CHALLENGES AND SOLUTIONS SATELLITE BIG DATA IN MONGOLIA

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ABSTRACT

Nowadays it is impossible to live another second without space technology and information gathered from space. The rapid pace of the development of satellite wildlife tracking tools has left little time for thorough testing of new equipment and identifying possible sources of technical failures.

Remote sensing data are some of the most effective input data for developing country like Mongolia. In particular, multispectral and hyperspectral space-borne and airborne data are widely used to study changes in land use and land cover. Further different natural and anthropogenic processes including fire detection, snow mapping, and grassland / rangeland vulnerability are mapped and evaluated by remote sensing data.

This paper describes the current situation concerning the satellite big data in Mongolia. Within the scope of the paper, challenges and solutions related to the satellite big data have been reviewed.

1. INTRODUCTION

Mongolia is a very special country; it has a total land area of 1,564 million sq. km and a population of 3 million people (NSO, 2015). A large proportion of the population live outside of the capital city Ulaanbaatar and have settled in about 350 provincial regions and towns known as soums and aimags. Almost 60 percent of the population of Mongolia's capital, Ulaanbaatar, lives in informal settlements, known as ger areas (NSO, 2015).

There are million more people who are dependent on the natural environment as they move with their herds as pastoralists. These physical, social and economic conditions in contrasting human habitats are sharpened by strong cultural identities which define Mongolians' rapidly changing requirements for productive livelihoods, human security and physical protection from disaster risks. Mongolians have the nomadic culture and can't access information communication technology and satellite related data as much as they wanted. Especially, for the herders who live far from the province centers, using of desktop or laptop computer is near impossible.

The country is exposed to several types of serious natural hazards. Parts of the country and particularly the densely populated capital area are subject to potentially severe seismic activity. The periodic and particularly severe Mongolian dzud is a natural hazard that combines extreme weather conditions which decimate herds that are already weakened by summer drought conditions. Droughts, floods (in urban and rural areas), steppe and forest wildfire, storms and agricultural vermin are other hazards that combine climatic effects, changing environmental conditions, and increasingly challenging economic conditions that characterize a perilous hazard-scape in Mongolia (Munkhzul et al, 2016).

Therefore, different time series satellite data from different sources are very important for monitoring, management and other research related activities. The aim of this paper is to describe the current situation, challenges and solutions related to the satellite big data in Mongolia.

2. CURRENT SITUATION, CHALLENGES AND SOLUTIONS

Satellite Observation System has become available in Mongolia in 1970, receiving information and images from the Polar orbit satellites. In 1971, the first APT meteorological station was established in Ulaanbaatar through which received cloud data, which was successfully used for weather forecasting services. Data for both meteorological and non-meteorological applications such as forest and steppe fires, land cover mapping and flood assessment has been used since 1987 (Batbayar, 2014).

A digital information station was installed during 1986-1988. An Arc/INFO GIS package on Sun Sparc Workstation was installed in 1994. Cooperation agreement with NASA was signed in 1993 to use satellite SEASTAR. With the satellite-aided observation, the monitoring of forest fires and bushfires became possible. Since 2007, Mongolia has been receiving satellite images from MODIS which increased monitoring quality significantly. Based on MODIS data Mongolia developed several operational monitoring tools that deal as an information source for decision making. One important operational tool is the Mongolia Livestock Early Warning System (Mongolia LEWS). During the period from 1999 to 2002, Mongolia experienced a series of droughts and severe winters that diminished livestock numbers by approximately 30% countrywide. In the Gobi region, livestock mortality reached as much as 50%. Due to these extreme events and its impact on pastoral livelihoods, the USAID mission in Mongolia and the Global Livestock-CRSP (GL-CRSP) initiated the Gobi Forage program with the goal of transferring Livestock Early Warning System (LEWS) technology to Mongolia. The Livestock Early Warning System technology combines near real-time weather, computer modeling, and satellite imagery to monitor and forecast livestock forage conditions so that pastoralists and other decision makers get information for timely decision making. Three major activities have been conducted including: 1) infusion of forage monitoring technology to assess regional forage quantity; 2) development of nutritional profiling technology to assess forage quality, and 3) information delivery and outreach (Martin et all, 2016).

The year 1981 has a special significance in the history of modern Mongolia as aerospace engineer J.Gurragchaa became the first and only Mongolian to conduct a space mission along with Russian cosmonaut Vladimir Dzhanibekov.

The Mongolian Government is placing importance on the promotion of international cooperation in the field of space applications. Mongolia joined as a member of international space organizations such as Center for Space Science & Technology Education in Asia and Pacific (CSSTEAP) since 1995, Asia-Pacific Regional Space Agency Forum (APRSAF) since 1993 and Asia-Pacific Cooperation Organization (APSCO) since 2005.

Nowadays, it is impossible to live another second without space technology and information gathered from space. In fact, the government led by former Prime Minister N.Altankhuyag between 2012 and 2014 raised funds to develop blueprints for a satellite project and attract investment. Unfortunately, the nation seems to be facing financial challenges now.

June 4, 2017 was the date for when Mongolia’s very first satellite “Mazaalai” was launched at Kennedy Space Center, Florida and became another important year for Mongolia’s presence in space. The miniature satellite is capable of taking 100m resolution images in the altitude of around 400km, transmitting data through 437MHz frequency modulation, identifying satellite locations, determining air density in the altitude of 400km, detecting space radiation and using ground stations as an international network.

The earlier satellite MongolSat-1 is sometimes reported as Mongolia's first satellite, but MongolSat-1 was an ABS satellite manufactured by Boeing and co-branded as MongolSat-1 after launch in April 2017.

“Mongolian National satellite project” was approved by Mongolian Government in 2013. The project included following 6 main activities:

- Improving legal environment to promote space technology development;
- Developing long term strategy for space industry development,
- Developing national communication satellite system,
- Developing national earth observation satellite system,
- Promote international cooperation for the space technology development,
- Human resource development.

A “National Space Council” was established in December, 2012. There are 40 members including space technology related researches, specialists and government bodies.

The mentioned satellite data from AVHRR, MODIS and SPOT Vegetation provide coarse resolution information about the earth surface. The pixel resolution in correspondence to the data product varies between 250m (MODIS) to 1, 4 or 8 km (SPOT, AVHRR). AVHRR offers the longest available satellite based data set on earth. Table 1 gives an overview of current available satellite data sets over Mongolia. In future many more sensors for ecosystem analysis like Sentinel, EnMAP and others will be available. Sentinel 2a was just launched in June 2015 and Sentinel 2b will follow in 2016.

With availability since 2014 large amount of “free and open” high-resolution Sentinel (1 and 2) data as well as Landsat-8 images, it becomes feasible to develop a lot of cloud services for fast access to satellite data and their products at high and medium spatial resolution scale. The first challenge was land use/land cover classification and mapping.

Table 1

Most important satellite missions over Mongolia

Sensor	Satellite	Overpass/ Orbit Frequency	Data Source (terrestrial data)	Data Record (years)	Spatial Resolution (s)	Processed TimeStep	Latency
AVHRR	NOAA series	Daily	USGS/ EROS[2]	1989-present	1km	1-week, 2-week	~24 hours
AVHRR	NOAA series	Daily	NASA Ecocast[3]	1982-2013	8km	Twice monthly	N/A
MSS	Landsat 1-5	18 days	USGS/ EROS[2]	1972-1992	79m	Distributed by scene	N/A
TM	Landsat 4-5	16 days	USGS/ EROS[2]	1982-2011	30m	Distributed by scene	N/A
ETM+	Landsat 7	16 days	USGS/ EROS[2]	1999-present	30m	Distributed by scene	~1-3 days
OLI	Landsat 8	16 days	USGS/ EROS[2]	2013-present	30m	Distributed by scene	~1-3 days
Vegetation	SPOT	1-2 days	VITO[4]	1999-present	1.15km	10-day	~3 months
MODIS	Terra	1-2 days	LPDAAC[5]	2000-present	250m, 500m, 1km	8-day, 16-day	~7-30 days
MODIS	Aqua	1-2 days	LPDAAC[5]	2002-present	250m, 500m, 1km	8-day, 16-day	~7-30 days
eMODIS	Terra/ Aqua	1-2 days	USGS/ EROS[6]	2000-present	250m, 500m, 1km	7-day	~15 hours, 7 days[6]

Nowadays, almost all national government organizations including institutes of Mongolian Academy of Sciences are actively using and developing remote sensing applications. There are also a number of private and non-government organizations, which have started to use remote sensing data and ground positioning systems. Some specific targeted remote sensing laboratories and centers are available in Mongolia based on state universities such as National University of Mongolia, Mongolian University of Science and Technology and the Mongolian University of Life Sciences.

Certain agencies have a period of informal satellite data sharing. This was in part because the satellite systems were new and the technology for sharing data was limited. It was also a period during which agencies were trying to understand the value of the data. The collection of satellite imagery compiled over the years in a specific geographical area of interest.

Big Earth observing data can be defined in terms of:

- volumes,
- degree of diversity and complexity including streaming of data from presently available and upcoming satellite capabilities, and
- innovative ground devices
- the unpredictable value added derivable from their innovative analyses and fusion (ESA, 2013)

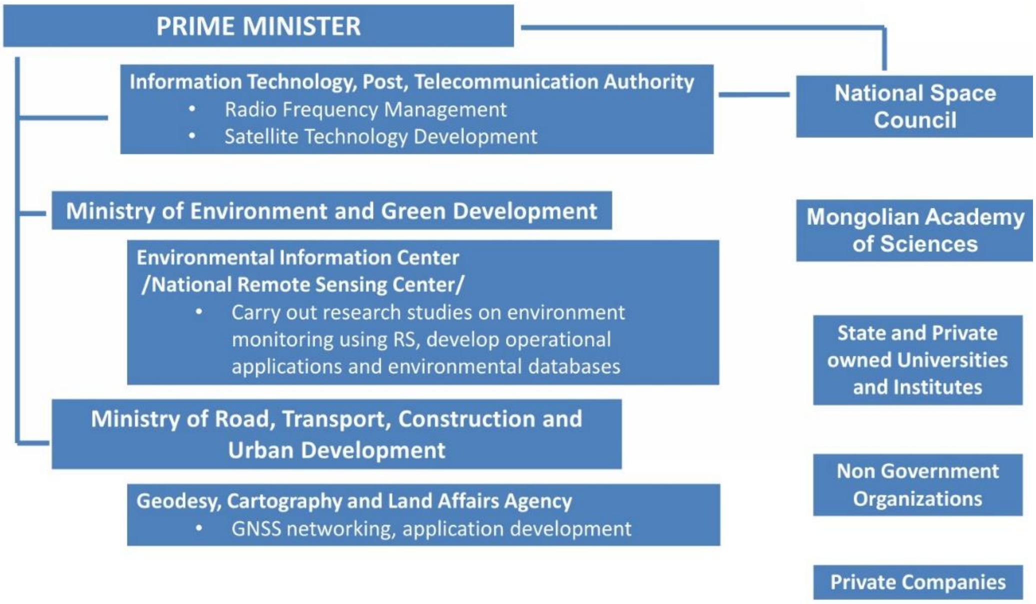

Figure 1. Space technology related organization

The term of satellite Big Data is relatively new in Mongolia. Some organizations are already using satellite big data initiatives (Figure 1):

- The National Remote Sensing Centre of Mongolia is the main institution promoting the practical use of remote sensing technology, e.g. for grassland distribution, land use change, desertification monitoring They operate the satellite data storage system for MODIS, NOAA and FY satellites. NRSC also publishes (www.icc.mn) and sharees value added information (Wildfire, NDVI, Snow Coverage, and Land Surface Temperature) extracted from satellite data.
- Administration of Land Affairs, Geodesy and Cartography combines 10 years of satellite imagery with different spatial resolution for aimag and soum center.
- Mineral Resource authority of Mongolia uses a variety of geological applications such as baseline geological evolution, regional geological mapping and structural and tectonic studies, especially with reference to their potential in oil exploration.
- Mongolian Civil Aviation Agency
- National Emergency Management Agency uses satellite images to coordinate/manage disaster risk.
- The institutes of Mongolian Academy of Sciences have long experiences in the applications and development of techniques for satellite big data acquired from multiple sources.
- The National University of Mongolia is the main satellite big data warehouse, combining 20 years of satellite data of the entirety Mongolia for study and research and they have an undergraduate and graduate program on environmental remote sensing since 2010.

Figure 2. National Emergency Management Agency.

The examples of the organizations dealing with satellite big data in Figure 2 (National Emergency Management Agency) and Figure 3 (Remote sensing department of the National Remote Sensing Centre).

Figure 3. National Remote Sensing Centre.

Main problems of Spatial data in Mongolia are:

- Duplication of data
- Lack of data sharing
- No standardization among organizations
- Inefficient use of Government budget
- Out-to-date
- No quality assurance

And there are several challenges for satellite big data including analysis, capture, curation, search, sharing, storage, transfer, visualization, privacy violations and human capacity. Disjointed activity approaches pursued separately within organizations, or by isolated funding initiatives divorced from the commonly agreed needs could be duplicative or wasteful.

There are several solutions for satellite big data sharing:

- To construct satellite big data infrastructure
- To find and develop data transmission tools
- To implement warehousing and mining tools and techniques
- To provide business intelligence and analytic tool

Finally, the Government of Mongolia should support more informed satellite data-sharing policy-making by analyzing the effect of existing and past satellite data-sharing policies, and providing information that further reduces the key uncertainties discussed here, including economic efficiency of data-sharing policies, climate impacts and the value of operational requirements. Such cloud-based infrastructure should be launched in operational way in early 2018 (GOM, 2016).

Future demand of National Satellite are:

- A low population density
- A large territory and there are many places where no one is living, desert and mountainous area satellite transponder lease is expensive
- An increasing demand to exchange important information
- A desire to develop the country's business and foreign economic cooperation
- The need to develop emergency health care service
- The need to develop educational services to citizens based on E-Education

To gain more knowledge through information communication technology achievements and to create conditions that allow the people of Mongolia have equal access to information. Web-based satellite and geospatial data sharing system will help to:

- Better information sharing & registering
- Better database based on spatial database
- Better disaster planning & vision
- Better disaster prevention & actual risk reduction
- Better human capacity enhancement & policy

3. CONCLUSION

For remote sensing the global change and sustainable development, and satellite swarms with hundreds of platforms for constant environmental monitoring of the whole earth. Spatial information science will increasingly deal with spatio-temporal modelling, social media and ubiquitous computing. Underlying concepts of these developments are big data, machine learning, parallel and cloud computing and the Internet of things. Information from imagery can thus be interpreted as the digitization of our planet in real time, and in many different scales and applications.

The aim of this research was to carry out a study on the current situation about the satellite big data in Mongolia. As part of the study, challenges and solutions concerning the satellite big data were briefly highlighted.

Variety and scope of functions for any size of satellites increase rapidly, access to space is becoming less complex, local and regional aspects received attention and last but not least inexpensive mission are significant.

There are many challenges in remote sensing technology because of increasing number of satellites, constellation technology, data cost decreasing, integration and processing of multi-satellite data. According to these changes, it is necessary to think and develop innovative technology how to integrate multi-satellite data with practical implementation in managements.

Quality satellite big data and services are available and accessible in a timely and coordinated way to support decision-making and operations within and across all sectors and phases of disaster risk reduction and management.

The biggest challenge in the framework of using long-term satellite data over Mongolia is the integration of these data with other environmental data into a unique GIS-based system to build up an integrated Land Data Assimilation System for Mongolia (LDAS-Mongolia) to push political decisions and provide decision support.

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