Building a Hydrologic Base Map

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Goals of the Exercise

This exercise shows how to develop a hydrologic base map for a catchment showing the catchment boundary and the rivers and streams within it. This is done in two ways – for the Rakaia river in Canterbury using the NZ Digital River Network, and for the Puriri river catchment in Papua-New Guinea using ArcGIS Online ready to use Hydro Services.

Computer and Data Requirements

To carry out this exercise, you need to have a computer, which runs ArcGIS Desktop version 10.5. This exercise will also work with version 10.4.1 if you do not have access to Version 10.5. You will need a login and password for the University of Canterbury Organizational Account for ArcGIS Online.

Part One: Basemap using the NZ Digital River Network

Check out information about the New Zealand Digital River Network, or REC (River Environment Classification) at <u>https://www.niwa.co.nz/freshwater-and-estuaries/management-tools/river-environment-classification-0</u> You can download a copy of the dataset for all of New Zealand at: <u>https://www.niwa.co.nz/static/web/nzRec2_v4.gdb.zip</u> This is a 487 MB file, so you need a good Wifi connection or wired internet connection to do this. When you uncompress this file, it looks like this

<mark>⊡]</mark> nzRec2_v4.gdb	5/22/2017 2:38 PM	File folder	
nzRec2_v4.gdb	3/13/2018 8:31 PM	Compressed (zipped)	487,643 KB

The nzRec2_V4.gdb is a 2.2 GB geodatabase covering all of New Zealand.

If you have the full REC database and you open ArcMap and look at the REC Geodatabase, below is what you see. The key items are the two Feature Datasets called **Hydro** and **rec2**-**watersheds** The other items shown are related attribute tables dealing with details of the REC classication of New Zealand Rivers that we are not going to get too much into in this class.

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Name:	Hydro		Add
Show of type:	Datasets, Lay	vers and Results V	ancel

Click on the **Hydro** Feature Dataset and add it to the map display, and you'll see a detailed layout of all of New Zealand.



Let's zoom into Christchurch and see what is there. Turn off the **Hydro_Net_Junctions** layer and add the **NZ Topographic** basemap (scroll down in the Basemap layer display if all you see are world maps).



Let's zoom in to the mouth of the **Rakaia River** just south of Christchurch. Open the **Utility Network Analyst** toolbar and use the **Flow/Display Arrows** to show that the network has flow directions assigned on it.



Add an **Edge Flag** on a riverline at the mouth of the Rakaia River and select **Trace Upstream** from the Trace Tasks toolbar. Hit the little **Solve** button the right of the Trace Tasks toolbar || and you'll get a nice upstream trace graphic in red for the Rakaia River drainage network.



and if you zoom out, you'll see the upstream trace as a simple graphic.



Now, let's establish a new geodatabase for the Rakaia River data.

Click on the Catalog tab in the top right of the map display and in your folder for Exercise 4, create a **New Personal Geodatabase**.



Let's call this **Rakaia**. Within this geodatabase, we'll create a new **Feature Dataset**.



Let's call this **Network** (the specific name doesn't really matter)

New Feature I	Dataset
Name:	Network

And hit **Next** to bring up a screen that defines the coordinate system to be used for this Feature Dataset. We'll use the standard **New Zealand Transverse Mercator** map projection which is used to define the Riverlines layer that we brought in from the REC:

New Feature Dataset		×
Choose the coordinate system that will be use Geographic coordinate systems use latitude a of the earth's surface. Projected coordinate s transform latitude and longitude coordinates	ed for XY coordinates in this data and longitude coordinates on a spi ystems use a mathematical conve to a two-dimensional linear syste	herical model orsion to m.
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WKID: 2193 Authority: EPSG Projection: Transverse_Mercator False_Easting: 1600000.0 False_Northing: 10000000.0 Central_Meridian: 173.0 Scale_Factor: 0.9996 Latitude_Of_Origin: 0.0 Linear Unit: Meter (1.0)		
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And hit Next again to choose a Vertical Coordinate System, which we'll ignore in this exercise,

New Feature Dataset			×
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And in the following screen hit Finish and your Network Feature Dataset will be created.



This is a container to put the feature classes in for the Rakaia catchment. Now let's get some data to put in this Feature Dataset.

In the Utility Network Analyst toolbar, select Analysis/Clear Results



And then in Analysis/Options/Results choose Selection.

Analysis C	Options						
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And let's execute the **Trace Upstream** task in the **Utility Network Analyst** toobar again, and we'll get a set of selected RiverLines.



If you open the **Attribute Table** of the **Riverlines** feature class, you'll see the selected reaches and hit the selection button at the bottom of the table, you'll see that we've selected 6081 reaches.

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		366842	Polyline	366845	960402	960777	594710.002926	594710	13097926
		366843	Polyline	366846	960403	960683	549714.214397	549714.1875	13098070
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Now let's export these Riverlines to our Rakaia geodatabase. Right click on the **Riverlines** feature class and select **Data/Export Data**

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And navigate to the **Network** Feature Dataset, and save the selected features as a new **RiverLines** feature class.

Saving Data	×
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Export Data	×
Export: S	Selected features
Use the sam	e coordinate system as:
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🔵 the data	frame
the feature (only approximation)	rre dataset you export the data into olies if you export to a feature dataset in a geodatabase)
Output featu	ure class:
C:\Users\m	naidment\Documents\Canterbury\Ex4\Rakaia.mdb\Network\F
	OK Cancel

then add the resulting dataset to the map display. Remove the original REC network from the map display



And color the resulting RiverLines in blue. Pretty cool!



Now let's symbolize the RiverLines with **Graduated Symbols** using **StreamOrde** as the Value Field with **7** Classes and a **Blue** Template color

Layer Propertie	es						
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And you'll end up with a rather beautiful river map.



If you zoom in to the upper part of the catchment, you'll see a nice map of the headwaters of the Rakaia River, including Lake Coleridge.



Save your map display using File/Save As in ArcMap as Ex4.mxd

To be Turned In: A map of the riverlines in the Rakaia Catchment. How many RiverLines do we have in the map? What is their total length (Km)? What is their average length (Km)?

Now let's get some drainage areas to go along with these stream lines. Go back to the REC geodatabase that we started with and add the **rec2_watersheds** feature dataset,

Add Data			×
Look in: 💷 nz	Rec2_v4.gdb	✓ 🕹 🔓 ଢୖ 🟥 💌 🖆 û 🗳 🦃	
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Name:	rec2_waters	heds	Add
Show of type:	Datasets, Lay	vers and Results v	Cancel

that has only the **rec2ws** feature class within it.

Add Data		
Look in:	₽ rec2_watersheds ∨	
[™] rec2ws		

And if you color this in a nice green color, you'll see an intricate pattern of local drainage areas associated with each reach.



Here is a zoom in to a local area



Let's set the **Label** properties for the **rec2_ws** feature class with Label Field **nzsegment** and **green** color with Arial **12** symbol size.

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And similarly label the **RiverLines** with Label Field **nzsegment** and a **blue** color with text size **12**.

Text String Label Field:	nzsegment	 ✓ Expression
Text Symbol		
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And you'll see that each RiverLine has an associated local drainage area with the same nzsegment ID number. Pretty cool!



Let's use this association to choose the rec2_ws features that encompaass the Rakaia drainage basin.

Turn off the **display of Labels** on the RiverLine and Rec2_ws feature classes.

Right Click on the RiverLine feature class and select Joins and Relates/Relate

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 ■ rec2ws ■ ■ LINZ/geotiffs 	-	Edit Features]	layer or standalone table via a
, , ,	%	Convert Features to Graphics Convert Symbology to Representation		relationship. Unlike a join, a
		Data Save As Layer File		append the associated data
		Create Layer Package Properties	600333	to the layer or standalone table.

And in the resulting table, select **nzsegment** as the field that the relate will be based on and **rec2_ws** as the related layer. I have named this relate **RiverLineHasWs** to signify the connection between the two feature classes but any name will do.

Relate >	<							
Relate lets you associate data with this layer. The associated data isn't appended into this layer's attribute table like it is in a Join. Instead you can access the related data when you work with this layer's attributes or vice-versa.								
Establishing a relate is particularly useful if there is a 1-to-many or many-to-many association between the layer and the related data.								
1. <u>Choose the field in this layer that the relate will be based on:</u>								
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2. Choose the table or layer to relate to this layer, or load from disk:								
💊 rec2ws 🗾 🖉								
3. Choose the <u>fi</u> eld in the related table or layer to base the relate on:								
nzsegment v								
4. Choose a <u>n</u> ame for the relate:								
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About relating data OK Cancel								

Now let's **Select** all the **RiverLines**

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Open the Riverline feature class Attribute Table and select the Table Options in the top left corner of the Table

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And select the Related Tables/RiverLineHasWS:rec2ws

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And you'll see the Attribute Table of the RiverLines feature class pops up with 6081 features selected

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Now right click on the re2ws feature class and select Data/Export Data to export the selected catchment areas for the Rakaia basin

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Save the data in the **Network** feature dataset as before, and call the feature class **RiverLineCatchment**

Remove the display of the national rec2ws features



Clear the selected RiverLine features

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And now you'll have just the features we want. Let's color the RiverLineCatchments green and zoom in to check out what we've got and you'll see we have a complete coverage of the land area that drains to these river features! Wow. That is really cool! This is a beautifully constructed geospatial dataset.



Let's make a single polygon that is the whole Rakaia catchment boundary. In the **Search** box in the upper right hand corner of ArcMap, select **Dissolve (Data Management).**

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Select the **Input Features** as **RiverLineCatchment** and the **Output Features** as a new feature class called **Boundary** in the **Network** feature dataset.

🔨 Dissolve			_		
Input Features	5				
RiverLineCa	tchment			•	6
Output Featur	e Class				
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nzsegmenn nzreach_rr Area Shape_Ler Shape_Are Select All Statistics Field	^{III} RiverLineCatc ^{III} RiverLines	hment			
Shape_Ar	Name:	Boundary		Save	
	Save as type:	Feature classes \vee		Cancel	

It looks like nothing is going on but then after a little while the screen display shakes a bit and you'll see a new boundary polygon appears



Lets symbolize the **Boundary** feature class as **Hollow**, with a **Green** outline width of **2**

Current Symbol				
Fill Color:	-			
Outline Width:	2.00			
Outline Color:	-			

And now you've got a pretty nice hydrologic basemap for a study of the Rakaia River Catchment



Save the **Ex4.mxd** project file

To be Turned in: A Basemap of the Rakaia River Catchment. What is the drainage area (Sq Km) of this catchment?

Part Two: Basemap using ArcGIS Online Hydro Services

Now let's suppose we are not in a country like New Zealand that has a Digital River Network dataset. We are going to construct a Basemap for the Purari River in Papua New Guinea using ArcGIS Online Hydro Services.

Make sure you've saved the **Ex4.mxd** project file from the first part of this exercise. Let's open a new ArcMap document



Add the World Topographic Basemap



And lets zoom into Papua New Guinea



Let's save this Map Document as Ex4World.mxd

Now we are going to use Geospatial services that ESRI has mounted in the cloud. **File/Sign In** to ArcGIS Online using your University of Canterbury Organizational Account login

🔇 Ex4World - ArcMap					
File	File Edit View Bookmarks Insert				
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	Share As				
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88	Sign In				
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	Print Preview	1			

Your Username is **WATR_Surname**, whatever your surname is, and the password is whatever you established as when you responded to the request from the UC Organizational account request you received recently.

Sign In	() esri		
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SIGN IN	CANCEL		
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In the **Catalog** tab at the top right of ArcMap if you look right down on the bottom, you'll see **Ready to Use Services (University of Canterbury)** which are services you now have access to by virtue of belonging to the ArcGIS Online Organizational Account at UC. One of these categories of services is for **Hydro**

```
    Ready-To-Use Services (University of Cantert
    Elevation
    Elevation
    Geocoding
    Hydro
    Logistics
    Traffic
```

And if you expand this out, you'll see that there are **Trace Downstream** and **Watershed** tools that are like those we've been using with the New Zealand Digital River Network, except that these tools apply anywhere in the world and they operate from remote land surface terrain datasets in the cloud that you don't have to download to use.

```
    ■ Hydro
    ■ Tools
    ■ Hydrology
    ^ TraceDownstream
    ^ Watershed
```

In the center of Papua-New Guinea, there is a rather large river called the Purari which flows near the town of Mendi.



Click on **Trace Downstream** and in the resulting box, select the **FINEST** dataset to work with and move the cursor to a point near Mendi and click a point location to begin your trace from.

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And now you'll see a nice Trace Downstream river line from Mendi to the coast



Now let's zoom in near the coast and click on the **Watershed** tool. Make the snap distance **500** meters, and Data Source Resolution **FINEST** and click on a point on the Purari River trace near the outlet at the coast.

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And you'll get a new point in your map display and a drainage area polygon (after a bit of waiting)



You'll see a couple of holes in this drainage area, which are regions that those who developed the dataset considered to be areas of internal drainage in the drainage basin.

Lets build a new geodatabase called **NewGuinea** with a feature dataset called **Purari** and use the **GCS_WGS_1984** coordinate system.



Now let's export the watershed boundary to a new feature class called Basin



And similarly export the Trace Downstream line as a new feature class called River and you'll find you've got a nice new geodatabase with two feature classes in it, Basin and River, that can serve as the Basemap for a study of the Purari river basin in Papua-New Guinea.





To be Turned In: A basemap of the Purari River basin in Papua-New Guinea.

Now that you've got the idea of how to create a new geodatabase and a basemap for a drainage area, I'd like you to create a comparable basemap for your Term Project study area, or if you are studying an abstract subject that doesn't have a drainage area associated with it, create a base map for a study area in some region of New Zealand or the world that interests you.

To be turned in: A basemap of a drainage area of your term project or of another drainage area that interests you. **The Geodatabase containing this basemap should be zipped up and submitted through Learn** along with your pdf document that summarizes your response to the items requested in this exercise.

Summary of Items to be Turned In:

- (1) A map of the riverlines in the Rakaia Catchment. How many RiverLines do we have in the map? What is their total length (Km)? What is their average length (Km)?
- (2) A Basemap of the Rakaia River Catchment. What is the drainage area (Sq Km) of this catchment?
- (3) A basemap of the Purari River basin in Papua-New Guinea.
- (4) A basemap of a drainage area of your term project or of another drainage area that interests you. The Geodatabase containing this basemap should be zipped up and

submitted through Learn along with your pdf document that summarizes your response to the items requested in this exercise.