spatial Imagery Information System, pp 62-63.

Ministry of Science & Technology, 2001. *Planning for Acquisition of Core Technology for Korean Space Development*, pp 87-158.

Park, Byung-Wook, 1991. A study on the generation of digital elevation model from SPOT satellite data, Master Thesis, Seoul National University.

Yun, Jong-Sung, 1991. A Study on the Orthophoto Production using PC and Low-Cost Scanner, Master Thesis, Seoul National University.