**Watershed Sciences 4930 & 6920**  
GEOGRAPHIC INFORMATION SYSTEMS

WEEK ONE – Lecture 1  
**Introduction to Course & Review of Maps**

Joe Wheaton

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**PURPOSE OF TODAY’S LECTURE:**

“**Introduction to Course & Review of Maps**” is to:

- Cover Introductions
- Go through syllabus & define goals of course
  - Manage your expectations about course & my expectations of you
  - Answer any questions you have about course logistics
- Review some basics about maps to help you do better on lab assignments and a more effective communicator with maps
TODAY’S PLAN

I. Introductions
II. Syllabus
III. Review of Maps
IV. Questions/Summary

WHO IS THIS JOE WHEATON GUY?

• Assistant Professor in Watershed Sciences (since 2009)
• Fluvial Geomorphologist
• Education:
  - Started studying Civil Engineering at Utah State University
  - BSc in Hydrology from University of California at Davis
  - MS in Hydrologic Sciences from University of California at Davis
  - PhD in Geography at University of Southampton (England)
• Professional Background:
  - Consulting Civil Engineering (California - 4 years)
  - Researcher – Fluvial Geomorphology & Ecohydraulics (since 2000)
  - Lecturer (i.e. Assistant Professor) in Physical Geography at Aberystwyth University (Wales – 2 years)
  - Research Assistant Professor in Geology at Idaho State University (1 year)
YOUR TA & UTF

• Shannon Belmont – Lab Instructor
  - Be nice to her as she'll be grading your work!
• Erin Fleming – Undergrad Teaching Fellow

HOW MANY OF YOU....

• Registered for this course because you were told you had to?
• Registered for this course because you thought it might be interesting and you wanted to learn a valuable skill?
• Have changed your major?
• Have some GIS experience
• Taken a GIS course before
• Like maps
• Want to be here
### WHAT CLASS IS RIGHT FOR YOU?

**WATS 4930/6920 – 10 INTENSE WEEKS**

**WATS 4930:** 21
**WATS 6920:** 28

#### About the Courses (Syllabi)

This page and its sub-pages act as the syllabi for the following Advanced GIS courses offered through Watershed Sciences:

- **WATS 4930/6920** - Advanced GIS & Spatial Analyses (3 credits) - 10 Weeks
- **WATS 4931/6921** - GIS Research Projects (2 credits) - 5 Weeks
- **WATS 6915** - GIS Fundamentals (1 credit) - 4 Weeks

#### Which Course(s) Should I Take?

**WATS 4930/6920** is what you should take if you want to get a comprehensive understanding of GIS and advanced spatial analyses. GEOG 1800 is a prerequisite for WATS 4930.

**WATS 6915** is the first four weeks of WATS 6920. The course is targeted at graduate students who want a crash course or refresher introduction to GIS, but don’t have the time or need for the full 10 week course. No prior GIS experience is necessary, but the pace is rapid. It’s perfect for someone wanting to know how to make some basic maps for their thesis or dissertation, as well as an introduction to building interactive web maps and doing basic spatial analyses.

**WATS 4931/6921** is a five week follow up course to WATS 4930/6920, which puts the skills and principles learned in Advanced GIS & Spatial Analyses into practice through student research projects. WATS 4930 is available for capstone credit to Watershed Sciences students. Students will prepare a poster to present in poster session and a mock manuscript for potential publication.

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WATS 4931/6921 - 5 MORE WEEKS

WATS 4931: 5
WATS 6921: 7

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WATS 6915 - 4 INTENSE WEEKS

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DEATH-GRI P ON THE OBVIOUS

What your friends said about this course was probably true... it is a lot of work.

SURGEON GENERAL WARNING:
These classes are a ton of work! Continuing may cause headaches, shortness of breath, loss of sleep, and increased stress levels. But you just might learn a lot about GIS too.

INTRODUCE YOURSELF (< 5 sec.)

- Just your First Name
- Where You’re From
TODAY’S PLAN

I. Introductions
II. Syllabus
   I. Primary Learning Outcomes
   II. Topics
   III. Labs
   IV. Text & Software
   V. Course Policies
   VI. Grades
III. Review of Maps
IV. Questions/Summary

ALL YOU NEED TO KNOW…

http://gis.joewheaton.org
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BROAD TOPICS

- Introduction/Review of GIS
- Abstracting the World to Digital Maps
- Working with Data in GIS & Geoprocessing
- Uncertainty & Vector Analyses
- Raster Analyses
- GIS Modeling
- Collecting Your Own Data

Approximate Schedule

<table>
<thead>
<tr>
<th>GIS Course(s)</th>
<th>Semester</th>
<th>Course Topics</th>
<th>Dates</th>
<th>Lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>4930, 4950</td>
<td>Winter</td>
<td>Introduction/Review of GIS</td>
<td>Jan 30 &amp; 32</td>
<td>GIS Lab 1 &amp; WebGIS</td>
</tr>
<tr>
<td>4930, 4950, 4970</td>
<td>Winter 2</td>
<td>Abstracting the World to Digital Maps</td>
<td>Jan 27 &amp; 30</td>
<td>GIS Lab 2 &amp; WebGIS</td>
</tr>
<tr>
<td>4930, 4950, 4970</td>
<td>Winter 3</td>
<td>Working with Data in GIS</td>
<td>Jan 24 &amp; 26</td>
<td>GIS Lab 3 &amp; WebGIS</td>
</tr>
<tr>
<td>4930, 4950, 4970</td>
<td>Winter 4</td>
<td>Processing Data in GIS</td>
<td>Jan 31 &amp; Feb 2</td>
<td>GIS Lab 4 &amp; WebGIS</td>
</tr>
<tr>
<td>4930 &amp; 4950</td>
<td>Spring</td>
<td>Vector Analysis</td>
<td>Feb 7-9</td>
<td>GIS Lab 5</td>
</tr>
<tr>
<td>4930 &amp; 4950</td>
<td>Spring 6</td>
<td>Raster Analysis &amp; Digital Image Manipulation</td>
<td>Feb 14-16</td>
<td>GIS Lab 6</td>
</tr>
<tr>
<td>4930 &amp; 4950</td>
<td>Spring 7</td>
<td>Raster Analysis &amp; Uncertainty in GIS</td>
<td>Feb 21-24</td>
<td>GIS Lab 7 &amp; GIS Lab 8</td>
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<tr>
<td>4930 &amp; 4950</td>
<td>Spring 8</td>
<td>GIS Modeling</td>
<td>Feb 28 &amp; Mar 3</td>
<td>GIS Lab 9 &amp; GIS Lab 10</td>
</tr>
<tr>
<td>4930 &amp; 4950</td>
<td>Spring 9</td>
<td>Collecting Your Own Data</td>
<td>Mar 8 &amp; 10</td>
<td>GIS Lab 11</td>
</tr>
</tbody>
</table>

Spring Break – March 12-16

| 4930 & 4950    | Spring 10 | Collecting Your Own Data | Mar 19 & 21 | GIS Lab 12 |
| 4930 & 4950    | Spring 10 | Raster Analysis | Mar 19 & 21 | GIS Lab 12 |
**COURSE TOPICS**

Course Topics

These courses are organized into a series of topics, which we will cover in the order listed below. For each topic, you will find downloads of lecture materials, links to teaching assignments, links to lab assignments and materials, and additional information. Please note that:

- topic pages may not be fully populated until we get to that topic in lectures; some lecture topics will appear populated with lectures and content from the previous year’s lectures.
- topic pages may be updated even after we've covered a topic as types and inconsistencies are brought to our attention or as new materials are added that may help you better understand a topic.
- if you find any problems or something that is confusing, please post a comment or question to the appropriate topic forum.

WATS 4930/6920 Topics

Note that WAT 5.6 is WATS 6915 Topics.

Course Topics (By week)

- **Research Topics**
  - Week 01: Introduction/Review of GIS
  - Week 02: Abstracting the World to Digital Maps
  - Week 03 & 04: Working with Data in GIS
  - Week 05: Uncertainty & Vector Analyses
  - Week 06 & 07: Raster Analyses
  - Week 08: GIS Modeling
  - Week 09 & 10: Collecting Your Own Data

**TOPIC PAGES ARE A REFERENCE**

**Week 02: Abstracting the World to Digital Maps**

**Captured Image Inserts**

- **Key Terms and Notes**
  - Lecture Notes
    - Handouts
    - Reading Assignments

- GIS Examples
  - Week 01: Abstracting the World to Digital Maps
  - Week 02: Abstracting the World to Digital Maps

**Background**

Introduction to Topic

The goal of geographic representation is to make data and spatial data is often used in GIS. GIS is a tool that helps us understand how data is represented digitally. We can use this information to make effective maps. GIS is added into maps using GIS, which can be analyzed.

One of the most important things is that the data is accurately represented. GIS is a tool that helps us understand how data is accurately represented. GIS uses different coordinates to represent data accurately. However, this method can be very important.

Another common concern is that the data is accurately represented. GIS is a tool that helps us understand how data is accurately represented. GIS uses different coordinates to represent data accurately. However, this method can be very important.

This week, we will look at using geographic information systems (GIS) for data collection and analysis. GIS is a tool that helps us understand how data is accurately represented. GIS uses different coordinates to represent data accurately. However, this method can be very important.

**Lectures**

- Projections & Coordinate Systems
  - 1 of 2 slides per page
  - 2 of 2 slides per page

- Raster Data
  - 1 of 2 slides per page
  - 2 of 2 slides per page

- Topo Data
  - 1 of 2 slides per page
  - 2 of 2 slides per page

- Projection & Coordinate Systems
  - 1 of 2 slides per page
  - 2 of 2 slides per page

- Projection Coordination
  - 1 of 2 slides per page
  - 2 of 2 slides per page

**Additional Resources**

- Map Background: Use of geographic information systems
  - Use Geographic Information Systems
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LABS ARE EVERYTHING!

- You only really learn GIS by doing it
- WATS 4930/6920
  - 10 Guided Labs
    - Due following week
  - 1 Self Paced Lab
- WATS 6915
  - First 4 Labs
    - Due them at your own pace... BUT

LABS CAN BE DONE ANYWHERE

- Data you need is online
- Instructions are spelt out on lab pages often w/ video tutorials
  - Bring headphones!
- ALWAYS backup to a portable drive
  - As often as you’re comfortable redoing something
- Encourage you to work off your own machine
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SOFTWARE - ArcGIS

We will primarily use GRASS GIS 5 for coding (ArcGIS version with all extensions), which is available on all the lab and department machines. As students taking this course, you are entitled to a free one-year student license of ArcGIS for installation on your personal computer (see below for details). Grad students, if you want a version for your research, it can be acquired through USGS software licensing (http://dds.usgs.gov/software/).

The reason we use ArcGIS is because it is the industry standard and the vast majority of employers, consultants and agencies you may end up working for will most likely be using ArcGIS as well. All of the principles and theory we have in this course will apply to any GIS software.

Open Source Desktop GIS Alternatives to ArcGIS

- MapWindow GIS
- Planet GIS
- Quantum GIS
- GRASS GIS

Website & WebGIS

You are welcome to use any software, hosting and servers that you wish to use, are knowledgeable about and meet your dynamic webGIS applications. However, it is strongly recommended that you use Quantum GIS for your website. It is free, easy to use, and requires no programming experience. Moreover, Google Maps and Google Earth are familiar to most web-users where your spatial analysis and maps might be designed. However, there are plenty of useful free and commercial alternatives out there.
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COURSE POLICIES

• Just be respectful of your peers
• Turn off your phones
• No texting in lectures
• Laptops fine for notes/demos

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**GRADES**

**Grade Overview**

Our primary concern is that you engage in achieving the learning objectives for this course. Your grade is a secondary concern to us, and if you are effectively learning your grade should be a moot point. However, we recognize how motivated some of you are by grades and we have attempted to provide clear guidelines (below) to help manage your expectations about what you need to do to earn the grade you want.

**Grading Scale**

We will use a standard grading scale:

<table>
<thead>
<tr>
<th>Grade</th>
<th>% of Available Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>A+</td>
<td>&gt; 97%</td>
</tr>
<tr>
<td>A</td>
<td>&gt; 90% to 97%</td>
</tr>
<tr>
<td>A-</td>
<td>&gt; 80% to 90%</td>
</tr>
<tr>
<td>B+</td>
<td>&gt; 87% to 80%</td>
</tr>
<tr>
<td>B</td>
<td>&gt; 77% to 87%</td>
</tr>
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<td>&gt; 65% to 77%</td>
</tr>
<tr>
<td>C+</td>
<td>&gt; 55% to 65%</td>
</tr>
<tr>
<td>C</td>
<td>&gt; 50% to 55%</td>
</tr>
<tr>
<td>D+</td>
<td>&gt; 40% to 50%</td>
</tr>
<tr>
<td>D</td>
<td>&gt; 35% to 40%</td>
</tr>
<tr>
<td>D-</td>
<td>&lt; 35%</td>
</tr>
</tbody>
</table>

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EVERYTHING YOU NEED TO KNOW TO GET AN A

• A highly recommended text... $8.99
• If for nothing else, impress your folks

HE CAN’T BE SERIOUS... THIS IS A SENIOR / GRADUATE LEVEL CLASS!

• I am...
• Maps are the ultimate end product of GIS and GIS analyses
• GIS makes it easy to make maps
• Making good and effective maps is an art that is being lost (i.e. cartography)
• You intuitively know this... but you probably forgot
**LET’S REFER TO THE CAT IN THE HAT**

I’m the Cat in the Hat
and I’m happy to say
there’s a map on my lap—
let’s get on our way!

We will travel the world.
See the whole U.S.A.
And still be back home
by the end of the day!

**WHAT ARE MAPS? ALL HAVE A PURPOSE**

Maps are drawings that help
to find out where you are
and get where you’re going—
no matter how far.

When mapmakers make maps,
they must first decide who
will be using the map
and what it needs to do.

Cartographer
Cartographer is just
a more formal name
for a mapmaker, but
both their jobs are the same.
ALL MAPS HAVE A PURPOSE

• What point is the map trying to convey?
• Context helps convey that point

<table>
<thead>
<tr>
<th>The Map</th>
<th>Example Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location Map</td>
<td>Show the location of something within a broader geographic context of common knowledge to audience (e.g. state, country, world)</td>
</tr>
<tr>
<td>Geology Map</td>
<td>Show spatial distribution of underlying geology</td>
</tr>
<tr>
<td>Habitat Map</td>
<td>Show spatial distribution of different habitat types</td>
</tr>
<tr>
<td>Topographic Map</td>
<td>Show spatial distribution of elevations</td>
</tr>
<tr>
<td>Watershed Map</td>
<td>Show delineated boundary of watershed</td>
</tr>
<tr>
<td>Election Map</td>
<td>Show which areas voted for which candidate</td>
</tr>
</tbody>
</table>

A GEOLOGY MAP: JUST GEOLOGY...
A GEOLOGY MAP: MORE VECTOR DATA

A Portion of the Geologic Map of the Logan 30° x 60° Quadrangle

Data from Utah Geological Survey: http://geology.utah.gov/

A GEOLOGY MAP: ADD DRG USGS BASE

A Portion of the Geologic Map of the Logan 30° x 60° Quadrangle

Data from Utah Geological Survey: http://geology.utah.gov/
A GEOLOGY MAP: ADD HILLSHADE RASTER

A Portion of the Geologic Map of the Logan 30' x 60' Quadrangle

Data from Utah Geological Survey: http://geology.utah.gov/
Topographic Data from: http://gis.utah.gov/

PROJECTIONS, LAT & LONG

The map of the earth
that we use most of all
is a globe. Like the earth,
it is round as a ball.

Peel the skin off an orange
and lay it out flat.
A flat map of the earth
would look something like that.

LONGITUDE:
These are long, north-south lines,
which run up and run down.

LATITUDE:
Latitudes lines
are drawn around and around.
SCALE

Now, if maps were the size of the places they show, mapmakers would run out of paper, and so . . .
A chart called a scale makes maps easy to use, shrinking miles into inches on each map that you choose.

SCALE & PLANS

You can make a map of far places you roam, or a map—called a plan—of your very own home.

We used this scale—

one inch equals three feet—

it helped us do something we both knew is neat!

We drew our whole room—

if this one . . .

. . . one sheet!
**DI RECTION / ORI EN TATION**

There are four main directions. All maps have got 'em. North is on top. South down at the bottom.

If you look to the right, that is where East will be. Look to the left and it’s West that you see.

To remember all four, here is one easy way:

**NEVER EAT SOGGY WHEAT!**

is what I always say.

I have here an atlas. Come on, take a look! You will find lots of maps and they’re all in this book.

**LEGENDS & SYMBOLOGY**

Sometimes maps use pictures to show where things are. A capital city is marked with a star. A tent shows a campsite. Tracks show where a train is. To get to the airport, just find where a plane is.
SYMBOLOGY - COLORS & HATCHES

Some maps use colors to tell you a lot. I used blue where it’s cold and red where it’s hot.

I made deserts light brown and jungles bright green.

The legend will show you what these colors mean.

SYMBOLS, LINE-TYPES, ABSTRACTIONS

Marine charts help boaters. These maps let them know if a rock, reef, or sandbar is hiding below.

When you visit a city where you’ve never been, a city map helps you know where to begin.

Here is a map we both carry around. It shows where the subway runs under the ground!
TOPOGRAPHIC MAPS

Topographical maps are the kind hikers like. They show where the land rises hilly and steep or goes down into valleys all rocky and deep.

SYMBOLIC REPRESENTATION

Dot maps, like this one, are covered with dots. Some have a few dots, but some others have lots.

Each dot stands for something. On this map you see each dot stands for one Frizzle-Frazzled Frazee. (Most Frazees live up north, where the haircuts are free.)
ROUTE ANALYSES (MIN. COST)

When you look at a map, it's important to see there is more than one way from point A to point B.

Firefighters use maps when they go fight a fire.

The short way would take them down Voogel to Vyur.

But traffic on Vyur can be a disaster.

So they choose a long way that's also much faster.

MEASUREMENT QUERIES

But in order to go from Parasol to Pahsing on the fifteenth of May for the bug Pahsing Sing—

When you want to go from Parasol to Pahsing, you can measure the miles for the road does not bend.

The road twists and turns, so...
THE EVER RELIABLE STRING TECHNIQUE

... first cut off same string.

Put it down on theroad all the way to Falixir.

Then take out your ruler and measure the string.

The scale on this map helps you see that it's far.

One inch equals ten miles, so...

... you should take the car!

GRID REFERENCES & COORDINATES

Use this trick to read maps.
You'll be glad that you did.
Some are covered with lines.
This is known as a grid.

There are letters on top.
Numbers run down the side.
Want to find where you are?
Let the grid be your guide.

Trace a line down from A.
Look across at line four.
The lines cross at A4—
at your very own door!
SOLVING PUZZLES WITH MAPS

Here is a map that I just got today. It's a puzzle map showing the whole USA. Puzzle maps come in pieces, and here's the best part—you can put them together, then take them apart.

PATTERN RECOGNITION

Here's a game that we play, so feel free to play too. What does each of the fifty states look like to you?

Michigan looks like a shoe and a mitten.

Louisiana looks like a cat you could sit in.
ISN'T THAT NICE?

You will have great adventures your whole life, and so I give you these maps. Oh, the places you'll go!

You may travel the world, but no matter how far, with a map on your lap you will know where you are.

You can always use maps. They will help you in knowing where you have been and just where...

...you are going!

EVEN HAS A GLOSSARY

GLOSSARY

Capital: A city where the government of a state or country is located.
Cartographer: A person who makes maps.
Equator: An imaginary line that circles the middle of the earth between the North and South Poles.
Globe: A representation of the earth in the shape of a ball.
Grid: A pattern of lines on a map usually running north-south and east-west that is used for giving positions.
Latitudes: Imaginary lines on the earth that run east and west, parallel to the equator.
Legend: The part of a map that lists and explains the symbols, colors, and scale used for the map.
Longitude: Imaginary lines on the earth that run north and south and meet at the poles.

Map: A flat representation of the earth or a part of the earth that shows the relative position of places.
Scale: The relationship between the actual size of an area and its size on a map.
Symbol: A sign or drawing that stands for something else.
Topographical map: A map that shows the shape and changing elevation of the land's surface.
WHY SHOULD YOU CARE?

- Making bad maps is easy with GIS!
- You need to know how to speak the language (i.e. nomenclature and terminology matters)
- You need to understand the spatial analyses you perform
- We’re going to grade you based on the Cat and the Hat and the 6 C’s

THE 6 C’s TO EARN BETTER THAN A C

- Colorful (but not cluttered)
- Creative (but not confusing)
- Consistent
- Context (location, coordinates, scale, orientation, setting)
- Convincing (fit for purpose)
- CORRECT
TODAY’S PLAN

I. Introductions
II. Syllabus
III. Review of Maps
IV. Questions/Summary
READING FOR THURSDAY

Reading Assignments will always be posted on the course website...

- I will try to highlight reading for you at the end of most lectures
  - Read Chapter One of Bolstad: "An Introduction to GIS"
- In general, you should get in the habit of checking the website. For this Thursday, see:
  - http://gis.joewheaton.org

THURSDAY’S READING/HOMEWORK:
THIS WEEK’S LAB

Introduction

• Lab 01 – ArcGIS Refresher & Intro to WebGIS
  - You’ll make a very basic map in ArcGIS just to get you used to working in ArcGIS again ;)
  - You will create a website that will be the repository for ALL of your lab assignments
  - You will publish your map and build an interactive google map on your website...

Everything you need:
http://gis.joewheaton.org/assignments/labs/lab01

NEXT LECTURE

On Thursday:

• Detailed Review of GIS & Intro to WebGIS
TODAY’S SUMMARY

• Nice to meet you…
• Syllabus is on http://gis.joewheaton.org
• Cat in the Hat and excellent reference
• 6’ C’s to avoid a C

QUESTIONS??

• Post other questions to our Class Forum at http://forum.bluezone.usu.edu/gis