Digital Image Data Formats

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Introduction

In order to properly process remotely sensed data, the analyst must know how the data is organized and stored on digital tapes and how the data are processed by computers and software. Understanding existing digital data formats is essential before the data can be processed. There are many different data formats used for storing digital remotely sensed data. Many commercial data suppliers such as EOSAT and SPOT, provide radiometrically corrected data in a customer specified format. There are four major data formats used by government and commercial data suppliers:

1 Band Interleaved by Pixel (BIP) Format

2 Band Interleaved by Line (BIL) Format

3 Band Sequential (BSQ) Format

4 Run-Length Encoding Format

Most digital data are stored on nine-track tape (800, 1600, and 6250 bpi), 4- or 8-mm tape, or on optical disks. The nine-track and 4- or 8-mm tapes must be read serially while it is possible to randomly select areas of interest from within the optical disk. This may result in significant savings of time when unloading remote sensor data. The 4- and 8-mm tape and compact disks are very efficient storage mediums, as opposed to the large number of nine-track tapes required to store most images (Jensen, 1996).

Band Interleaved By Pixel Format (BIP)

One of the earliest digital formats used for satellite data is band interleaved by pixel (BIP) format. This format treats pixels as the separate storage unit. Brightness values for each pixel are stored one after another. It is practical to use if all bands in an image are to be used. Figure 2-3.1 shows the logic of how the data is recorded to the computer tape in sequential values for a four-band image in BIP format.

Figure 2-3.1 Band Interleaved by Pixel Format (BIP)								
Line 1	Pixel **1**	Band 1	Line 1	Pixel **2**	Band 1	Line 1	Pixel **3**	Band 1
Line 1	Pixel **1**	Band 2	Line 1	Pixel **2**	Band 2	Line 1	Pixel **3**	Band 2
Line 1	Pixel **1**	Band 3	Line 1	Pixel **2**	Band 3	Line 1	Pixel **3**	Band 3
Line 1	Pixel **1**	Band 4	Line 1	Pixel **2**	Band 4	Line 1	Pixel **3**	Band 4

All four bands are written to the tape before values for the next pixel are represented. Any given pixel located on the tape contains values for all four bands written directly in sequence. This format may be awkward to use if only certain bands of the imagery are needed. Often data in BIP format is organized into four separate panels, or tiles, consisting of vertical strips each 840 lines wide in the x direction and 2,342 lines long in the y direction. In order to read all four bands of the image, all four panels must be pieced together to form the entire scene (Campbell, 1987).

Band Interleaved By Line Format (BIL)

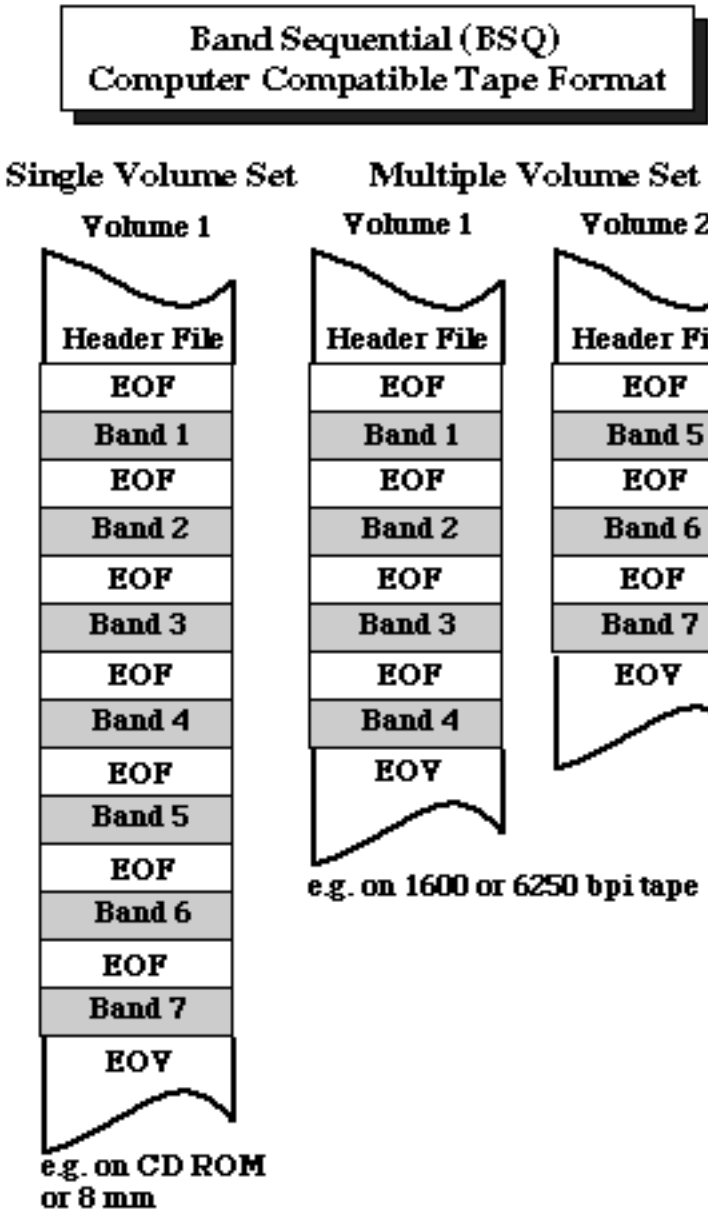
Just as the BIP format treats each pixel of data as the separate unit, the band interleaved by line (BIL) format is stored by lines. Figure 2-3.2 shows the logic of how the data is recorded to the computer tape in sequential values for a four band image in BIL format.

Figure 2-3.2 Band Interleaved by Line Format (BIL)										
Line **1**	Band 1	Line **1**	Band 2	Line **1**	Band 3	Line **1**	Band 4			
	Line **2**	Band 1	Line **2**	Band 2	Line **2**	Band 3	Line **2**	Band 4		
		Line **3**	Band 1	Line **3**	Band 2	Line **3**	Band 3	Line **3**	Band 4	
			Line **4**	Band 1	Line **4**	Band 2	Line **4**	Band 3	Line **4**	Band 4

Each line is represented in all four bands before the next line is recorded. Like the BIP format, it is a useful to use if all bands of the imagery are to be used in the analysis. If some bands are not of interest, the format is inefficient if the data are on tape, since it is necessary to read serially past unwanted data.

Band Sequential Format

The band sequential format requires that all data for a single band covering the entire scene be written as one file (see Fig. 2-3.3). Thus, if an analyst wanted to extract the area in the center of a scene in four bands, it would be necessary to read into this location in four separate files to extract the desired information. Many researchers like this format because it is not necessary to read serially past unwanted information if certain bands are of no value, especially when the data are on a number of different tapes. Random-access optical disk technology, however, makes this serial argument obsolete.



Run-Length Encoding

Run-length encoding is a band sequential format that keeps track of both the brightness value and the number of times the brightness value occurs along a given scan line. For example, if a body of water were encountered with brightness values of 10 for 60 pixels along a scan line, this could be stored in the computer in integer (213) format as 060010, meaning that the following 60 pixels will each have a brightness value of 10. Storing the two values 60 and 10 would require far less memory on disk or tape than storing 60 number 10s. However. if the data are exceptionally heterogeneous, with very few similar brightness values, this format is no better than the others.

Data Exchange Standards

Data exchange is characterized as data import and data export. The data exchange process is not typically reciprocal, but rather, users import data purchased from data exporters (providers). These are usually government agencies or commercial data sources. To be successful, GIS users must know how to cope with the heterogeneous data environment. For data export, each internal data model must be converted to a specific file structure on disk or other media. The process is reversed for data import. The goal of data exchange is to transfer information to enable understanding of the phenomena being represented (Robinson, 1986).

There are three basic design strategies that can be used by data exchange software:

Data exchange between image systems using direct translation. This design is an effective method of data exchange because it involves the most efficient path between two systems. It is a good choice when only two systems are involved but requires an understanding of how the two systems work. Routines can be written to fit the data in a desired format. Problems with this design develop when more than two systems are involved. In such a case, alternative routines can be written for each system exchange.

Data exchange between image systems using a "data switchyard". This method of data exchange avoids the factorial increase in the number of translation programs associated with direct translation. Data is converted into one internal standard. The software then translates data to the desired export format on output. Only two translation routines are required for all systems. This method works well when a large number of system translations are needed because it reduces the number of routines needed to convert the data.

One important thing to consider when using the data switchyard is that attention must be paid to incoming and outgoing characteristics of the data so you don't lose information during the conversion. The central hub of data exchange must be all-inclusive so that you accommodate all the characteristics of the data.

Data exchange between image systems using a neutral format. When using the neutral exchange format, all parties must agree on one standardized common file. The advantage is that only two routines are required (one to read and one to write the exchange format). Problems occur when a routine is unable to effectively encode and decode data to the neutral format and data characteristics are lost. The neutral structure must be all-inclusive and all parties must agree on a common implementation.

References

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Robinson, A. H., J. Morrison, P. Muehrcke, A. Kimerling, S. Guptill, 1995, Elements of Cartography, 6th Edition, John Wiley & Sons, Inc., pp. 190-192.