Pixel to Picture and Picture to Person

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Pixel, Picture, Person, Resolution, Remote Sensing, Social Benefit Areas

ABSTRACT

Remotely sensed data are related with the words pixel and resolution as the picture is formed from the pixel having the size defined by the value of resolution of the data. There are unlimited sectors where remote sensing technology can be applied to uplift the social status of the people. In order to make best use of this system, Regional Workshop on Himalayan GEOSS was organized in Nepal. The workshop developed a concept ***"pixel to picture and picture to person****" based on the technology related to Earth observation. The concept to be used for the several sectors identified by the workshop which are also related with the Social benefit areas of the Global Earth Observation System of Systems (GEOSS) of Group on Earth Observation (GEO). Therefore, this paper tries to summarize the result of the workshop in this particular theme.*

1. INTRODUCTION

Earth observation system provides the remotely sensed data which are used in many applications. Earth observation (EO) can be made either using airborne platform such as aircraft, helicopters or space borne platform such as artificial satellites. Using such system, data are collected as pixels to form a picture. The pictures thus formed are used by the persons for their corresponding applications whether the person is a professional in this field or a user. The professional creates the picture from the pixels using appropriate technology and the users make use of such pictures for their corresponding activities after interpreting the picture. So, this concept ***"pixel to picture and picture to person"*** became the slogan for the community of earth observation. This concept was materialized during "Regional Workshop on Himalayan GEOSS", which was jointly conducted by International Centre for Integrated Mountain Development (ICIMOD) and Global Earth Observation (GEO) from 10-11 August, 2017 in Lalitpur, Nepal.

The workshop also identified the priority sectors for the sustainable development of the country using the earth observation technology. The sectors are agriculture and food security, water resources, disaster risk reduction, land use, land cover change and ecosystem services. Furthermore, it is also mentioned that these are not only the themes to be considered but also other themes could be included if the country recognize some particular theme(s) to be prioritized.

2. HIMALAYAN GEOSS

Before explaining the Himalayan GEOSS, it is worthwhile to provide brief introduction

of the related initiatives of this subject. They are International Centre for Integrated Mountain Development (ICIMOD), Group on Earth Observation (GEO) and Global Earth Observation System of Systems (GEOSS).

ICIMOD is a regional intergovernmental learning and knowledge sharing centre situated in Nepal. The member countries of this organization belong to the Hindu Kush Himalayan regions and they are Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan. It was realized that globalization and climate change have an increasing influence on the stability of fragile mountain ecosystems and the livelihoods of mountain people. Therefore, ICIMOD aims to assist mountain people to understand these changes, adapt to them, and make the most of new opportunities, while addressing upstream-downstream issues. *[6]*

The Group on Earth Observations (GEO) is an intergovernmental organization working to improve the availability, access and use of Earth observations for the benefit of society. GEO works to actively improve and coordinate global GEO systems and promote broad, open data sharing [5].

A central part of GEO's Mission is to build the Global Earth Observation System of Systems (GEOSS). GEOSS is a set of coordinated, independent Earth observation, information and processing systems that interact and provide access to diverse information for a broad range of users in both public and private sectors. GEOSS links these systems to strengthen the monitoring of the state of the Earth. It facilitates the sharing of environmental data and information collected from the large array of observing systems contributed by countries and organizations within GEO. Further, GEOSS ensures that these data are accessible, of identified quality and provenance, and interoperable to support the development of tools and the delivery of information services. Thus, GEOSS increases our understanding of Earth processes and enhances predictive capabilities that underpin sound decision-making: it provides access to data, information and knowledge to a wide variety of users [5].

Therefore, GEOSS community activity will build a platform for regional collaboration by bringing together all GEO members and participating organizations with thematic line agencies from the region working on Earth observation (EO) and geospatial technologies. As it is clearly mentioned that some of the initiatives of ICIMOD are to build capacity and promote Earth Observation and geo-information applications in the Hindu Kush region. So, based on the approaches of GEOSS and the scope of ICIMOD, ICIMOD realized to initiate **Himalayan GEOSS** for the region to address the issues related to the specific working areas.

This endeavor is meant to develop coordinated frameworks to implement innovative Earth observation (EO) and geospatial solutions and services. It will focus to make observation for mountain-specific situations, aligning with regional priorities and GEO's societal benefits areas. *[5]*

Furthermore, Hindu Kush Region has mountain areas consisting of remote areas with difficulties in accessing mainly due to difficult terrain. So, it is very challenging tasks to collect data and information and disseminate the results to the communities living in those areas. However, with the availability of earth observation system, it has become easier to collect the data which can be integrated with the emerging geographic information and communication technologies for decision making in different aspects of fields related to sustainable development of mountain people *[6]*. Since ICIMOD is a participating organization in GEO and the Hindu Kush Himalayan, therefore, ICIMOD intends to facilitate the regional implementation of **Himalayan GEOSS** with active involvement from its member countries in the region. It is believed that the initiatives of Himalayan GEOSS will ultimately contribute to the development of spatial data infrastructure (SDI) in the region through the promotion of policy, standards, and practices for open access to data, information, and services. *[2]*

3. TYPES OF REMOTELY SENSED DATA

In remote sensing technology, two basic components: platform and sensor play a role to collect remotely sensed data. The platform is the vehicle used to board the sensor for the collection of related data. The platform could be either a space borne system in which artificial satellites orbiting the earth in its orbit are used or airborne system in which an aircraft is flown over the interested area. The sensor deployed in the vehicle will have a field of view covering a certain area, termed as a scene. Therefore, numbers of scenes are necessary to cover the area of interest. The size of the scene depends upon the altitude of the vehicle and opening of the field of view. The sensor may be of different types depending upon the type of data needed such as thermal imagery, hyperspectral data, multi-spectral data, *et cetera*. Besides that, the data can also be obtained from the technology related to RADAR, LIDAR, Unmanned Aerial System (UAS), *et cetera.*

Hence, in general, data of the interested area are captured either from the artificial satellites that are orbiting the earth continuously throughout the year or by flying the aircraft above the area. The data thus obtained are used for the applications in the related fields using remote sensing technology.

In fact, majority of the persons who use internet in computers and mobiles, are very much familiar with the Google Earth and they use it to find and locate their house or some location to display in their screen or to navigate the route to reach to their destination. This can be considered as special applications which are easily available free of cost and understandable to an individual who have no knowledge about remote sensing technology. However, the professionals use particular data from different sources which are suitable for their purposes, such as GEOEYE, IKONOS, Landsat, QuickBird, SPOT, *et cetera*.

4. PIXEL TO PICTURE

A picture is composed of small squares termed as pixels and the number of elements that compose the image is termed as definition of a picture. For example, in figure 1, an arrow is formed from 26 pixels in one row and 16 pixels in one column. So the definition of the image of the arrow is considered to be 26 x 16.

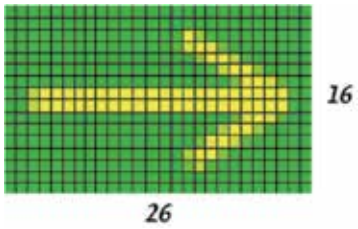

Figure 1

If more pixels are used to form an image its definition will be higher. The size of a square may varies according to the size and resolution of the monitor in which it has to be displayed. Resolution of the monitor is referred to in terms of dots per inch (dpi). If the size of the pixel is small, it will produce sharp picture but it needs more memory for storing the colour and intensity of each pixel. For example, in figure 2, the definition of left picture of a house is 300 x 220 made with 66000 pixels and the definition of right picture of the same house is 30 x 20 is made with 660 pixels. This signifies that left picture has a higher definition than right picture. From these two figures, it is clear that, if there are more pixels the image resembles with the original object.

Figure 2: Image of a house with different no. of pixels

Pixel is referred to a Digital Number (DN) which is related to the energy level reflected by the object and it is also refer to a grey value. The grey value ranges from 0-255. If two-bit memory pixels are used it can display only eight colors whereas eight-bit pixels can display 256

colors.

Remotely sensed data are related to a word "resolution" and there are four types of resolutions namely spatial, spectral, radiometric and temporal resolution *[4]*. Spatial resolution is ability of a sensor to identify the smallest size detail of a pattern in an image. In other words, spatial resolution refers to the number of pixels utilized in construction of a digital image. If an image is composed with greater number of pixels it refers to an image with higher spatial resolution.

Spatial resolution is expressed in terms of a value which provides the size of the pixel. For example, if an image is 15m resolution, this refer to each pixel of the image is 15m x 15m on ground. Higher resolution data mean that more pixels are used to create sharp and clean image. Consequently, such images can produce high accurate results.

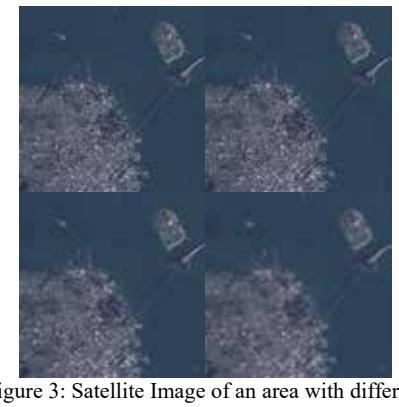

Figure 3: Satellite Image of an area with different resolutions *(Source: Finnish Meteorological Institute)*

In figure 3, there are four pictures of part of San Francisco city with different resolutions. The resolutions of the pictures clockwise from top left are 10 m, 30 m, 60 m and 100 m respectively. It can easily be recognized that higher the resolution better is the definition of the picture. For higher definition of picture, it takes more time to display and processing will be slower as well in compare to the picture with lower definition. Obviously, features in the higher resolution picture are more clearly recognizable than that in the lower resolution picture. Therefore, appropriate resolution of the picture should be chosen to meet the objective of the mission.

Radiometric resolution is mainly to discriminate very slight difference in energy of the objects. The finer radiometric resolution of a sensor enables to detect even smaller differences in reflected or emitted energy from the objects. Spectral resolution is ability of a sensor to record the information on a particular spectral wavelength range. It plays very important role for designing the sensor as different objects have different spectral signature. Temporal resolution is to capture the images by revisiting the satellite over the same area at same interval of time. This will facilitates to monitor the area of interest.

5. PICTURE TO PERSON

The products for the application of the technology will be prepared by the persons through the pictures formed from the pixels as shown in the figure 4.

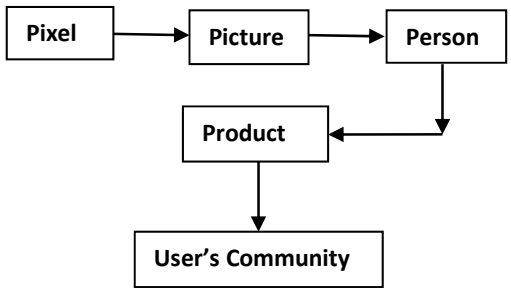

Figure 4: Flow Diagram for Pixel to Users Community

As soon as a picture is formed from the pixels, the picture will be observed by the person either on the screen of the computer or in a printed form. By observing the picture, the person will identify, interpret and recognize the features in the picture to extract information using appropriate remote sensing technology. The information thus extracted from the picture is the product to be used to fulfill their mission and then share the results with the persons from the user's community, see figure 4. .

The person who interprets data needs some knowledge on remote sensing and an experienced person can interpret better. The factors such as

shape, size, shadow, pattern, tone and texture of the features as well as associated features in the picture guide to identify the features. However, it is necessary to make sample field verification or ground truth for confirming the results otherwise it could mislead sometimes.

6. USE OF PICTURE IN REMOTE SENSING

Remote sensing technology is applied in many sectors of our community, and it is still in the process of growing further in the sectors which are beyond the imagination of a layman. In other words, it can be mentioned that the sky is the limit for the application of remote sensing technology. To mention a few sectors where the technology is applied are as follows *[3]*:

- **Mapping:** Mapping organization used satellite data for producing different types of maps such as topographical maps, land resources maps, geological maps, trekking maps, mapping of ocean floor, *et* cetera. The data can also be used to update the existing maps. Consequently, the corresponding maps can be used for the development activities of the country, for teaching and learning process in the domain of geoinformatics, for hiking, trekking and mountaineering, *et cetera.*
- **Weather forecasting:** Analyzing the trend of the weather from the temporal data and recent satellite image, weather can be forecasted such information is used by the persons from several sectors such as pilots, mountaineers, farmers, *et cetera* for planning their corresponding activities. Even a layman can take advantage from such information whether she/he to wear a thick clothes or to take an umbrella for going out from their house.
- **Monitoring:** Remote Sensing technology is used to monitor corresponding activities of different sectors such as status of agricultural crops, health of trees in the forest, movement of whales for protecting their life to avoid stranding in the beech of the ocean, control smuggling across the border between two countries, *et cetera.*
- **Detecting changes:** It is used to detect changes such as to observe growth in urban areas, deforestation, study wild animal migration, assessment of damages from natural hazards, loss of forest area from forest fire, amount of melting of icebergs, record rising of sea water level, and so on.
- **Searching and rescuing:** The technology is used to search and rescue operation after occurrence of a disaster such as floods, earthquakes, landslides, avalanche, tsunami, *et cetera.*
- **Observing biodiversity:** Biodiversity sector is one of the most important aspects of the present concerns. In order to understand this field, remote sensing technology is used to make hyperspectral structure and 3D vegetation structures.

Furthermore, there are many more sectors where remote sensing technology can be applied using different types of remotely sensed data. The results will be used for improving social status of the people.

7. WAY FORWARD

As mentioned above, an international organization, Group on Earth Observation (GEO) has established Global Earth Observation System of Systems (GEOSS). The system has identified *agriculture, biodiversity, climate, disasters, ecosystems, energy, health, water and weather are the Social Benefit Areas. One of the objectives of GEOSS is to link Earth observation resources world-wide and to make available these resources for better decision making in the areas mentioned above [5]*. Based on this principle, the workshop has realized to create **Himalayan GEOSS**. The group proposed to make use of the concept, ***pixel to picture and picture to person*** of Earth observation system for some of the sectors related to social benefit areas of GEOSS. The sectors are as follows:

- ***Agriculture and food security****: Monitoring agriculture crop area and yield, develop climate services for agriculture management*
- ***Water resources****: Assessment of present and future availability of water in the region. Application of EO data for monitoring surface and ground water, snow and glacier, precipitation, water bodies.*
- ***Disaster risk reduction****: Assessment*

of disaster risk from flood, land slide, earthquake, river erosion, forest fire etc. Monitoring of disaster events and damage assessment.

- ***Land use, land cover change**: Land cover mapping and change monitoring at national and regional level*
- ***Ecosystem services**: Application of EO for ecosystem monitoring. Assessment of ecosystem services and vulnerability*

These priority themes will build on the existing programs and initiatives and will synergize with different activities in the regional member countries. Other themes will be included as needed and prioritized by the regional member countries through regional consultations [2].

Therefore, the communities related with these sectors should make best use the system for improvement in these sectors which will benefits the people of the country to uplift their social status.

8. CONCLUSION

Remotely sensed data are used more and more in different sectors whether it is a space borne or airborne system. These systems are termed as the earth observation system. Recognizing its potential for betterment of the people of the member countries of ICIMOD and supportive nature of GEO to address some of the related social benefit areas of GEOSS, the regional workshop organized in Nepal proposed to initiate **Himalayan GEOSS**. The group also prioritized the sectors namely: *Agriculture and food security, Water resources, Disaster risk reduction, Land use and land cover change, and Ecosystem services* which are to be addressed to improve its present status. The slogan of Earth observation system ***"Pixel to picture and picture to person"*** will be a powerful tool to solve the issues related with the social benefit areas identified during the workshop organized jointly by ICIMOD and GEO. Therefore, **Himalayan GEOSS** initiative could be one of the milestones for the member countries to uplift the status of the people belonging to Hindu Kush Region.

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