

# A WEB-ENABLED REMOTE SENSING AND GIS COURSE FOR EXTRAMURAL STUDENTS

Mike Tuohy  
Institute of Natural Resources, Massey University  
Palmerston North, New Zealand  
[m.tuohy@massey.ac.nz](mailto:m.tuohy@massey.ac.nz)

**KEY WORDS:** Remote sensing, Education, On-line Teaching

## ABSTRACT:

Massey University, New Zealand has a long pedigree in distance education with an extramural roll almost three times that of the internal students. Remote sensing and GIS have been part of the curriculum in the College of Sciences since 1989 and offered in extramural mode since 2000. This year a further step towards e-learning has been taken with the introduction of the open source Virtual Learning Environment known worldwide as Moodle.

The usual practice has been to provide students with a study guide which contains selected readings and detailed instructions for the practical exercises that are completed using the software and data supplied on CDs. Over a period of fifteen weeks eleven assignments based on the practical exercises are required to be submitted for assessment. Model answers and flowcharts detailing the correct procedures accompanied the marks and grades which were also accessed via Moodle. A practical test and final exam completed the assessment.

In 2010 the study guide, software and data CDS were again printed and dispatched but the course was also web-enabled. The readings, exercises and assignments were all available on-line. In addition various activities such as self-learning quizzes, wikis, chat rooms and discussion groups were available. Forums were established to explore relevant topics. Instructional videos and links to useful websites were often added to the course website to keep it interesting and current.

## 1. INTRODUCTION

Remote sensing and GIS (Geographic Information Systems) courses have been offered in the Institute of Natural Resources, College of Sciences, Massey University since 1989 and 1992 respectively. These have been both 200 and 300-level (2<sup>nd</sup> and 3<sup>rd</sup> year) papers contributing to the BSc degree in Earth Science or as electives for other degrees. A postgraduate paper (Applied Remote Sensing) has also been popular as part of the Diploma in GIS – a qualification designed primarily for people already in the workforce and therefore requiring it to be taught in block course mode.

Since 2000 the 200-level papers have been offered extramurally. Massey University is the only New Zealand university offering degree-level courses that can be studied in this mode from anywhere in the world. The usual practice has been to provide an administration guide that gives details of the aims and objectives of the course, an outline of the topics to be studied, information on the assignments and an assessment schedule. Other information contained in this document can include instructions on how to access library services from home, how to submit assignments and what to do if you fall behind. It may also contain a previous exam paper and a course evaluation questionnaire.

A study guide is also mailed to students. This sets out the structure of the course and usually includes lecture notes and the exercises that need to be completed for assessment. Recommended reading might include chapters from books, journal articles and conference papers; these were all provided in hard copy for the student's benefit. With the remote sensing and GIS papers, the students were expected to buy software

(IDRISI) and were supplied with a CD that contained the digital data needed to do the practical exercises.

In 2005, the courses became web-enabled with the introduction of Web-CT – an online virtual learning system. This gave the students more direct access to not only the teacher but also each other via discussion pages and chat tools. Other enhancements made possible in this e-learning environment were video tutorials, quizzes and links to relevant webpages or files for additional information or resources. The latest development for these courses has been the adoption, in 2010, of the open source Virtual Learning Environment known as Moodle, although at Massey it is called Stream. Moodle is registered in almost 50,000 sites covering 210 countries at the time of writing (<http://moodle.org/stats/>).

This paper will describe the now-combined, 200-level paper, 233.251 GIS and Remote Sensing and some of the experiences that the author has had with Moodle while teaching students living and learning in many remote locations.

During the past twenty years of teaching remote sensing and GIS, a considerable archive of digital imagery and other spatial data has been collected to provide resources for student exercises and research projects. This archive was first made accessible to students and staff via a website called ATLAS way back in 2001 (4 years before the world had Google Earth). The latest development in this vein has been the OASIS (Online Archive of Satellite ImageS) project and its associated website. The paper will describe some of the innovative features of this site made possible with ERDAS Apollo software.

## 2. 233.251 GIS AND REMOTE SENSING

### 2.1 Aim

To introduce students to digital geospatial data and teach them how to collect, manage and analyse these data to produce useful information. Some understanding of geography or earth science is advantageous and basic computing skills are required. New knowledge gained will include how to process digital imagery of Earth's surface and how to operate a GIS efficiently.

### 2.2 Learning outcomes

A student who successfully completes this paper should:

- have a good understanding of digital geospatial information
- be proficient in the collection, management and use of geospatial data
- know how to discover, appraise and access geospatial datasets
- understand how to use GIS and remote sensing to measure, map, monitor and model our world

More specifically they will:

- learn how to use the tools that a GIS provides
- have an appreciation of spatial analysis
- become proficient at querying spatial databases
- study selected remote sensing systems
- understand basic digital image analysis
- acquire skills at converting spatial data to useful information
- know where to find relevant spatial data for particular projects
- know how to manipulate spatial data for scenario evaluation

### 2.3 Hardware and Software

All participants need to have access to a computer with the following requirements:

- Intel Pentium IV or higher
- Windows XP, Vista and Windows 7
- If utilizing a server, Windows Server 2003 and above
- Minimum display of 1024 x 768 with 64,000 colours
- 1 GB RAM or greater
- 1.3 GB hard disk space for installation
- CD-ROM for installation

The software used in the course is IDRISI Taiga, a 32-bit object-oriented system designed for computers running the Microsoft Windows operating system. IDRISI, from Clark Labs, Massachusetts, USA has been the preferred software for teaching image processing and GIS in the College of Sciences, Massey University since it was first acquired in 1992. As an institution with a campus licence we are able to have the program running on all networked Massey University computers and extramural students are able to purchase a 12-month licence for only US\$39.

IDRISI Taiga is easy to learn with extensive pull-down menus and many built-in wizards to lead the user through the more complicated analyses. It has a comprehensive library of modules that perform all of the common operations used in image processing and spatial analysis. Another feature of this package is the documentation. In addition to a very informative 'Guide to GIS and Image Processing', there are over sixty tutorial exercises with almost 900Mb of data and a further 200Mb of global topographic data supplied with the software.

All students are advised of the computing requirements before enrolment and most view the purchase of the software as equivalent to buying a textbook. There are relatively few issues with the installation of the program and authentication of the licence which is done online. It is recommended that some of the supplied tutorials are completed to learn basic navigation and simple operations but most of the assessed exercises are written specifically for the course. This means that a separate data CD is also sent out to the extramural students.

### 2.4 Assignments

The 2010 semester consisted of two six-week blocks separated by a two-week break around Easter. Extramural students receive the study guide 2-3 weeks prior to the start of the semester and have plenty of time to buy the software and have it installed and running. Each week during the six-week blocks, there is a new assignment to be completed and submitted. In the final week, an open-book practical test is sent out in place of the assignment.

The assignments for 2010 included the following:

One: Composing Maps and Digitising

Two: Basic GIS Operations

Three: Database and Map Query

Four: Monitoring Change & Site Selection

Five: Library, Radiometer & Photogrammetric Exercises

Six: Satellites & Digital Images

Seven: Image Acquisition and Enhancement

Eight: Image Registration

Nine: Image Classification

Ten: Spatial Analysis

Eleven: PowerPoint Presentation - Applications

### 2.5 Practical Test

In the final week of the semester, there is an open-book practical test. This test examines how well the students have learnt to use the GIS and image processing tools that have been demonstrated in the assignments and online tutorials.

## 2.6 Examination

The examination for 233.251 is of two hours duration and requires both essay and note-type answers. There are usually two compulsory questions and then a further four questions of which only two are required to be answered. Extramural students are able to attend the examination at various invigilated venues throughout the country.

## 3. ONLINE LEARNING ENVIRONMENT

Massey Stream, the e-learning environment for Massey University, is based on Moodle – the most widely-used course management software in the world. Moodle is registered in over 50,000 sites covering 210 countries at the time of writing (<http://moodle.org/stats/>). Moodle was originally an acronym for Modular Object-Oriented Dynamic Learning Environment but it is also a verb that describes the process of lazily meandering through something, doing things as they occur to you: an enjoyable tinkering that can lead to insight and creativity. Depending on how a course is set up, the opportunity is there to provide all the resources necessary for a comprehensive, current and enjoyable learning experience.

The highlights of Stream are that it is interactive, collaborative, media-rich and personalised. Tools such as blogs, wikis and journals provide interactivity with the online

environment as well as enhanced opportunities for transparency of the students learning progress if used in an educationally effective manner. Forums and chat sessions encourage the students to work together to discuss any difficulties they may be having and thereby to provide support for each other. The use of audio and video for detailed instructions may require a good broadband connection but such presentations are often more easily understood by students.

From a course coordinator's viewpoint, perhaps the greatest advantage of using Stream is its assignment management system. Students submit assignments through Stream using the web-based tools and the lecturer grades them and provides feedback at the same time. This is accomplished via a single grading page which is then saved and the next student's grading page is opened automatically. All grades are written into a database that allows individual students to view their grades and keep a check on their progress.

By keeping all submissions, grades and feedback in electronic form, these documents are available almost instantly if they are needed for any reason e.g. a student queries the grade he/she has been awarded. There is no danger of losing documents, awarding the wrong grade to a student or indeed failing to award a student a grade. At any stage of the course, the full history of assignment submission, including the exact time of uploading by the student, is available to the administrator of the course.

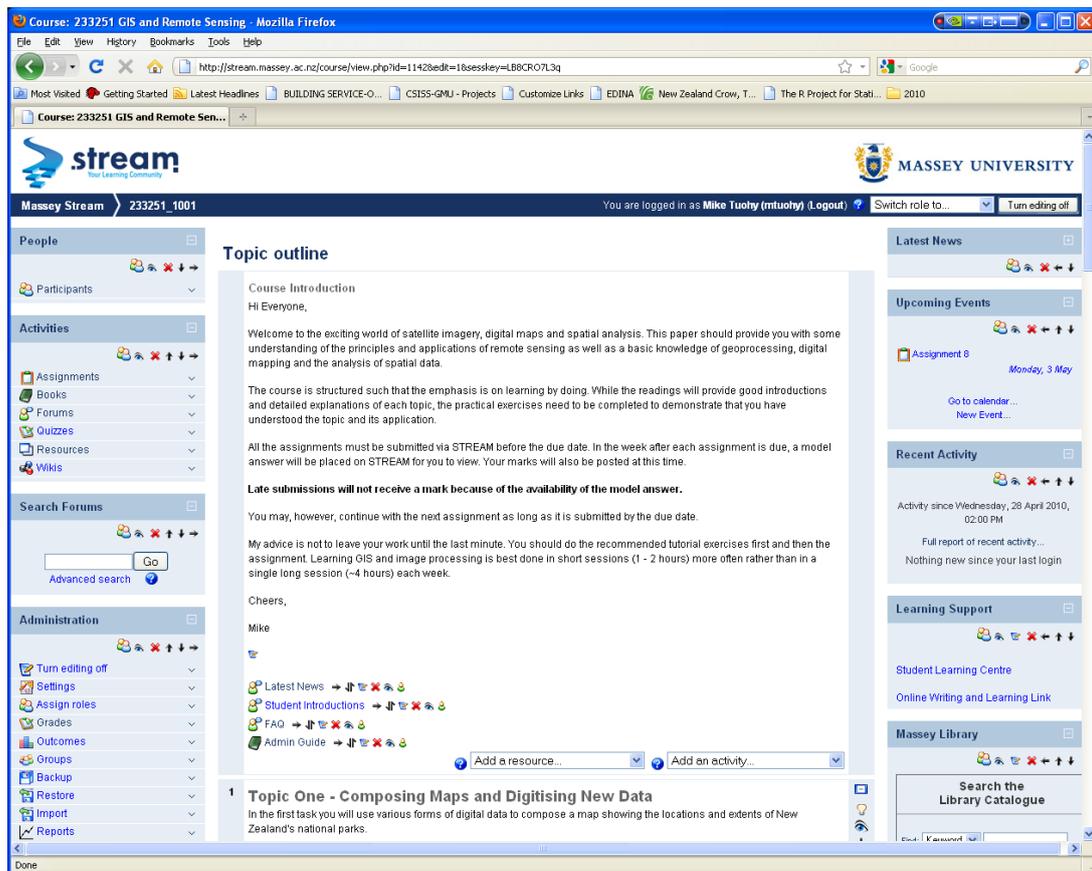


Figure 1. The front page of Stream for 233.251 GIS and Remote Sensing

#### 4. ASSIGNMENT EXAMPLE

A typical exercise is the image registration exercise. Only the first part is included in this paper, the second part required the georeferencing of coincident ASTER and Landsat images.

##### 4.1 Registration using a scanned map

Data for this exercise can be found in the GOLF folder.

You have two images; one is a digital version of the 1:50,000 topographical map in geotiff format (**karaka\_nztm.tif**) and the other is a scanned aerial photograph (**golf.tif**). The map is a geotiff and contains geo-referencing in the New Zealand Transverse Mercator (NZTM) projection, the photo is not a geo-referenced image – it is in a simple tiff format.

The exercise requires you to select ground control points (GCPs) that can be identified easily on both the aerial photograph and the map, e.g. road intersections, stream junctions, fence-lines, and other prominent landmarks. Both the input and output coordinates will be selected interactively on the images.

##### 4.2 Importing the images.

Use Import /... / GEOTIFF to convert **karaka\_nztm.tif** and **golf.tif** to IDRISI format. Give them the same names. Create a colour composite of the map and call it **karaka\_rgb**.

##### 4.3 Registering the photo.

From the Window List pull-down menu, click on Close All Windows.

Run the RESAMPLE module. A new window will open and you should enter the names of the input image – **golf** – and the output image – **golpreg**. Select **golf** as the Input reference and it will appear in another window. Explore this image for a while: Use the Zoom Window tool to see different regions in more detail and then Restore Original Window to zoom out again. Select **karaka\_rgb** as the Output reference.

Notice the Magnify window on the right of the RESAMPLE window. Select a zoom factor of 4 x and be sure to have the Show cursor option ticked. Move the cursor onto the image and observe the small magnified region shown in the RESAMPLE window. Zoom in to a smaller area on the **map** image and observe the details in both windows.

Now comes the tricky part. Where it says Digitize GCP in the RESAMPLE window, press the Input button. A cursor, similar to a gun-sight will appear in the centre of the Input reference image. Move your cursor onto this gun-sight and hold the left button on the mouse down to drag the gun-sight on to the pixel that you want as your GCP. You may need to zoom in to see the point more clearly. Use both the image and the magnified window to position the gun-sight over the point that you have chosen. When you are satisfied that it is positioned correctly, click the left button on your mouse to enter the Input X and Y into the table of ground control points in the RESAMPLE window.

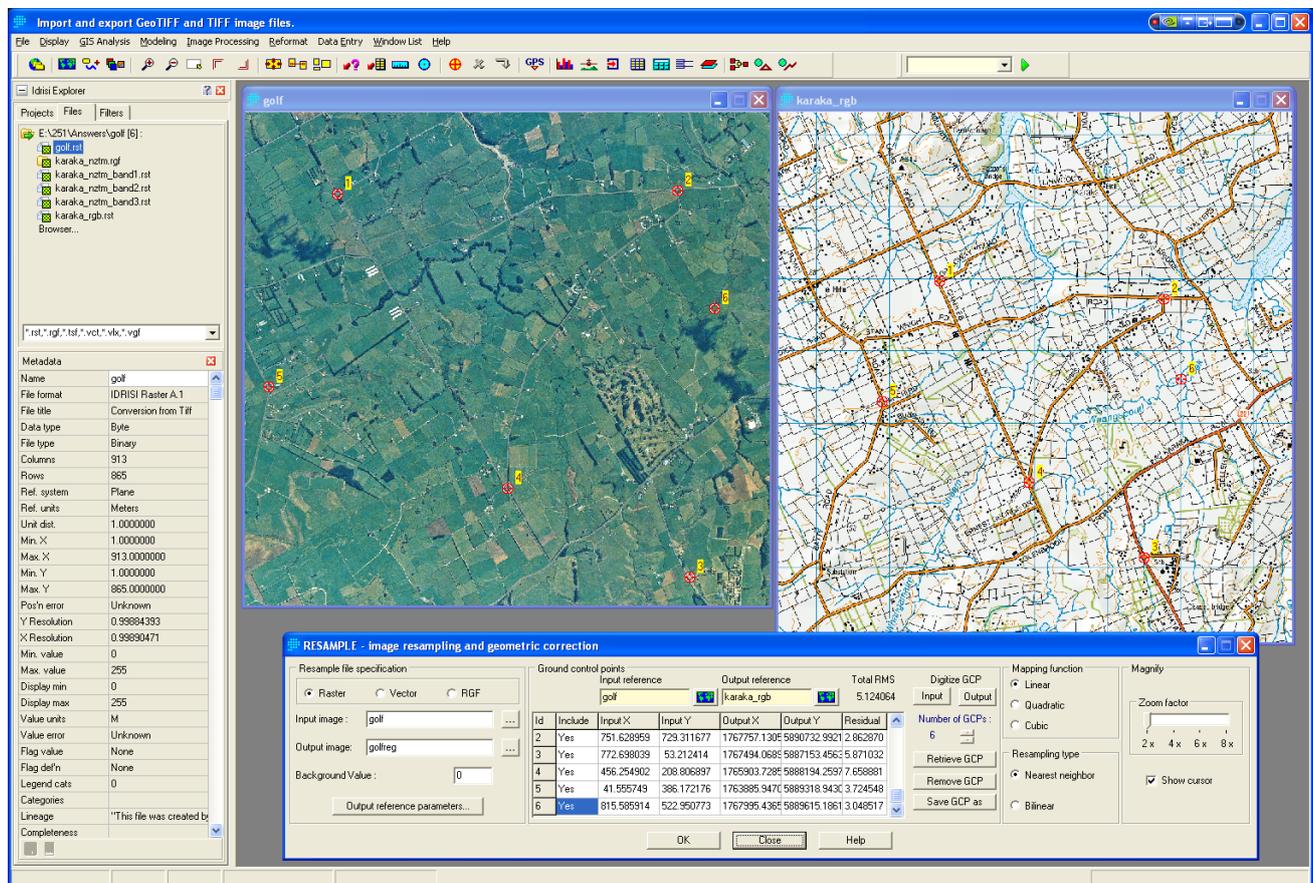


Figure 2. Selection of ground control points on an image and a map.

Now press the Output button under Digitise GCP, and select the same location on the map.

When you press the left-mouse button the eastings and northings in NZTM coordinates will be entered into the table in the Output X and Output Y columns. Repeat this procedure for at least eight GCPs spread evenly over the photo.

Now press the Output reference parameters button and enter these as follows:

Minimum X coordinate	1763500
Maximum X coordinate	1769000
Minimum Y coordinate	5886000
Maximum Y coordinate	5892000

Calculate the image dimensions as follows:

Number of columns =  $\text{Max X} - \text{Min X} / \text{resolution}$

Number of rows =  $\text{Max Y} - \text{Min Y} / \text{resolution}$

In this instance, use a resolution of 5m. Enter the appropriate values and then click OK.

For the Reference system, choose NZTM from the pull-down menu.

All the parameters required for resampling are now in place. Accept the default options of a linear mapping function and a nearest neighbour resampling type, press OK.

The output image (the registered photo) will be displayed automatically but you will have to change the palette to **golf** to see the correct colours. Note how the x and y coordinates displayed at the bottom of the window are now in eastings and northings.

#### 4.4 Overlaying a vector file.

A shapefile of the roads in the district has been provided in the GOLF folder. Use SHAPEIDR (File / Import / Software-specific Formats / ESRI Formats) to convert the shapefile to an IDRISI vector file.

**Create a map composition that displays the registered photo with the roads overlaid as vectors. Include a title, north arrow, 1000m grid-lines, the overall RMS error and your name. Copy your final map composition to the clipboard, paste it into a WORD document and send it in to me for assessment.**

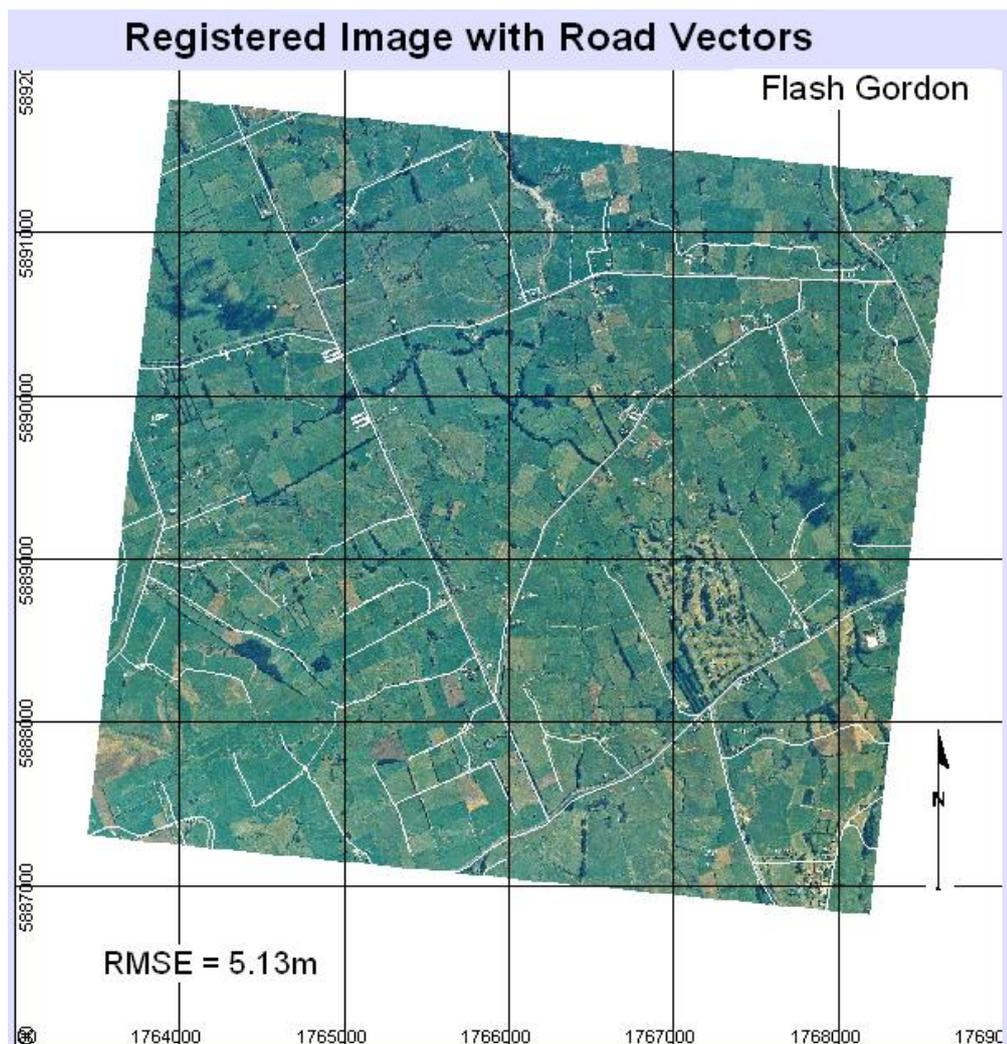


Figure 3. The completed assignment.

## 4.5 The assignments on Stream

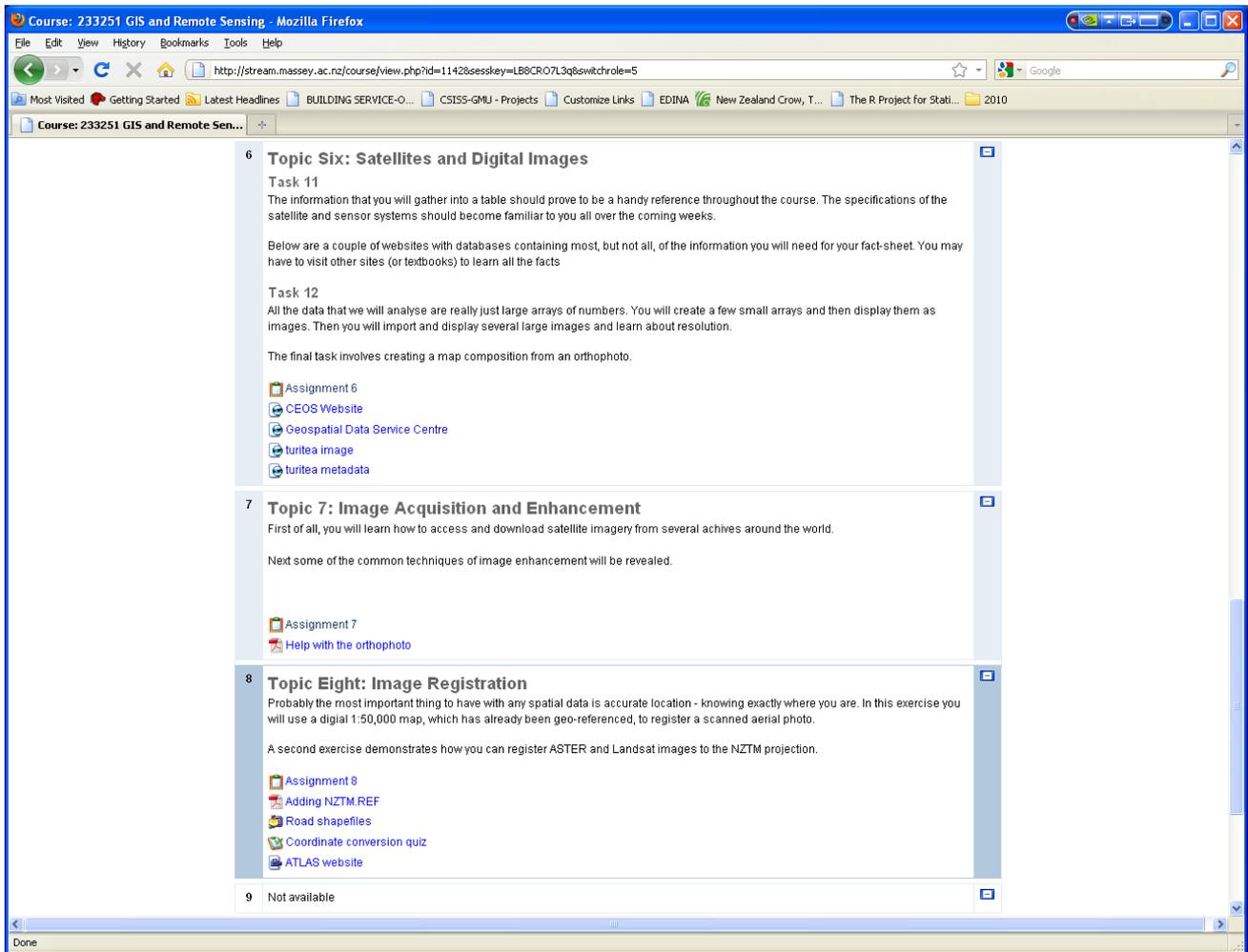


Figure 4. The assignments as they appear in Stream

Figure 4 shows what the students see on the Stream webpage for the course. Three topics are covered on this screen: Six -Satellites and Digital Images, Seven – Image Acquisition and Enhancement and Eight – Image Registration. There is a brief description of each task or exercise and various links and activities are provided.. The image registration exercise has five activities: The first (Assignment 8) is a link to the submission page where the completed assignment will be uploaded as a document. Next is a PDF that explains how to add a reference file for the projection being used in the exercise. Then there is a link to a zipfile which will be automatically unzipped and the files made available for extraction to a folder that the student will select. The fourth link opens a quiz – an optional test to give the student confidence in using a coordinate conversion tool. Finally, there is an instructional video to demonstrate how coordinates for any New Zealand location can be determined using an interactive website.

The number and variety of links and activities varies for each exercise; it is often necessary to provide students with more data than those supplied originally on the CD or it may simply be a matter of explaining a procedure in more detail by means of a link to a document. This often depends on the feedback from the students if they are having difficulty with an assignment. The online environment can provide real-time responses to queries via the forums and chat sessions or the instructor can produce videos that demonstrate how to enhance an image, query a database or perform a supervised classification.

In the author's experience, videos are best kept short (< 1 minute), with a preset video size no greater than 800x600 and converted to the .flv format. This is the format the majority of YouTube videos and most students watch YouTube so the software to view the videos will already be installed on their computers.

## 5. CONCLUSION



Figure 5. Logo for Stream at Massey University

Moodle has been renamed to 'Stream' to better reflect Massey University's vision and aspirations for Online Learning.

Stream is a metaphor for knowledge. Always flowing and moving, the stream runs at different speeds, directions and strengths. The stream feeds its surroundings and provides life to everyone, as does life-long learning and constructing knowledge, creating a rich and vibrant environment (MU webpage – about-stream).

The three bytes represent the traditional Māori view of the three baskets of knowledge. Three baskets [*kete*] encompass the experience of our senses [*te kete aronui*], the understanding of what lies behind those experiences [*te kete tuauri*] and the experience we have, particularly in ritual [*te kete tuātea*].

The bytes also represent the stepping-stones to encourage people to take bold new steps, follow the paths down the stream, and access the knowledge and expertise Massey has to offer.

The course described in this paper is just one of hundreds on offer from all the colleges at Massey University. Some are more advanced in the implementation of Stream while most have still to make the transition to an online course. The experience gained by the early adopters will make the path easier to follow for those to come. The investment in digital media has been made to broaden and enrich the learning experience of all students, whether they are distant, internal or international. Massey University is determined to remain the pre-eminent provider of blended (combining face-to-face with online learning) and distance education. (MU webpage – Plans and Reports / Defining).

## REFERENCES

<http://www.massey.ac.nz/massey/fms//About%20Massey/Documents/Defining-road-to-2020.pdf> (accessed 28 April, 2010)

[http://www.massey.ac.nz/massey/learning/online-learning/about-stream/about-stream\\_home.cfm](http://www.massey.ac.nz/massey/learning/online-learning/about-stream/about-stream_home.cfm) (accessed 28 April, 2010)

<http://moodle.org/stats/> (accessed 28 April, 2010)