Land Use/ Land Cover Spatial Data Layer Development and Update Project

In Support of Non-Point Total Maximum Daily Load (TMDL) Analyses Lower Yakima River Basin, Yakima County

TECHNICAL PROCESS DOCUMENTATION

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Project Objectives

Revise the 1970's USGS Land Use / Land Cover spatial data set for one project area in eastern Washington using the development of grid coverage data from the 1991 Landsat Thematic Mapper (TM) Imagery and other supporting land use/ land cover spatial data sets and readily available local information. Develop and document data comparison and compilation procedures used for future updating efforts. Maintain the Anderson Classification Scheme for LULC coding and expand the current second level coding to a third level where verified information is available.

Project Comparison Data Sets

1991 Landsat Image (YAKGRID) University of Washington - Fisheries, 1991 30 meter resolution
Yakima County Zoning (ZONING) Yakima County, Wa., 1991 1:24,000
Yakima County Agriculture (AG) Yakima County, Wa., 1991 1:24,000
National Wetland Inventory (NWI) U.S. Fish and Wildlife , 1975 1:24,000
Washington Digital Elevation Model (LAT75) Wa. State Dept. of Natural Resources, 1994 1:24,000
USGS 1975 Land Use / Land Cover (LULC) USGS, 1976 1:250,000
Water Resource Inventory Areas (WRIA) Wa. State Dept. of Natural Resources, 1994 1:24,000
Tiger (COUNTY), (CITIES) Wa. State Office of Financial Management, 1990 (census) 1:100,000
Washington State Vegetation (VEG) Wa. State Dept of Fish and Wildlife, 1991
Washington State Subregions (SUBREGNS) EPA, 1995 1:250,000
Township Digital Ortho Photography Wa. State Dept. of Natural Resources, 1994 1:24,000

Project Development

The development process from image to final grid coverage is presented on the following pages as series of brief descriptions of sequential steps, followed by the ARC/INFO commands used to perform the specific operation. Six separate grids were developed from the collected spatial data sets listed above. The data base of each grid was analyzed and coded for its specific relationship to land use / land cover. The six grids were then combined into one grid and the final land use / land cover coding was processed within ARC/INFO Tables by cross referencing the combined value_items of all the grids based on an ordering process involving data accuracy and relevant, area extent, elevation, observation and best professional judgment. Some of the data relationships include vegetation density and elevation, documented farming areas within different zoning classifications, detailed water and wetlands within farming and zoning classifications, physical extent of forest and range cover within the study area and observed cloud and shadow errors on the Landsat image. The final LULC coding was done in a three digit data field to accommodate a third level for Anderson's land use / land cover classification scheme. The third level was coded only where detailed information was available and the information was verifiable and logically useful for the scope and scale of the project.

Detailed Processing Procedures

Step 1 - BOUNDARY COVERAGE AND GRID (bndrygrid)

This step involves establishing the boundary coverage for the study area. Two coverages were extracted from Ecology's $STATE coverage directory, one was clipped with the other to form the study area. The study area encompasses the portion of WRIA #37, (the lower Yakima River Basin), within Yakima County. The polygon for WRIA #37 was extracted from the state WRIA coverage and the polygon for Yakima County was extracted from the state county coverage using the Arc RESELECT command.

```
Arc: reselect $state/wria w37 poly
>: res wria_id = 37
>:
Arc: reselect $state/county yc poly
>: res name = 'Yakima'
>:
Arc: clip w37 yc bndry
Arc: tables
Enter Command: sel bndry.pat
Enter Command: res bndry-id > 0
Enter Command: ca bndry-id = 1
Enter Command: q
```

Polygon coverage 'bndry' is transformed into the grid coverage 'bndrygrid' in the following step. This grid was used to define further grid coverages areas from available data sets. The cell size for 'bndrygrid' was determined from the listed cell size of the TM image using the describe command.

```
Arc: describe yakgrid
   Cell Size =            84.566          Data Type:          Integer
   Number of Rows =       2610            Number of Values =  20
   Number of Columns =    4036            Attribute Data (bytes) = 8
            BOUNDARY                              STATISTICS
   Xmin =          1819674.000            Minimum Value =     25.000
   Xmax =          2160980.753            Maximum Value =     124.000
   Ymin =          257820.500             Mean          =     92.944
   Ymax =          478536.711             Standard Deviation = 31.587
```

```
Arc: polygrid bndry bndrygrid bndry-id
Cell Size (square cell): 84.5          ----  (cell size was chosen from the cell size information above)
Convert the Entire Coverage? (Y/N): y
```

```
Arc: list bndrygrid.vat
Record    VALUE     COUNT
   1        1       8408312     ---     (total number of cells for the study area grid)
```

Step 2 - YAKIMA AREA TM GRID

The original portion of the TM Image was reduced to fit within the maximum x,y extent of the study area boundary as described in step #1 above by multiplying the image grid and the developed boundary grid. The color remap table 'allscr_rmt', provided by the University of Washington Fisheries Department, was then joined to the yakgrid.vat with the joinitem command adding data column 'symbol' to the .vat. The 'allscr_rmt' is a generalization and grouping of TM image cell values (1-255) into 20 different color values. The grouping was based on research done by the U.W. Fisheries Dept on vegetation density. The Yakima grid was then reclassified based on the item 'symbol'. The numbers in the VALUE column for yakgrid now contain color values that correspond to shade set colornames in ARC/INFO and depict areas of vegetation density.

*Grid: yakgrid = bndrygrid * imagegrid*
Arc: joinitem yakgrid.vat allscr_rmt yakgrid.vat value count
Grid: yakgrid = reclass(yakgrid,yakgrid.vat,data,value,symbol)
Arc: list yakgrid.vat

Record	*VALUE*	*COUNT*
1	*25*	*705536*
2	*26*	*3634*
3	*27*	*648*
4	*29*	*212280*
5	*32*	*72832*
6	*53*	*170851*
7	*56*	*9566*
8	*57*	*25*
9	*62*	*36360*
10	*73*	*658747*
11	*76*	*298616*
12	*78*	*666454*
13	*83*	*645502*
14	*84*	*431976*
15	*86*	*126736*
16	*110*	*242637*
17	*113*	*728588*
18	*120*	*1620284*
19	*122*	*1753755*
20	*124*	*10108*

Sample grids were clipped from yakgrid to coincide with digital ortho photographs purchased from Washington State Department of Natural Resources (DNR). These small sample grids were converted to polygon coverages with the gridpoly command. Individual polygon labels (cell values) were checked against the ortho photo background in ARCEDIT. In this way a color value group could be matched to a respective vegetation type shown on the ortho photos.

Step 3 - ELEVATION CONTOUR GRID (contgrid)

An elevation grid was developed for the purpose of determining forest vegetation communities within the study area landscape. On the eastern slopes of the cascade mountains the evergreen forest cover begins with Ponderosa Pine at elevations above 1800 feet. Also, most riparian valleys contain mixed evergreen and deciduous forest types. In the final LULC grid certain cell values in areas above 2200 feet were coded as evergreen forest while those same values at or below 2200 feet were coded as mixed forest. In this way cell values that are the same for different elevation levels can be coded accordingly. First an elevation grid is developed from a state elevation lattice. Next a polygon coverage is formed from the elevation grid using the latticepoly command with the range option creating eight equally spaced elevation levels. The polygon cover is then converted back to a grid using the elevation values as the value_item.

*Grid: yakelev = bndrygrid * $grid/lat75*
Arc: latticepoly yakelev yakconts range
Arc: polygrid yakconts contgrid elev
Cell Size (square cell): 84.5
Convert the Entire Coverage? (Y/N): y

Arc: list contgrid.vat

Record	*VALUE*	*COUNT*
1	*1400*	*3413891*
2	*2200*	*1988471*
3	*3000*	*1326988*
4	*3800*	*975171*
5	*4600*	*406562*
6	*5400*	*205858*
7	*6200*	*74618*
8	*7000*	*16971*

The resulting contour grid contains cell values coded for elevation levels from 1400 feet to 7000 feet.

Step 4 - NWI WETLAND GRID (nwigrid)

The NWI data library was used to develop a grid coverage for a more accurate accounting of water and wetlands within the study area. The library is tiled by 7.5 minute quad so it was necessary to establish a quad name list and then mapjoin all NWI quad covers by name. Using BNDRY as the clipcover option with the mapjoin command, the combined NWI coverage was clipped to the study area. The new NWI coverage was coded for land cover values in the .pat file, using Anderson's classification method, into a new data item called LULC. A grid was developed from the coded NWI coverage using LULC as the value_item.

Arc: clip $state/quad24 bndry quads poly
Arc: pullitems quads.pat quad.list name
Arc: mapjoin nwi net features bndry
Arc: tables
Enter Command: additem nwi.pat nwi 3 3 i
Enter Command: sel nwi.pat
*Enter Command: res fws.code lk '*FO*'* *(all forested wetlands)*
Enter Command: ca lulc = 610
Enter Command: asel
*Enter Command: res fws.code lk '*OW*' or fws.code lk '*UB*'* *(all lakes and reservoirs)*
Enter Command: ca lulc = 520
Enter Command: asel
Enter Command: res fws.code lk 'R'* *(all rivers and streams)*
Enter Command: ca lulc = 510
Enter Command: asel
Enter Command: res lulc = 0
Enter Command: nwi-id > 0 and fws.code <> 'U' *(all other wetlands)*
Enter Command: ca lulc = 620

Arc: polygrid nwi nwigrid lulc
Cell Size (square cell): 84.5
Convert the Entire Coverage? (Y/N): y

Arc: list nwigrid.vat

Record	*VALUE*	*COUNT*	
1	*1*	*8274476*	*(all other cells within study area)*
2	*510*	*18461*	*(rivers and streams)*
3	*520*	*11695*	*(lakes and reservoirs)*
4	*610*	*35716*	*(forested wetlands)*
5	*620*	*67960*	*(non-forested wetlands)*

The grid contains four wetland classes based on Anderson's classification scheme.

Step 5 - URBAN ZONING GRID (zonegrid)

The zoning coverage of Yakima County is used as a base to determine urban land within the study area. Again land use values from Anderson's classification method are added into the .pat under item lulc. Values for all residential are coded 110, commercial 120, industrial 130 and mixed 160. Areas outside the urban core such as general rural are coded 170, agriculture 200, and other non-urban areas are given a value of 1 as a place holder for the future zoning grid.

Arc: tables
Enter Command: additem zoning.pat lulc 3 3 i

Enter Command: sel zoning.pat
*Enter Command: res zone lk '*R*'*
Enter Command: ca lulc = 110
Enter Command: asel
Enter Command: res zone = 'GR'
Enter Command: ca lulc = 170
Enter Command: asel
*Enter Command: res zone lk '*A*'*
Enter Command: ca lulc = 200
Enter Command: asel
Enter Command: res zone = 'LIM'
Enter Command: ca lulc = 160
Enter Command: asel
Enter Command: res zone = 'LI' or zone = 'I' or zone = 'M1'
Enter Command: ca lulc = 130
Enter Command: asel
*Enter Command: res zone lk '*C*' or zone lk '*B*'*
Enter Command: ca lulc = 120
Enter Command: asel
Enter Command: res zone = 'FD' or zone = 'TL' or zone = 'FW' or zone = 'PD'
Enter Command: ca lulc = 1
Arc: polygrid zoning zonegrid code
Cell Size (square cell): 84.5
Convert the Entire Coverage? (Y/N): y

Arc: list zonegrid.vat

Record	VALUE	COUNT	
1	1	5421820	(all other cells within study area)
2	110	90192	(residential)
3	120	1514	(commercial)
4	130	11997	(industrial)
5	160	140697	(mixed)
6	170	827376	(other/unknown)
7	200	1914536	(agriculture)

Step 6 - AGRICULTURE/URBAN GRID (augrid)

The agriculture coverage of Yakima County is used to develop an agriculture/urban of the study area. Anderson's classifications were added into the .pat file under the item lulc. The completed coverage was then coded for land use/cover and then converted to a grid coverage using lulc as the value_item.

Arc: tables

Enter Command: sel ag.pat
Enter Command: res ag.code = 'FC'
Enter Command: ca lulc = 210
Enter Command: asel
Enter Command: res ag.code = 'HAY/PAST'
Enter Command: ca lulc = 211
Enter Command: asel
Enter Command: res ag.code = 'GRAIN'
Enter Command: ca lulc = 213
Enter Command: asel
Enter Command: res ag.code = 'ORCH/VIN'
Enter Command: ca lulc = 220
Enter Command: asel
Enter Command: res ag.code = 'HOPS'
Enter Command: ca lulc = 223
Enter Command: asel
Enter Command: res ag.code = 'LVS' or ag.code = 'DAIRY'
Enter Command: ca lulc = 230
Enter Command: asel
Enter Command: res ag.code = 'AG IND'
Enter Command: ca lulc = 240

Arc: polygrid ag augrid lulc
Cell Size (square cell): 84.5
Convert the Entire Coverage? (Y/N): y
Arc: list augrid.vat

Record	VALUE	COUNT	
1	1	5486322	(all other cells within study area)
2	100	1286678	(cells within urban area)
3	210	1280489	(cropland)
4	211	22554	(hay/pasture)
5	213	3151	(other cropland)
6	220	304541	(orchards/vineyards)
7	223	17148	(hops)
8	230	7166	(livestock)
9	240	261	(other agriculture)

Step 7 - SELECTING CLOUD AND SHADOW ERRORS (fixgrid)

Viewing the TM image provided, with the associated colormap table (allscr_rmt), white (# 26) and blue (#56) indicated clouds and shadow respectively. Value 56 also represented water using this colormap table, so 1:24,000 USGS topological quad maps were used to differentiate areas that appeared to be large lakes on the TM image and actual water bodies. Since there were very few match-ups with cell values

equaling 56 and actual water bodies all values equaling 26 or 56 were copied into a new grid called fixgrid1 using the 'select' function within grid.
A polygon coverage (fgpoly) was made of the reselected cell values. A union was done with the 'fgpoly' coverage and 'bndry' coverage to combine the selected polygons (#'s 26 and 56) with the study area polygon. Polygons in the union coverage 'fgunion' were coded to match the predominate neighboring cell values in the TM image in Arcedit. This was accomplished using the TM image in an ARCPLOT AML to produce a background view with the 'ap' command in Arcedit and individually selecting and coding label points to coincide with the dominate surrounding land cover. In this way all clouds and shadow values were replaced with forest and range values.
The recoded coverage was transferred back into a grid coverage containing the new cell values 330, 420, and 430. Cell value 1 is the result of the union with 'bndry' and provides a place holder for future grid combination analysis.

Grid: fixgrid1 = select(yakgrid,'value in {26,56}')
Arc: gridpoly fixgrid1 fgpoly
Arc: union fgpoly bndry fgunion
Arc: ae
Arcedit: edit fgunion
Arcedit: ap image.aml (note: draws TM image using allscr_rmt colors)
Arcedit: ef label
Arcedit: sel grid-code = -9999 and bndry-id = 1
Arcedit: ca grid-code = 1
Arcedit: sel (all other labels and code values to match closest lulc neighboring values)
Arcedit: save
Arc: polygrid fgunion fixgrid grid-code
Cell Size (square cell): 84.5
Convert the Entire Coverage? (Y/N): y

Arc: list fixgrid.vat

Record	*VALUE*	*COUNT*	
1	*1*	*8396054*	*(all other cells within study area)*
2	*330*	*2623*	*(mixed rangeland)*
3	*420*	*7195*	*(evergreen forestland)*
4	*430*	*1283*	*(mixed evergreen,deciduous forestland)*

Step 8 - COMBINE GRIDS (lulc1)

Using the combine command in grid, the completed grids (yakgrid, contgrid, augrid, nwigrid, zonegrid, and fixgrid) were brought together in one grid (lulc1). The value item from each separate grid was joined to the lulc1.vat file during the combine process and was given the item name of the grid it represented. This overlay process allows the value item from each grid to be viewed together for purposes of association and final coding. The grid yakgrid contains eight items in its .vat file. Value is

the new cell id number, count is the number of cells for each value number, yakgrid is the cell value for the allscr_rmt remap color table (step #2), contgrid contains cell values for elevation at 800 foot intervals starting at 1,400 feet, and augrid,nwigrid,zonegrid and fixgrid all contain land use land cover values added in steps 4-7 .

Grid: lulc1 = combine(yakgrid,contgrid,augrid,nwigrid,zonegrid,fixgrid)

A sample from the resulting grid database (lulc1.vat) is shown below with a description of individual values.

Arc: list lulc2.vat

VALUE	= *1*	*(cell id number)*
COUNT	= *70437*	*(# of cells with the above id)*
YAKGRID	= *122*	*(allscr_rmt color shade value)*
CONTGRID	= *3000*	*(general elevation value in feet)*
AUGRID	= *1*	*(cell value outside ag- urban area)*
NWIGRID	= *1*	*(cell value is non-wetland or non-water)*
ZONEGRID	= *170*	*(cell value is other urban lulc code)*
FIXGRID	= *1*	*(cell value contains no cloud/shadow error)*
VALUE	= *345*	*(cell id number)*
COUNT	= *134*	*(# of cells with the above id)*
YAKGRID	= *56*	*(allscr_rmt color shade value)*
CONTGRID	= *4600*	*(general elevation value in feet)*
AUGRID	= *1*	*(cell value outside ag- urban area)*
NWIGRID	= *1*	*(cell value is non-wetland or non-water)*
ZONEGRID	= *1*	*(cell value is outside urban zoning)*
FIXGRID	= *420*	*(cell value contains cloud/shadow error code)*

The next step involves adding a new data column to lulc1.vat to receive the final land use/land cover coding. The aml program, process.aml was written to perform this task in ARC/INFO Tables. The following example shows some of the logic and inter-relationships involved in the coding process.

Step 9 - LULC CODING PROCESS SAMPLE

This is a sample of the coding process that occurs during the operation of 'process.aml'.
The selection process is keyed to color shade values, landscape position, elevation and documented land use. Digital ortho photos were used in conjunction with 7.5 minute quad maps and other local information, where possible, to help improve conclusions for different lulc classes. The data column lulc is populated with Anderson's land use/land cover codes by using the reselect process within ARC/INFO

Tables. The process order is based on vegetation density, data accuracy and data age so that any overwriting of codes taking place will be intended. For example, the NWI data set is older than the Agriculture data set, and it's known that many wetlands fall victim to draining and filling for farm use. Agriculture coding therefore, should overwrite wetland coding, but not overwrite lakes or river coding. Another example is the one given at the beginning of this report. Evergreen forest types in this region prevail in elevations above 2,200 feet. From observing digital ortho photos and against cell color density values a group of cell values was identified to represent evergreen forest. If the cell values 53,62,76,78,84 or 86 occurred at an elevation greater than 2,200 feet the cell value for lulc was coded 420. If those same cell values occurred at a lower elevation the lulc coding would be entered as 430 or mixed forest. If those same cell values also contained an agricultural coding in the augrid column they were coded with the corresponding lulc code for agriculture.

The following two examples show the lulc item column being coded in tables. The nwigrid values greater that 600 include 610 for forested wetlands and 620 for non-forested wetlands. All cells containing these nwigrid codes have the same code transferred to the lulc item column. The augrid values greater than 100 cover all values from 210 to 240 and the color values inside the braces are all areas that have been defined as having active farm vegetation. The second part of example 9a. shows all agriculture codes between 210 and 240 being written to item column lulc. Even where a previous wetland value already existed in item column lulc.

a./* Selecting and coding wetlands:

```
Arc: tables
additem lulc1.vat lulc 3 3 i
sel lulc1.vat
 res nwigrid > 600
 ca lulc = nwigrid
 asel
 res augrid > 100
 res yakgrid in {25,26,53,56,57,62,73,76,78,83,84,86,110,113}
 ca lulc = augrid
```

```
VALUE       = 400 ..grid cell id number
COUNT       =   2 ..number of cells
YAKGRID     =  78 ..color indicating vegetation
CONTGRID    = 2200 ..elevation of sample
AUGRID      = 220 ..agriculture use (vineyard)
NWIGRID     = 620 ..wetland (non-forested)
ZONEGRID    = 200 ..agricultural zoning area
FIXGRID     =   1 ..outside cloud/shadow error
LULC        = 220  ..code from reselection process

VALUE       = 1376 ..grid cell id number
COUNT       =  19 ..number of cells
YAKGRID     =  83 ..color indicating vegetation
```

CONTGRID = *1400 ..elevation of sample*
AUGRID = *210 ..agriculture use (cropland)*
NWIGRID = *510 ..wetland (open water, riverine)*
ZONEGRID = *200 ..agricultural zoning area*
FIXGRID = *1 ..outside cloud/shadow error*
LULC = *210 ..code from reselection process*

b./* Selecting and coding water:

```
res nwigrid in {510,520}
ca lulc = nwigrid
```

VALUE = *1376 ..grid cell id number*
COUNT = *19 ..number of cells*
YAKGRID = *83 ..color indicating vegetation*
CONTGRID = *1400 ..elevation of sample*
AUGRID = *210 ..agriculture use code(cropland)*
NWIGRID = *510 ..wetland code (river)*
ZONEGRID = *200 ..agricultural zoning area*
FIXGRID = *1 ..outside cloud/shadow error*
LULC = *510 ..code from reselection process*

In example b. the lulc code of 210 for agriculture, is overwritten by the stream code 510 where both share the same cell id number. In this case, by reselecting and coding all cell values containing water values after the agriculture has been coded the water coding overwrites all others.

Step 10 - PROCESS.AML

This aml was written to automate the coding process for the lulc1 grid. It shows the data relationships that were developed and observed over the course of the study. Many areas were generalized because of a lack of quality ground truth data and time constraints on the project.

```
Arc: &r process.aml
tables
additem lulc1.vat lulc 3 3 i
sel lulc1.vat
/* Range
 res yakgrid in {25,27,29,32,120,122,124}
 ca lulc = 330 /* (mixed range)
 asel
 res yakgrid in {110,113}
 ca lulc = 320 /* (shrub/brush range)
 asel
/* Forestry
```

```
res contgrid > 2200 and yakgrid in {53,62,76,78,84,86}
ca lulc = 420 /* (evergreen forest)
asel
res yakgrid in {73,83} and augrid = 1
ca lulc = 430 /* (mixed forest)
asel
res contgrid > 3800 and yakgrid = 110 and zonegrid = 1
ca lulc = 430 /* (mixed forest)
asel
res contgrid < 3000 and augrid = 1
res yakgrid in {53,62,73,76,78,83,84,86}
ca lulc = 430 /* (mixed forest)
asel
/* Clouds and shadows:
res fixgrid > 1 and yakgrid in {26,56}
ca lulc = fixgrid
asel
/* Zoning/ Residential and Mixed Urban:
res yakgrid in {25,26,57,113} and zonegrid = 110
ca lulc = 110 /* (residential)
asel
res yakgrid in {25,26,57,113} and zonegrid in {120,130,160}
ca lulc = 160 /* (mixed urban)
asel
/* Wetlands:
res nwigrid > 600
ca lulc = nwigrid
asel
/* Zoning/ Commercial and Industrial:
res zonegrid in {120,160}
res yakgrid in {27,29,32,120,122,124}
ca lulc = 120 /* (commercial)
asel
res yakgrid in {27,29,32,120,122,124} and zonegrid = 130
ca lulc = 130 /* (industrial)
asel
/* Agriculture:
res augrid > 100
res yakgrid in {25,26,53,56,57,62,73,76,78,83,84,86,110,113}
ca lulc = augrid
asel
res augrid in {230,231}
ca lulc = 230
asel
/* Water:
```

```
res nwigrid in {510,520}
ca lulc = nwigrid
asel
/* Zoning/Other Ag. and Other Urban:
res zonegrid = 200 and lulc = 0
ca lulc = 240  /* (other ag.)
asel
res lulc = 0
ca lulc = 170  /* (other urban)
q
```

Step 11 - RECLASSIFYING THE LULC1 GRID ON LAND USE/LAND COVER VALUE

The final grid was produced using the RECLASS command with the grid LULC1. This step is done so that the VALUE item in the new grid will be equal to item LULC in the grid LULC1.

```
Grid: lulc = reclass(lulc1,lulc1.vat,data,value,lulc)
Arc: list lulc.vat
```

Record	VALUE	COUNT	SYMBOL
1	1	4260546	0
2	110	27306	33
3	120	26224	29
4	130	2458	27
5	160	59141	31
6	170	341232	141
7	210	1181536	93
8	211	20707	108
9	220	298941	77
10	223	16846	86
11	230	7083	89
12	240	156950	141
13	320	819761	188
14	330	4028591	80
15	420	1076482	76
16	430	200257	66
17	510	18444	55
18	520	11674	55
19	610	35264	72
20	620	64901	70

Conclusions

The final product is a grid with 30 meter resolution with generalized land use/land cover values coded for the Lower Yakima River Basin Study Area. The process outlined above provides a method for updating land use/land cover data for a defined area using Landsat TM Imagery and local source GIS coverages. The polygon coverages that were used in this study were given unique values for land use / land cover codes. These code items were then used to transform the poly coverages to grids which were in turn combined together in an overlay process to provide a data base of land use / land cover, elevation, and color codes for each cell value. The resulting grid shows a high degree of landscape definition when compared to the generalized polygon coverages it was derived from and provides a more accurate resource for environmental assessment. Depending on the availability and accuracy of local, digital resource information this process will work for areas where landscape conclusions are needed. As with all information processing, the better the input data, the better the output conclusions. This project was limited in its objectives due to lack of quality agriculture resource data. It was hoped that we would be able to identify individual crop (farm) types from the TM Image but that level of detail was not achieved. In the end, we were able to identify forestry, rangeland, urban areas and hydrology very well and overall landscape definition from the TM Image was very good when compared to our original 1970's land use / land cover data set and other local area polygon coverages.

Geospatial Data Sources

1991 Landsat Image	University of Washington - Fisheries
Yakima County Zoning	Yakima County
Yakima County Agriculture	Yakima County
National Wetland Inventory	US Fish & Wildlife Service
Washington Digital Elevation Model	WA Department of Natural Resources
USGS 1975 Land Use / Land Cover	US Geological Survey
Water Resource Inventory Areas	WA Department of Natural Resources
Tiger	WA Office of Financial Management
Washington State Vegetation	WA Department of Fish & Wildlife
Township Digital Ortho photos	WA Department of Natural Resources

References

Anderson, J.E., E.E. Hardy, J.T. Roach and R.E. Witner
A Land Use and Land Cover Classification System for Use with Remote Sensor Data
U.S. Geological Survey, Professional Paper 964. 1976.