Custom Raster Format Support in ArcGIS through GDAL

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Introductions

I am Frank Warmerdam:

- Primary developer of GDAL Library
- Part time ESRI contract developer
- Unfortunately, not an ArcGIS guru!

You are:

- A C++ developer
- Wanting to extend ArcGIS with new/custom raster file formats via a plugin

Schedule

- **Today we will cover**
  - Data Model Review
  - Compile and Install new ArcGIS Raster Driver
  - Brief introduction to GDAL/OGR
  - Review the driver implementation
  - Extend the driver in various ways
  - Advanced topics for GDAL drivers
- **Ask questions at any time!**

Please complete the session survey!

Introduction to GDAL/OGR

- C++ Geospatial data access library
- GDAL is for raster data
- OGR is for feature (vector) data
- Python/C#/Java/Perl and Ruby bindings
- Command line utilities for end users, testing

A Brief History

- Launched in fall 1998
- Early home at RemoteSensing.org
- Adoption by GRASS, OSSIM, OpenEV and MapServer by 2002
- Proprietary adoption by FME, Cadcorp SIS, and recently ArcGIS
- Project joined OSGeo in early 2006
- Project Steering Committee and sponsorship program in late 2006
- Stable release: 1.6.0
- Used by ArcGIS 9.3: 1.4.1.1e

Data Model (Dataset)

Please visit:

http://www.gdal.org/gdal_datamodel.html

Key Dataset Points:

- Dataset is a collection of Bands
- Coordinate System is OGC WKT (slight variation on PE strings / .prj)
- Georeferencing is usually affine (like .tifw)
- All bands have matching size, georef.

Data Model (Band)

Key Band Points:

- Variety of pixel data types: Byte, UInt16, Int16, UInt32, Int32, Float32, Float64, and the complex types CInt16, CInt32, CFloat32, and Cfloat64.
- Dataset defined block size.
- Optional RGB color table.
- Optional nodata value
- Optional Pyramids
- Optional histogram and other metadata.

Building for ArcGIS

- ArcGIS used a slightly custom build of GDAL 1.4.
- New drivers can be built as DLL plugins with MSVC
- Plugins must normally be dropped into:

"C:\Program Files\ArcGIS\bin\gdalplugins"

- New formats should also be registered in:

"C:\Program Files\ArcGIS\bin\RasterFormats.dat"

Build Environment

- It appears ESRI builds gdal14.dll with MSVC 7.1 (Visual Studio 2003) in ArcGIS 9.3
- Newer versions *cannot* be used
- Use compiler options /MD and /EHsc
- *Must* use GDAL 1.4.x include files
- *Must* use GDAL 1.4.x stub library (gdal_i.lib)

Provided Environment

- Provided “ArcGIS_GDAL” directory tree:
  - Bin: contains gdal command line programs
  - Lib: Contains gdal_i.lib
  - Include: Contains GDAL include files
  - Jdem: Plugin development directory
  - setup_env.bat: establish work env.
- Using an NMAKE Makefile (Visual Studio project left as an extra exercise)

Setup Command Shell

- Edit ArcGIS_GDAL\setup_env.bat

```
call C:\"Program Files"\"Microsoft Visual Studio 9.0"\vc\bin\vcvars32.bat
PATH=C:\Program Files\ArcGIS\bin;%PATH%
```

- Adjust visual studio path
- Adjust ArcGIS Path
- Open cmd.exe shell
- CD to ArcGIS_GDAL
- Run setup_env.bat
- Copy ArcGIS_GDAL\bin\gdalinfo.exe to ArcGIS\bin

Test Command Shell

- Test compiler is available and in path:

```
cl.exe /help
```

- Confirm gdalinfo.exe works, and reports GDAL version is 1.4.1.1e

```
gdalinfo –version
```

- Confirm our test file is not yet supported:

```
cd jdem
gdalinfo jdem_custom.mem
```

- Should get “...not recognised as a supported file format”.

Build Plugin

- In jdem directory:

```
nmake plugin
```

- Which does (no magic!)

```
cl /nologo /MD /EHsc /W3 /Ox
   -I..\include /c jdem2dataset.cpp

link /dll /out:gdal_JDEM2.dll

jdem2dataset.obj../lib/gdal_i.lib

mt -manifest
   gdal_JDEM2.dll.manifest
   -outputresource:gdal_JDEM2.dll;2
```

Install Plugin

- Copy to ArcGIS plugin directory

```
nmake install
```

- Which does:

```
mkdir C:\"Program Files"\ArcGIS\bin\gdalplugins
copy gdal_JDEM2.dll C:\"Program Files"\ArcGIS\bin\gdalplugins
```

- Now try opening jdem_custom.png in ArcMap

Update RasterFormats.db

- Edit RasterFormats.db file in ArcGIS “bin”
- Add the following at the end

```
<e on="y" nm="JDEM2"
ex="*.mem"  et="JDM"  at="0x27" />
```

  - nm=”JDEM2”: should match the driver name?
  - ex=”*.mem”: define format extension
  - et=”JDM”: format string (used for?)
  - at=”0x27”: format type codes, 0x27 means read; 0x2f means read/write
- Restart ArcMap – jdem_custom.mem should be visible in “add data”

Examining the Code

- Refer to:
  http://www.gdal.org/gdal_drivertut.html

Extending with Statistics

- Add GetStatistics() to return default scaling:

```
CPLErr JDEM2RasterBand::GetStatistics(
    int bApproxOK, int bForce,
    double *pdfMin, double *pdfMax,
    double *pdfMean, double *pdfStdDev )

{
     *pdfMin = 0.0;
     *pdfMax = 2000.0;
     *pdfMean = 0.0;
     *pdfStdDev = -1.0;
     return CE_None;
}
```

Extending To Write

- Add Create() method.
- Update Open() to support update mode.
- Implement SetGeoTransform()
- Implement IWriteBlock() on band.
- Update the driver information accordingly.
- Update the RasterFormats.dat.
- Currently ArcGIS UI does not allow writing to new GDAL plugin formats, but scripting does.

Extending To Write (Scripted Call)

- See demo.mxd for example scripted save.

```
Dim pWs As IRasterWorkspace
Dim pRasterDs As IRasterDataset
Dim pSaveAs As ISaveAs

Set pWs =OpenWorkspace("c:\ArcGIS_GDAL\jdem")
Set pRasterDs =
   pWs.OpenRasterDataset("jdem_custom.mem")

Set pSaveAs = pRasterDs
Dim pNewDataset As IRasterDataset
Set pNewDataset =
   pSaveAs.SaveAs("out.mem", pWs, "JDEM2")
```

Additional ArcGIS Specifics

- Raster Attribute Tables (limited support)
- GetFileList() for 9.4 dataset management
- GDAL vs. PE coordinate systems
- GDAL geotransform != world file origin
- More about PAM
- GDAL replacing RDO as ArcGIS raster extension mechanism
- Backporting new drivers possible

General Driver Implementation Notes

- Use gdalinfo, gdal_translate to test
- Drivers can implement non-file datasources
- Building GDAL in debug mode not too hard
- Many GDAL resources at gdal.org
- There is a community!
- GDAL plugins useful in other environments (MapGuide, GRASS, QGIS...)
- Drivers may be contributed back to project

Questions?

Questions are welcome now...

- also available Wednesday
- Or by email: warmerdam@pobox.com\