University of Southern Queensland

Faculty of Engineering and Surveying

Preliminary Report

Production of semi-real time media-GIS contents of natural disasters using MODIS satellite data

A Dissertation submitted by

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ABSTRACT

In the event of a natural disaster, the information provided to the public can play an important role in its mitigation and management. Use of media-GIS content has been shown to provide information that is visual and accessible to the public. This report focuses on the information provided to the public through the media and develops rigorous production methods and quality practices to encourage increased strategic use of media-GIS content.

The report utilizes three natural disaster case studies to evaluate the production method and presents recommendations and conclusions based on the information these provide. Previous studies identified five aspects that are important to media-GIS contents. These are accuracy, high aesthetic quality, speed, low cost and reusability. A review of MODIS imagery has shown it to sufficiently satisfy all five aspects.

The report identifies an ideal source of MODIS data and a production method based on the information available to be obtained. By applying this methodology to the three case studies, it was found that the process could be more streamlined than previously identified methods. Further observations identified both positive and negative aspects of the method allowing improvements to be made were possible. Whilst limitations of MODIS were identified, the properties of MODIS data make it evident that it is the most effective source of satellite data for the production of media-GIS content where time and cost need to be minimised.

Completion of the case studies led to the production of a guidebook, presented in Appendix F, which is intended to be issued to media outlets as an instruction manual for producing media-GIS contents. It is hoped that this will encourage an increase in the use of GIS within the media industry and provide thorough production method and quality practices information.

Keywords: MODIS; media; GIS; natural disaster; worldview; real-time

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ABBREVIATIONS

CRED - Centre for Research on the Epidemiology of Disasters

DFO - Dartmouth Flood Observatory

EOSDIS - Earth Observing System Data and Information

EMDAT - International Disaster Database

GDP - Gross Domestic Product

GIBS - Global Imagery Browse Services

GIS - Geographic Information System

JPEG - Joint Photographic Experts Group

KML - Keyhole Mark-up Language

KMZ - Keyhole Mark-up language Zipped

LANCE - Land, Atmosphere Near real-time Capability for EOS

MODAPS - MODIS Adaptive Processing System

MODIS - Moderate-resolution Imaging Spectroradiometer

NASA - National Aeronautics and Space Administration (USA)

NRT - Near Real Time

PNG - Portable Network Graphics

RGB - Red, Green, Blue (image)

SEDAC - Socioeconomic Data and Application Centre

TIFF - Tagged Image File Format

Chapter 1: Research Outline and Reasoning

1.1 Outline of study

During the event of a natural disaster, information in the media can provide great assistance to the public through illustrating the extent of the disaster, informing of impending danger, giving an indication of the magnitude of damages and providing relevant local and emergency service information. However, it is important that the information being provided to the public is easy to understand and accurate. Visual representation of a natural disaster is an effective method of providing information that is easily accessible and able to be understood by the general public. MODIS (Moderate-resolution Imaging Spectroradiometer) provides a free and readily available source of satellite imagery.

In a study completed by Perera in 2010 entitled *Production of Semi Real Time Media-GIS Contents using MODIS Imagery* the abstract states that:

> "*Delivering environmental disaster information, swiftly, attractively, meaningfully, and accurately, to public is becoming a competitive task among spatial data visualizing experts.*" The study "*emphasizes on application of freely available MODIS true colour images to produce near real time contents on environmental disasters, while minimizing the production cost.*"

This dissertation uses MODIS imagery to produce media-GIS contents for three recent natural disasters. In doing so, the study aims to evaluate the effectiveness of MODIS satellite data for the use in the media industry and develop a method for content production and quality assurance.

1.2 Introduction

According to Merriam-Webster (2015), the term 'media', in the context of this report, was first used in the early 1920's and is derived from the word *medium*. It is used to reference modern mass communication and can describe a vast array of communication tools that are used to store and deliver information. Information can be disseminated through many avenues such as newspapers, magazines, online or broadcast through television and radio.

Trends in global internet access and media distribution have meant that information is rapidly available to the public, often from multiple sources many of which may not be evidence-based, or underpinned by accurate information or technology. This has created a demand for high quality, accurate information from reputable sources.

Access and use of the internet as an information source varies across the world as identified in the 'Internet World Stats: Usage and Population Statistics' table below. However, the data presented in this table doesn't take in to account the added global penetration of internet access through mobile devices. According to an info-graphic produced by 'We are Squared', a distance learning provider created by Google and Home Learning College, an estimated 91% of the global population has access to the internet by mobile device.

WORLD INTERNET USAGE AND POPULATION STATISTICS JUNE 30, 2014 - Mid-Year Update						
World Regions	**Population (2014 Est.)**	**Internet Users Dec. 31, 2000**	**Internet Users Latest Data**	**Penetration (% Population)**	**Growth 2000-2014**	**Users % of Table**
Africa	1,125,721,038	4,514,400	**297,885,898**	26.5 %	6,498.6 %	9.8 %
Asia	3,996,408,007	114,304,000	**1,386,188,112**	34.7 %	1,112.7 %	45.7 %
Europe	825,824,883	105,096,093	**582,441,059**	70.5 %	454.2 %	19.2 %
Middle East	231,588,580	3,284,800	**111,809,510**	48.3 %	3,303.8 %	3.7 %

North America	353,860,227	108,096,800	**310,322,257**	87.7 %	187.1 %	10.2 %
Latin America / Caribbean	612,279,181	18,068,919	**320,312,562**	52.3 %	1,672.7 %	10.5 %
Oceania / Australia	36,724,649	7,620,480	**26,789,942**	72.9 %	251.6 %	0.9 %
WORLD TOTAL	**7,182,406,565**	**360,985,492**	**3,035,749,340**	**42.3 %**	**741.0 %**	**100.0 %**
NOTES: Internet Usage and World Population Statistics are for June 30, 2014. (2) Internet usage information comes from data published by Nielsen, by the International, by GfK, local ICT Regulators and other reliable sources. Information in this site may be cited, giving the due credit to www.internetworldstats.com. Copyright © 2001 - 2014, Miniwatts Marketing Group. All rights reserved worldwide.						

Table 1.1: World internet usage and population statistics as of June 30, 2014 (Internet World Stats, 2014)

Global internet access creates a large and varied audience that spans multiple languages, cultures, societies and religions. Written text requires translation and care must be taken that the translated product sensitively addresses relevant cultural and religious variances of the intended audience. The use of imagery and graphics can often reduce or remove these barriers between audiences and ensure that the information being received is relevant, able to be understood and useful.

Figure 1.1: Image of damage caused by Cyclone Tracy (Enjoy Darwin, n.d)

In general, imagery is an extremely effective method of portraying information both explicitly and contextually. The devastating effects of disasters have often been shown through imagery. The following examples are just a few of the more significant natural disasters in Australian History. Figure 1.1shows the devastation following cyclone Tracy in 1974, which caused significant damage to Darwin, killing 71 people and causing an estimated $837 million worth of damages ($4.45billion approximately today).

Figure 1.2 shows an image of the 2011 Queensland Floods taken in the suburb of Graceville in South-western Brisbane. The Queensland floods lead to 35 confirmed deaths, 3 people missing and cost an estimated $2.38 billion in damages, which resulted in a projected reduction in the Australian GDP by $30 billion or more.

Figure 1.2: Image of 2011 Brisbane Floods - Suburb of Graceville (Long, B, 2011)

Figure 1.3 is an image of the Black Saturday bushfires that devastated Victoria in 2009. Black Saturday caused the deaths of 173 people and resulted in the injury of 5000 more. It destroyed 2029 homes and 4500 square kilometres of land. Local industry, in particular, agriculture and farmland was significantly affected.

Figure 1.3: Survivor 's Photo of the Black Saturday Bushfires from the 2009 Royal Commission Statements of Lay Witnesses. (From the statement of Matt Ahern, 2009)

The effects of these three natural disasters, among many others, have left a lasting impression on the local population and Australian history.

Our ‘Australian experience’ of disaster events and the effects they have had on our economy, culture and psyche is not unique. Natural and man-made disasters are occurring indiscriminately and with regularity across the world, creating despair and destruction that is universally felt by all affected people regardless of race, religion, wealth, culture or geographic boundaries. Thefinal image, Figure 1.4, provides an example of the impact of a recent natural disaster that has occurred internationally. The Nepal earthquake occurred on the 25th of April 2015 and cost the lives of more than 8000 people. It has left tens of thousands homeless and caused destruction that will take years, if not decades, to repair.

Figure 1.4: Nepal Earthquake 25th April 2015 (NBC News, 2015)

1.3 The Problem

The images shown in the previous figures illustrate the 'on the ground' effects of significant natural disasters in a powerful and emotive way. They immediately allow the viewer to form an understanding of the event and illustrate how effective the use of imagery can be to create empathy and emotional engagement in the reader.

JACKPOT LOTTERY MAJOR PRIZES P. 30

THE NEWS

LAST

Adelaide: Friday, December 27, 1974

WEATHER

A CITY IN RUIN

Looting in Darwin, disease fears—P.3

Figure 1.5: Old Newspaper Article after Cyclone Tracy hit Darwin in 1974 (Adelaide News Limited - The News, 1974)

Photographic imagery, such as those I have highlighted in my examples have been used to support reporting of events in the media for decades. For example, Figure 1.5, 'A city in ruin' from the Adelaide: News Limited newspaper in 1974, shows the devastation of cyclone Tracy through a large image central on the page. Buildings in ruin and debris littering the streets give an immediate picture to the reader, communicating the level of destruction and devastation of the event at a glance.

However, the problem with this use of imagery is that this represents the extent of the information it can provide to the viewer. It provides context to the reader who can see the disaster from a local perspective, can empathise with those people affected and can form a preliminary opinion of the probable scale of the damage. However, whilst from a media standpoint this approach is compelling and sellable, it doesn't establish a spatially accurate scope of the damage. The reader therefore, cannot gain a true understanding of the immediate and ongoing impacts of the disaster event.

Similarly, Figure 1.6 provides a typical online news article example of the traditional use of imagery in disaster reporting, using the Nepal earthquake of April 2015. This example effectively uses imagery and video to extract an emotional response to the experience of devastation and


The Sydney Morning Herald

World

Race to the White House 2016 Altered States Gallipoli: 100 years Environment Data Point

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Earthquake of 7.8 magnitude shakes Nepal, tremors felt in India

April 26, 2015

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Huge earthquake hits Nepal

Autoplay ON OFF Video feedback Video setting

Huge earthquake hits Nepal

Scores of Aussies missing as 7.9 magnitude earthquake strikes Nepal sending tremors throughout northern India and triggered a fatal avalanche on Mount Everest.

- Fears for Australians missing in Nepal
- Devastation witnessed firsthand
- At least 10 dead and hundreds stranded at Everest

Kathmandu: A massive earthquake has killed more than 1800 people as it tore through large parts of Nepal, toppling office blocks and towers in Kathmandu and triggering a deadly avalanche at Everest base camp.

It is the quake-prone Himalayan nation's worst disaster in more than 80 years.

An injured person receives treatment outside the Medicare Hospital in Kathmandu, Nepal. *Photo: AP*

A home ministry official said on Sunday that the official death toll had risen to 1805, with 4718 people injured.

The final toll from Saturday's 7.8-magnitude quake could be much higher, and dozens more people were reported killed in neighbouring India and China.

Emergency workers fanned out across the Himalayan nation to rescue those trapped under collapsed homes, buildings and other debris.

A collapsed building is seen in Nepal's capital Kathmandu. *Photo: Xinhua News Agency*

Figure 1.6: Typical News Report (Screenshot of The Sydney Morning Herald, Antony, A. 2015))

human cost but fails to provide a spatial context that establishes the extent of the affected area, the broader impact of the event or the potential recovery challenges.

1.4 Integration of GIS into media production

Integrating satellite imagery through a GIS (geographic information system), such as Google earth provides an accurate representation of the event at specific times and can be used to show the true extent of a natural disaster, allowing for response and recovery planning, assessment of potential financial impact and disaster management strategy. ESRI, a leading developer in the GIS industry, states that a GIS is a system that "*lets us visualize, question, analyse, and interpret data to understand relationships, patterns, and trends."* (ESRI, 2015)

ESRI states the ability to manage what is happening across a geographical area as being a key benefit of GIS. In addition, the use of informative geographic imagery provides an avenue for effective communication across language, department and understanding barriers. With respect to communication, ESRI believe:

> *"GIS-based maps and visualizations greatly assist in understanding situations and in storytelling. They are a type of language that improves communication between different teams, departments, disciplines, professional fields, organizations, and the public."* (ESRI, 2015)

The previous diagram, figure 1.7, shows the basic process that takes place following a natural disaster event to the presentation of information in the media.

Currently, media-GIS components that incorporate satellite imagery and GIS are used by the media either sparingly or after the immediate event.

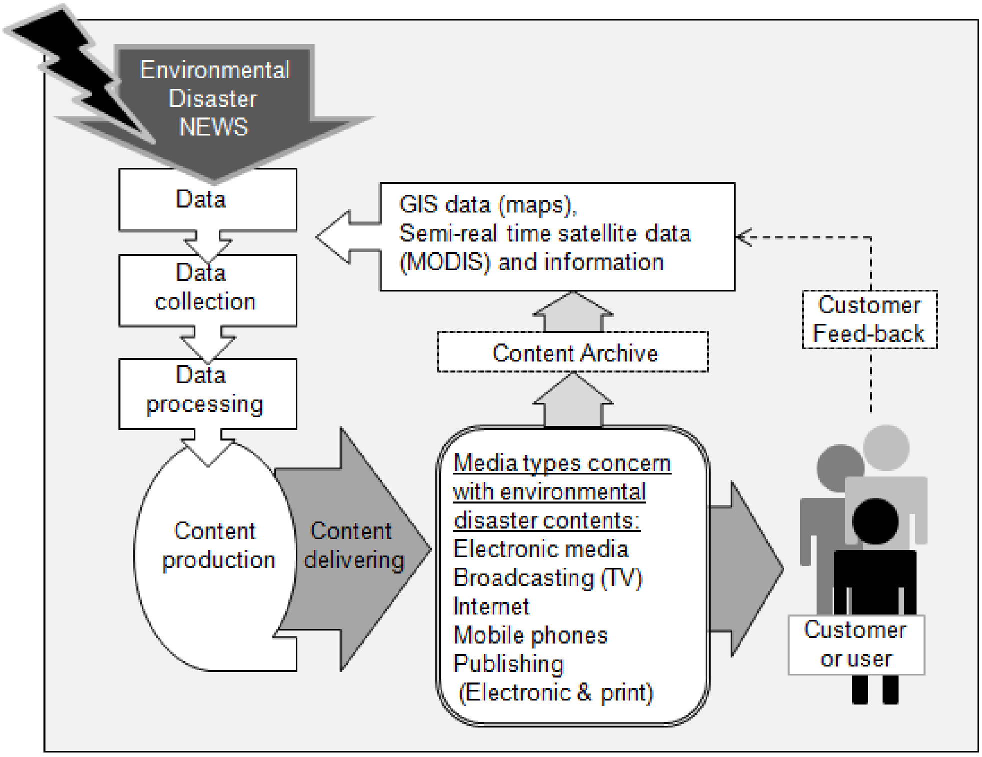


Figure 1.7: Simplified production flow of media-GIS contents (Perera and Tateishi, 2007).

This is highlighted in the media response to the Nepal Earthquake.During the month since the event over 300 seperate articles have been posted on the BBC News Online. The following Table provides a list of the media-GIS contents used as well as the date of their first apparent use.

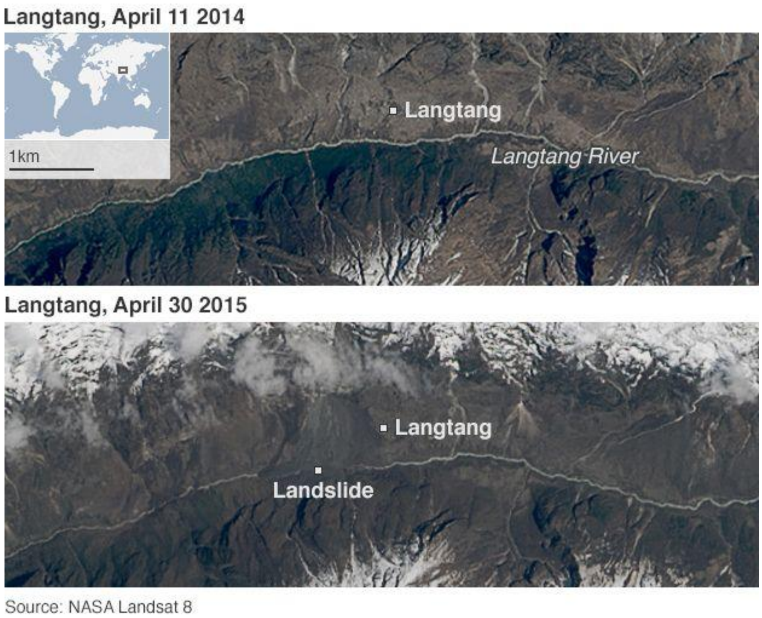
Date of Article	Days since Event	Title	Media-GIS contents	Source
25/04/15	0	Nepal Quake: Death toll passes 1000	GIS Map with approximate location of earthquake and country borders.	http://www.bbc.com/news/world-asia-32467986
26/04/15	1	Everest's 'worst disaster	Stock video showing everest map derived from 3D satellite	http://www.bbc.com/news/w

		ever'	imagery	orld-asia-32474948
28/04/15	3	Landslide fears after Nepal quakes	GIS Map with locations of glacial lakes and river systems in relation to quake location.	http://www.bbc.com/news/science-environment-32501206
28/04/15	3	Eight million people affected, UN says	Before and after satellite image of Dharara Tower	http://www.bbc.com/news/world-asia-32492232
29/04/15	4	Sentinal satellite reveals Nepal Quake Movement	Satellite radar imagery used to show ground movement before and after earthquake.	http://www.bbc.com/news/science-environment-32515059
01/05/15	6	Towns near epicentre 'devestated' - Red Cross	GIS map showing countries regions and relative death tolls	http://www.bbc.com/news/world-asia-32543518
06/05/15	11	Horror in Nepal's 'worst-hit' village	Satellite image of landslide along Langtang River	http://www.bbc.com/news/world-asia-32595883
06/05/15	11	How 'crisis mapping' is helping relief in Nepal	GIS mapping of Kathmandu region. Map of supply needs.	http://www.bbc.com/news/world-asia-32603870
08/05/15	13	Himalayan ' drop after Nepal quake'	Satellite image: Showing measurments of ground movement relative to satellite position in Himilaya Mountains.	http://www.bbc.com/news/science-environment-32625431
12/05/15	17	Unsettled Earth continues to rattle Nepal	Satellite image: Showing measurments of ground movement relative to satellite position.	http://www.bbc.com/news/science-environment-32708779

15/05/15	20	Devastation in maps and images	Collection of imagery including location of earthquakes and aftershocks on detailed maps. Location of deaths and refuge camps. Before and after satellite images.	http://www.bbc.com/news/world-asia-32479909
24/05/15	29	People flee as landslide blocks river	Map:. Showing location of Kathmandu. Satellite Image: Showing quake area and intensity levels	http://www.bbc.com/news/world-asia-32859353

Figure 1.8: Example of Media-GIS content used by BBC News (NASA Landsat 8, 2015)

Table 1.2: News articles that feature media-GIS contents on www.bbc.com/news in the month proceeding the Nepal earthquake.



Within these articles 12 different forms of media-GIS contents have been used. Some are repeated several times but, in general, approximately only 1 in 10 articles include GIS contents. In addition, the first satellite imagery wasn't provided until 3 days after the event. Although there is limited use of media-GIS contents, overall underutilisation of this resource reduces the commercial value of the information being presented.

The following diagram, Figure 1.9, by Perera from *Production of Semi Real Time Media-GIS Contents using MODIS Imagery (2010)*, shows the link between the use of media-GIS and the commercial value of the article.

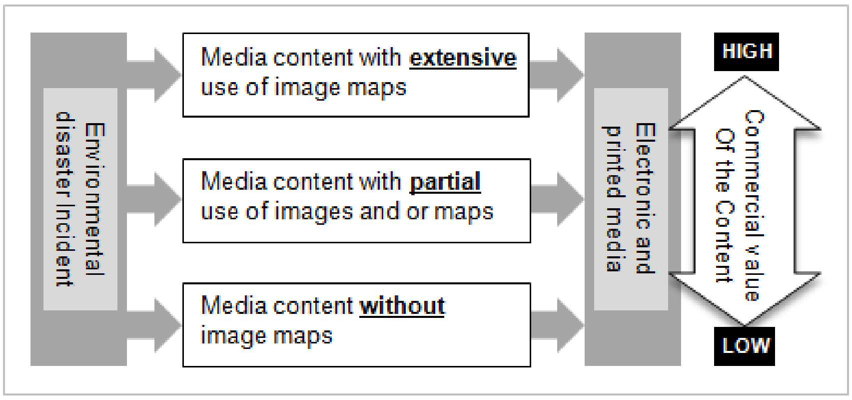


Figure 1.9: Relationship between commercial value related to the use of image maps (Perera, 2010)

Whilst traditional 'on the ground' photography assists in presenting the human-face of a disaster, this diagram indicates that increased use of MODIS imagery, increases the commercial value of the information. Why then, is the media use of this resource limited? Does access to this resource and understanding of its value need to be improved?

1.5 Research Objectives

This research aims to explore the fundamentals behind the MODIS imagery system and analyse the benefits of a multi spectral imagery to portray information during a natural disaster. The report will identify the appropriateness of MODIS imagery for different situations and analyse its ability to maintain spatial accuracy standards developed by the data providers.

This research will analyse the methods used to acquire and manipulate the imagery, paying particular attention to accuracy, quality, speed, cost and reusability. A thorough review on current literature will be used to develop a set of criteria to create media-GIS components on three recent natural disasters.

From this, comparisons and conclusions with the actual reported media components will be made to provide evidence that supports or negates the use of MODIS imagery. The research will clearly state improvements, positive outcomes as well as any potential negative outcomes or impacts.

From this information the report will seek to identify consistencies or standards that can be implemented when using MODIS imagery to minimise misuse or misinterpretation of the data. The research will also suggest potential avenues to better integrate media-GIS contents in to the media.

1.6 Conclusions

Natural disasters have a devastating impact on the world. The effects are felt through the loss of life, deterioration of physical and mental health and the damage to infrastructure, housing, business and finance.

The media has a responsibility to provide information to the public that is accurate and timely. There is a danger of misinterpretation of information leading to misleading outcomes as a result of cultural, language, educational, geographic and access barriers. However, the audience, regardless of these barriers, has a right be provided with information that is accessible and able to be understood. Effective use of imagery, including appropriate levels of MODIS satellite imagery, assists in achieving this goal.

Media-GIS contents are currently not used in sufficient quantity by the media to effectively exploit their full potential benefit to the provision of public information and disaster management response. The requirement for spatially accurate satellite imagery that is cost-effective and accessible, whist maintaining accuracy and an ability to be understood by the general public can be viably met by MODIS satellite imagery. Effective use of this resource will assist the media and governments to disseminate relevant information regarding disaster events to the public allowing for a timelier mobilisation of disaster response and promotion of public behaviour that supports safety and positive outcomes.

Chapter 2: MODIS Instruments and Image Characteristics

2.1 General Characteristics of MODIS instruments

MODIS is an acronym for 'Moderate Resolution Imaging Spectroradiometer'. It refers to two instruments installed on the 'Terra' and 'Aqua' satellites launched in 1999 and 2002 respectively. Both satellites were launched, and maintained by NASA (National Aeronautics and Space Administration). The NASA MODIS website details the paths of these two satellites. It states that:

> *"Terra's orbit around the Earth is timed so that it passes from north to south across the equator in the morning, while Aqua passes south to north over the equator in the afternoon. Terra MODIS and Aqua MODIS are viewing the entire Earth's surface every 1 to 2 days, acquiring data in 36 spectral bands, or groups of wavelengths."*(NASA, 2014)

The NASA MODIS website provides detailed design components on its website. The following excerpt provides information on the imagery provided:

> *"The MODIS instrument provides high radiometric sensitivity (12 bit) in 36 spectral bands ranging in wavelength from 0.4 µm to 14.4 µm.... Two bands are imaged at a nominal resolution of 250 m at nadir, with five bands at 500 m, and the remaining 29 bands at 1 km. A ±55-degree scanning pattern at the EOS orbit of 705 km achieves a 2,330-km swath and provides global coverage every one to two days."*(NASA, 2014)

Refer to Appendix B for detailed specifications of the MODIS instruments and satellites.

The MODIS imagery is processed through MODAPS (MODIS Adaptive Processing System) that can use a forward processing system to ensure that imagery can be provided to EOSDIS in near real-time.

2.2 MODIS Satellite Paths

The following images, Figure 2.1 and 2.2, show a typical image produced during a one to two day period by the MODIS instruments and the typical paths of the satellites respectively. It is important to note that the path of a single satellite cannot provide complete coverage of the earth. Overlapping the paths of the satellites ensures that a complete picture is acquired with each cycle, however there are small portions of the earth's surface where imagery is not available as regularly due to it only being covered by one of the satellites.

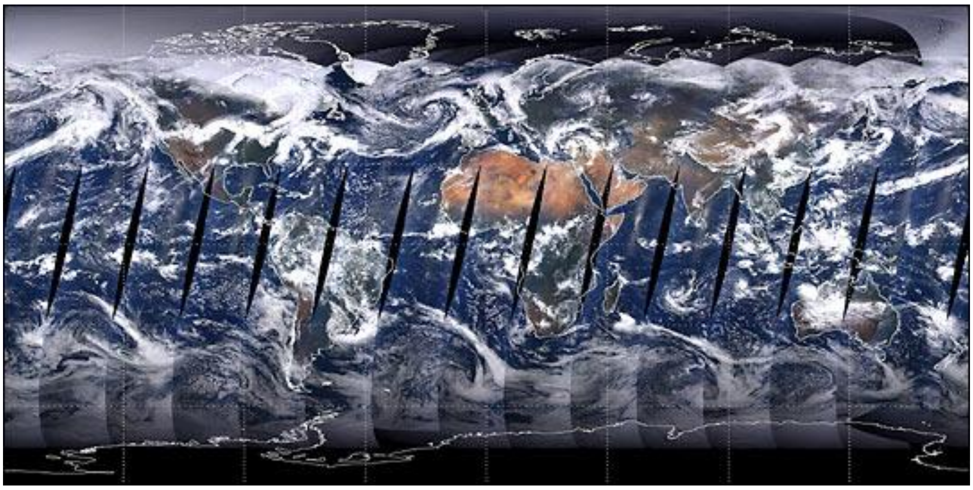


Figure 2.1: Typical image map provided by a single MODIS satellite over a one to two day period. (NASA Worldview, 2015)

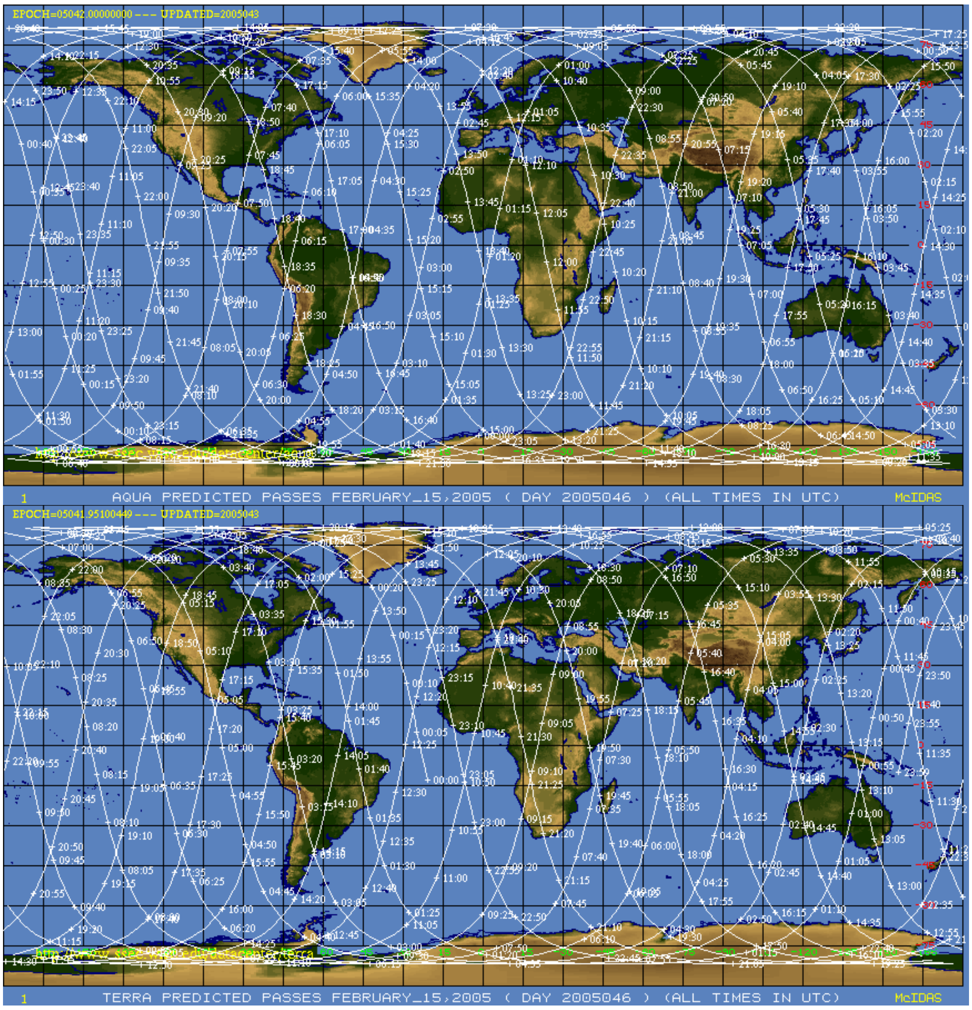


Figure 2.2: Example path of the Aqua satellite (top) and Terra satellite (Bottom) during the same time period. (NASA, 2005)

2.3 Availability and Analysis of MODIS imagery

It is possible to acquire MODIS imagery through NASA's 'Earth Observing System Data and Information System (EOSDIS). These can be freely obtained online from https://earthdata.nasa.gov/.

> *"NASA states that it "supports an open data policy and encourages publication of imagery from Worldview...when doing so, please cite it as "NASA Worldview" and also consider including a permalink to allow others to explore the imagery."* (NASA, 2015).

A more detailed 'NASA Data and Information Policy' is provided in Appendix C.

A number of additional resources can be obtained through the EOSDIS website. Figure 2.3 is taken from the worldview utility provided by EOSDIS at https://worldview.earthdata.nasa.gov/. The Worldview utility is managed by the 'Global Imagery Browse Services' (GIBS)

According to EOSDIS, the GIBS system is designed to provide *"a scalable, responsive, highly available, and community standards based set of imagery services."* (2015)

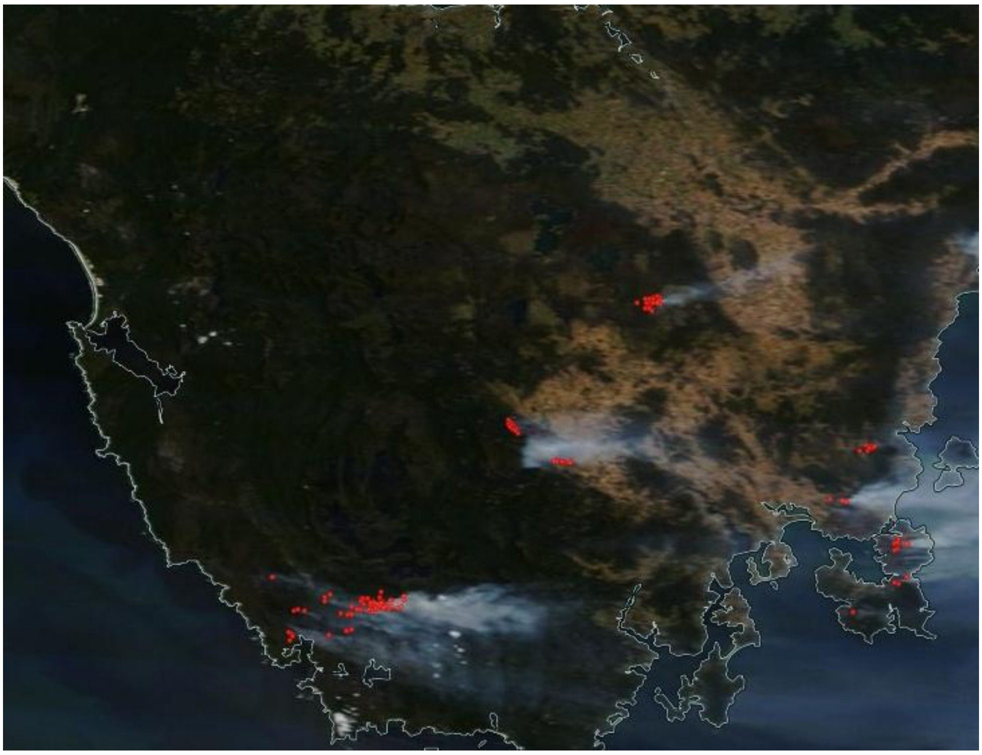


Figure 2.3: NASA Worldview - MODIS Image of Tasmania from 6th Jan 2013 showing fire and thermal anomalies (NASA Worldview, 2015)

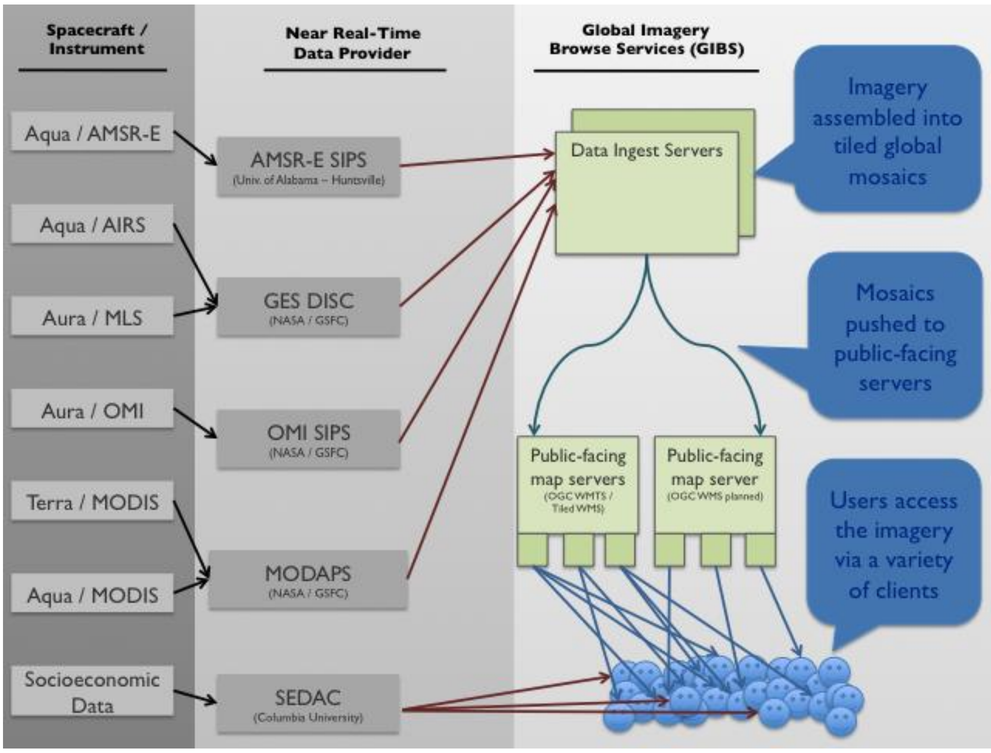


Figure 2.4: GIBS system architecture diagram (NASA, 2015)

The GIBS system has roughly 90 different imagery products that can be used to emphasize certain aspects of the data. This includes 12 different band combinations, 65 scientific parameter visualizations and 11 utility layers.

Many of these would not be necessary for use in media-GIS contents however others could be extremely useful. The image below shows examples of a number of imagery products Further analysis will be completed in Chapter 4.

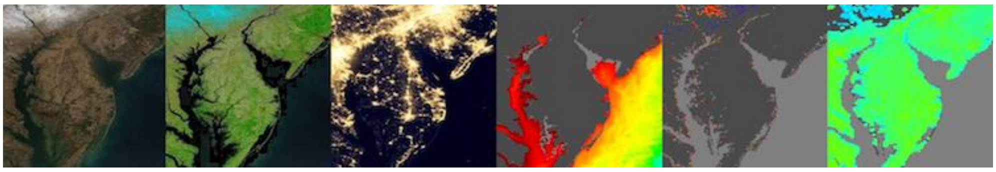


Figure 2.5: A few examples of different image products available (NASA, 2015)

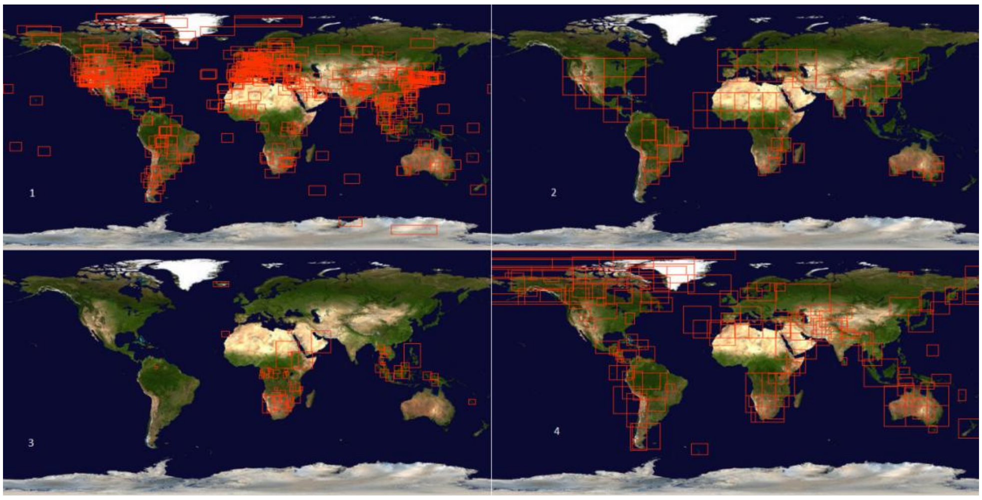


Figure 2.6: The figure above shows the geometrically and radiometrically corrected MODIS subsets available. The images show subsets provided by 1. Aeronet, 2.FAS, 3.FIRMS and 4. Other Subsets. (Compiled from LANCE, NASA, 2015)

Specific data subsets are also available through separate services as per Figure 2.6.

1. The Aeronet subset is designed to monitor aerosol optical depth and precipitable water through a series of ground and satellite based observations. The Aeronet mission statement provided by the Goddard Space Flight Centre of NASA states:

   "The program provides a long-term, continuous and readily accessible public domain database of aerosol optical, microphysical and radiative properties for aerosol research and characterization, validation of satellite retrievals, and synergism with other databases." (NASA, 2015)

2. The subset is provided for FAS (Foreign Agriculture Service). According to an ESRI press release:

   "The mission of FAS is to improve foreign market access to U.S. agricultural products, build new markets, improve the competitive position of U.S. agriculture in the global

> *marketplace, and provide food aid and technical assistance to foreign countries. FAS achieves a part of this mission by analyzing global crop production capacity with remote-sensing and GIS tools and by issuing commodity intelligence reports highlighting current international crop conditions*." (NASA, 2015)

3. The FIRMS (Fire Information for Resource Management System) is available through the Worldview utility within 3 hours of satellite images being taken. According to EOSDIS:

   > *"MODIS near real-time (NRT) active fire/hotspot locations are processed by LANCE using the standard MODIS...Fire and Thermal Anomalies product. Each active fire location represents the center of a 1km pixel that is flagged by the algorithm as containing one or more fires within the pixel."* (EOSDIS, 2015)

   Archived products are also available through the EOSDIS webpage.

4. A range of other subsets typically focusing on a particular feature or area are also available as per the fourth portion of the image from the EOSDIS web page.

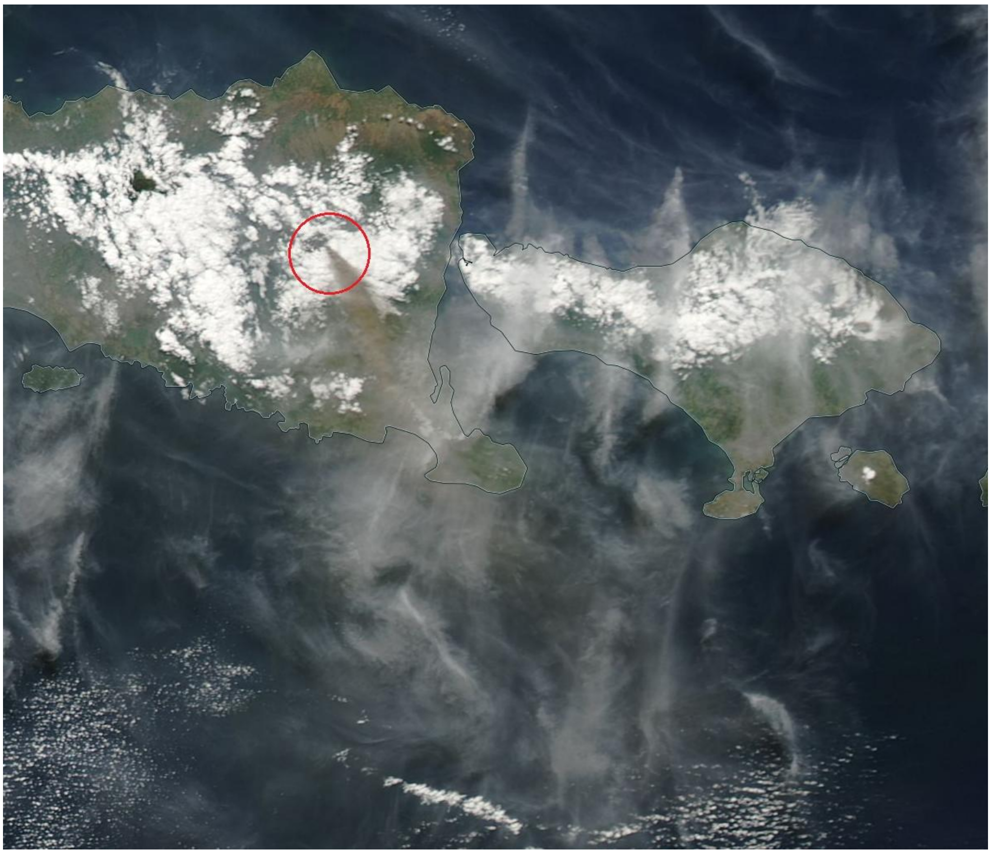


Figure 2.7: Snapshot of EOSDIS Worldview true colour corrected reflectance imagery taken on the 5th of August 2015 showing the ash plume after the eruption of Mount Raung (circled in red), an active volcano, on the 29th of June on the island of Java. Resolution: 250m. (NASA Worldview, 2015)

2.4 'Semi-real time' aspect of MODIS

Due to the paths and travel times of the satellites an image is taken of an area approximately twice a day; once in the morning and once in the afternoon. Establishing an acceptable timeframe is imperative in establishing whether MODIS imagery adheres to the semi-real time criteria.

In 2001 the 'Rapid Response system' was developed. It initial goal was to:

> *"provide near real-time data and imagery from the Moderate Resolution Imaging Spectroradiometer (MODIS) instrument on board the Terra Satellite, to meet the needs of the US Forest Service (USFS), the National Interagency Fire Centre (NIFC) and other federal and state users."*(EOSDIS, 2015)

Demand of the 'Rapid Response system' has meant that it has been implemented on both the Terra and Aqua satellites and further prompted the development of the LANCE (Land, Atmosphere Near real-time Capability for EOS [Earth Observing System]) system in 2009.

> *"The Land, Atmosphere Near real-time Capability for EOS (LANCE) makes EOS data from AIRS, AMSR2, MLS, MODIS, and OMI instruments available within three hours of satellite overpass to meet the timely needs of applications such as numerical weather and climate prediction; forecasting and monitoring natural hazards, ecological/invasive species, agriculture, and air quality; providing help with disaster relief; and homeland security."* (NASA, 2015)

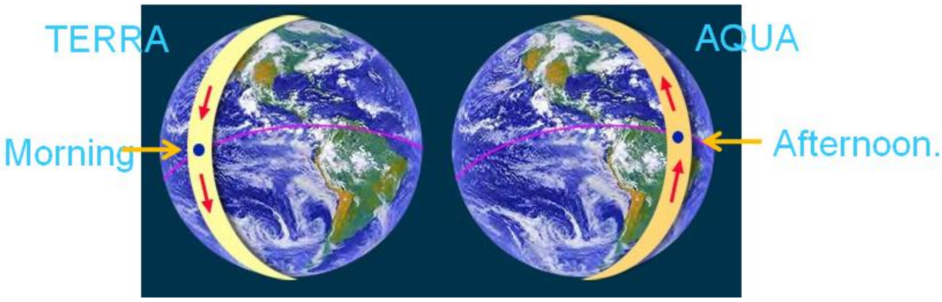


Figure 2.8: The MODIS satellites successfully cover the earth's surface every 1 - 2 days. Terra passes north to south across the equator in the morning. Aqua passes south to north across the equator in the afternoon. (Perera, 2009)

This means that MODIS satellite data is available for free to the public and media roughly between 3 to 15 hours of an event occurring. This is available through the Worldview utility with the ability to use the additional analysis layers to highlight areas of interest such as the fire and thermal anomalies layer shown previously in Figure 2.3.

In the instance of disasters that build up over time such as flooding and storm systems the 'real-time' aspect would be effective if used in the media as a pre-warning system as well as report on ongoing effects. However, disaster such as earthquakes or tsunamis that occur rapidly would not be able to utilize this.

The timeline provided by the LANCE system would be able to provide imagery in the immediate coverage after the event of a natural disaster and would have no issues reporting on the recovery as this can often take extended lengths of time.

2.5 Conclusions

MODIS imagery provides a viable resource for the production of media-GIS contents. Due to the potential of human morbidity and mortality during a natural disaster, careful consideration needs to be taken to ensure information is portrayed in a manner that is able to positively contribute to public and government decision making and is notable to be misinterpreted resulting in poor decisions. The following chapter will now explore these matters in detail.

Chapter 3: Media-GIS Contents - A literary review

3.1 Disasters and the Media

EM-DAT, the International Disaster Database, was originally founded by CRED (Centre for Research on the Epidemiology of Disasters) of the Université Catholique de Louvain in Brussels, Belgium. CRED in turn has culminated with the World Health Organisation's Global Programme for Emergency Procedures and the United Nation's Department of Humanitarian Affairs to provide accurate, systematic data collection and storage on disasters. Trends provided from this information indicate a significant increase in the number of disasters occurring over the last century. Figure 3.1 shows the number of Natural Disasters reported since 1900.

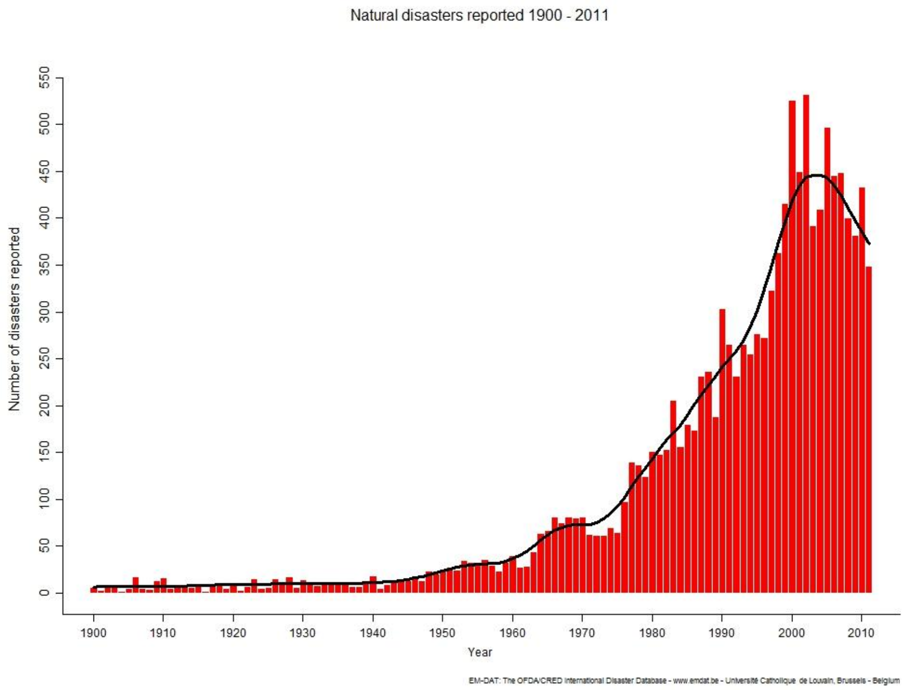


Figure 3.1: Natural Disaster reported 1900 - 2011 (EMDAT, 2012)

Some of this can be attributed to an increase in reporting from an improved global communication network. Lowrey et al. (2007) attributes "*population growth, urbanization, increasingly complex technologies, a rise in world-wide terrorism, social unrest, global economic and social interdependence* *and the emergence and re-emergence of infectious diseases"* as major factors.

A major concern for Lowrey is the "*inaccurate, incomplete, and sensational coverage that may contribute to public misunderstanding"*. This view is shared by Benthall (2008) who likens the presentation of news as an "*export commodity"* and aid or assistance as a commercial investment by those involved. One of the major issues cited by Benthall is restricted 'on ground' access to media that only allows a portion of the disaster to be seen.

Lowrey's study focuses on the distribution of information around health aspects of Natural Disasters but applies to all media coverage of the event. It found that two complaints commonly occurred.

> *"First, they complain that stories are too often hectic and breathless, that the need for journalists to file stories frequently and quickly leads to stories that focus on details and events that experts deem to be irrelevant, unimportant, unhelpful, and sometimes inaccurate. Second, they complained that stories are too often shallow and do not provide much contextual information, focusing instead on whatever details may be new, providing little attention to how these details may be related to a comprehensive understanding of the situation."*(Lowrey, et al. 2007)

Perera and Tateishi (2008) and Perera (2010) state the "*lack or very limited use of location based images and maps"* are the missing component in environmental disaster contents. The application of satellite images, especially semi-real-time satellite images can be a very effective addition for reporting of most of the natural disasters (Perera and Tateishi, 2012; USGS, 2011; Altan at el, 2010; Nakya et al, 2007, Perera & Pathirana, 2006). Perera and Tateishi(2008) also identify that a "*content maker should have basic knowledge and skills in; GIS, remote sensing data handling and graphic production"*.

Both Lowrey (2007) and Benthall (2008) state that a high demand and short deadlines play a major role in the distribution of poor information. Perera (2010) linked the increase in demand to the "tremendous development in online and broadcast internet access" and the link between the security of human society and disaster incidents.

Dealing with this peak in demand and the need for accurate information has led to the development of the MODIS satellite network and in particular the near real time LANCE system, formally known as the Rapid Response System.

3.2 Demand for semi-real time MODIS imagery

The Rapid Response system was developed in conjunction with NASA and the University of Maryland after MODIS data was initially used to monitor the Montana fires in the year 2000. Descloitres et al. (2002) identified that the combination of daily spatial coverage, spatial resolution and spectral characteristics were unprecedented at that time and would be ideal for tracking weather events such as "*active fires, floods, smoke transport, dust storms, severe storms, iceberg calving, and volcanic eruptions*."The initial Rapid Response system focused primarily on fire events and integrated the use of an active fire detection algorithm developed for the AVHRR (Advanced Very High Resolution Radiometer) and TRMM VIRS (Tropical Rainfall Measurement Mission Visible and Infrared Scanner) Giglio et al. (1999), Justice et al. (1996) and Kaufman et al. (1990) which would automatically identify fire anomalies. Descloitres et al. (2002) concluded in stating that the Rapid Response System was a "*flexible, responsive system, capable to provide quality imagery from MODIS within a few hours of data acquisition"* and, beyond this, held many further applications.

Scharfen et al. (2000) and Appel & Salomonson (2002) provide an example of this. Both investigated the use of MODIS imagery to map global snow coverage and track changes over time. Appel & Salomonson (2004) and

Painter et al. (2009) then developed improved snow mapping products which were verified for accuracy by D. Hall & G. Riggs (2007) and Arsenault K. et al (2012).This data has been used to contribute information about the size of global ice coverage and track changes over time that has assisted in fields of study such as global warming.

Further academic literature covers a wide variety of applications for MODIS imagery ranging from vegetation phenology (Zhang, et al., 2003), crop distribution and health (Sakamoto et al., 2005), algae growth and deposits (Zhao et al, 2014), aerosol monitoring (Remer et al., 2008), evapotranspiration (Matterrese et al., 2012) and soil respiration (Wu, et al., 2014) which contribute to our understanding of the health of flora and fauna, and preservation of our global environment. . Much of this literature is very specific and doesn't relate directly to the production of media-GIS but is important in establishing the available products that may help to illustrate the information the media could access in providing public information on disaster events.

3.3 Worldview resource capabilities

As eluded to earlier, journalists require some basic education of available imagery resources and a product that is intuitive to use resulting in reduced misrepresentation or misinterpretation of information. The EOSDIS site, and more specifically, the Worldview utility is an ideal source of data should minimise the potential for incorrect use of the data.

To assist in the representation of certain information the worldview utility has approximately 90 different image possibilities as mentioned previously in Module 2. Of these there are several that would be effective in demonstrating different information for use by the media. The Fire and Thermal Anomalies layer, developed through the Rapid Response System, is one of the available layers as is the snow cover layer which could be attributed to flood events and potential natural disasters. A more complete list of the relevant worldview layers will be analysed in Module 4.

3.4Uses of GIS in the media

El-Masri and Tipple (2010) and Perera and Tateishi (2012) highlight

> "*the value of development of a better understanding of the interaction between human and natural systems and their environmental and socioeconomic dimensions, with regard to natural disaster mitigation plans."*(El-Masri and Tipple, 2010; Perera and Tateishi, 2012)

El-Masri and Tipple discuss the correlation between public participation and government decision making; and the participation in localised disaster mitigation activities. "*When the public has a better awareness of natural disasters, mitigation plans can be convinced with better productivity"* (Perera and Tateishi, 2012; Weichselgartner, 2001;Jayawardane, 2005; Godschalk, at el, 2010).This is a considerable factor highlighting the importance of media-GIS contents.

According to Kraak (1999) there are 3 major objectives of visualizing spatial data;"*data presenting, data analyzing and data exploring*." Media-GIS contents focus primarily on data presenting with some underlying data analysis. The focus when presenting data in the media should be on the image variables such as the "*size, value, texture, hue, orientation*, and *shape*."

With this in mind, media-GIS content production has to focus on maximizing the five basic qualities or standards as stated by Perera and Tateishi (2008& 2012) and by Perera (2010). These are:

1. Accuracy
2. High aesthetic quality
3. Speed
4. Low cost

5. Reusability

3.5. The five aspects of media-GIS contents

3.5.1Accuracy

Accuracy is a highly important aspect of GIS and this importance is also highly relevant to media-GIS. .As the media are providing information at the time of an event to the public, *"the geographical and informative accuracy of the contents is paramount*" (Perera and Tateishi, 2012). The reliability of the data source and its relevant accuracy needs to be established prior to publishing.

LANCE data provides near real-time information that:

> "*differs in the amount of processing the raw data receives. Near real-time data is processed with different, less accurate ancillary data to make it available to users within 3 hours of observation. The main difference is in geo-location due to the use of predictive orbit information vs. waiting for definitive orbit information."* (EOSDIS, 2015)

This means that some level of accuracy is sacrificed in the interest of time. Media organisations using this data need to be aware of this constraint when drawing assumptions in their reporting, however the timely release of this data is useful in reporting on an unfolding disaster event.

EOSDIS has also completed side-by-side comparisons between standard and near real-time observations. Figure 3.2 is an example provided by them.

They state:

"In this side-by-side comparison of a standard and near-real time Land Surface Reflectance granule over the Midwest there appears to be no difference between the products. However, under close examination the near-real time view shows slightly more haze West of the Great Lakes." (EOSDIS, 2015)

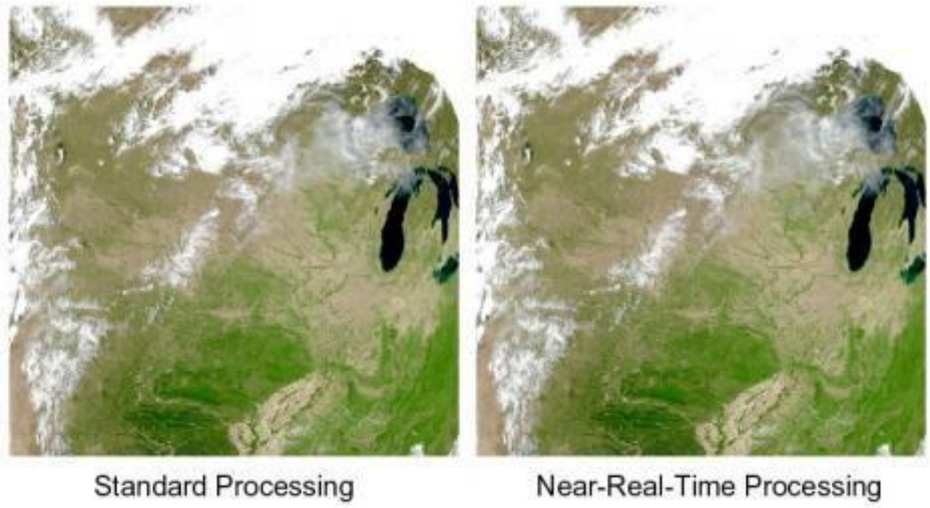


Figure 3.2: Side by Side comparison of MODIS imagery. (NASA, 2015)

The standard processing would be important in scientific study where accurate results are important in producing correct results however for the use of media-GIS contents the near real-time processing is sufficient for the purpose of providing timely information to inform the public regarding an unfolding event, allowing for response and recovery planning.

EOSDIS themselves state the LANCE product is made specifically available for:

"*applications, such as numerical weather and climate prediction; forecasting and monitoring natural hazards, ecological/invasive species, agriculture, and air quality; providing help with disaster relief; and homeland security."* (EOSDIS, 2015).

This data, combined with good graphical and editing techniques, will ensure that the accuracy is maintained throughout the editing process. When defining the geographic location of the imagery it is important to keep a reference on the specific location, particularly if comparisons are going to be made with archived data. Using longitudes and latitudes or a polar reference system such as WGS84 (World Geodetic System) will assist in this task. The worldview utility provides the longitudes and latitudes of any exported image and a live position depending on the cursor (mouse) position.

3.5.2 High aesthetic quality

The variables of *size, value, texture, hue, orientation*, and *shape* were previously mentioned. These relate directly to the aesthetic quality of an image. The variables need to be such that audiences that will potentially differ depending on geography and intended use of the content can still relate to the images. When considering size, it is important to understand the medium in which the image is going to be displayed. Standard resolutions that are used on a computer for example may not be accessible on a mobile device that cannot render high resolution images effectively. Table 3 shows the percentage of users that use their mobile device for internet browsing. If the media is directing their 'publication' to a younger demographic or a lower-income group Table 3.1 illustrates that it is more important to ensure the size of images are mobile compatible.

Internet users in 2014

Among adults, the % who use the internet, email, or access the internet via a mobile device

		Use internet
	All adults	87%
	Sex	
a	Men	87
b	Women	86
	Race/ethnicity*	
a	White	85
b	African-American	81
c	Hispanic	83
	Age group	
a	18-29	97[cd]
b	30-49	93[d]
c	50-64	88[d]
d	65+	57
	Education level	
a	High school grad or less	76
b	Some college	91[a]
c	College+	97[ab]
	Household income	
a	Less than $30,000/yr	77
b	$30,000-$49,999	85
c	$50,000-$74,999	93[ab]
d	$75,000+	99[ab]
	Community type	
a	Urban	88
b	Suburban	87
c	Rural	83

Source, Pew Research Center Internet Project Survey, January 9-12, 2014. N=1,006 adults.
Note: Percentages marked with a superscript letter (e.g., [a]) indicate a statistically significant difference between that row and the row designated by that superscript letter, among categories of each demographic characteristic (e.g., age).
* The results for race/ethnicity are based off a combined sample from two weekly omnibus surveys, January 9-12 and January 23-26, 2014. The combined total n for these surveys was 2,008; n=1,421 for whites, n=197 for African-Americans, and n=236 for Hispanics.

PEW RESEARCH CENTER

Table 3.1: Breakup of internet use on mobile devices (Pew Research Centre, 2014)

Similarly, the hue (colour), text and symbols need to be legible, accentuate the intended data and be relevant to the target audience.

> "*Graphics should not hinder the original information in image. Font sizes must be large enough to read easily, and priorities of words on the content must be carefully balanced to maintain the informative and visual quality."* (Perera and Tateishi, 2012)

3.5.3 Speed

As outlined in section 3.1 the speed of information required by the media is a lot faster than many other industries; certainly a lot faster than that of a spatial scientist. The rate at which information is required by the media, government and emergency services has pushed the development of near real time technologies. Ostrow, A. (2007) and Perera and Tateishi (2012) expand on this concept further into commercial competitiveness through indicating that their research has identified that "*rapidly growing commercial competition...using innovative, visually stunning, and useful data visualisation tools are upgrading daily."*

When referring to speed of image generation, the production of images needs to be completed in the shortest time possible whilst maintaining specific quality and accuracy requirements. Perera and Tateishi (2012) break speed in to 3 different components. They are "*data mining, downloading and converting graphic production process*...and *speed of data mobility."*

The speed at which the data underpinning LANCE images is available is currently approximately 3.5 hours (as referenced in Module 2). From the perspective of the media industry, this time frame is fixed. That is, the media does not have the ability to decrease this time-frame as a third party user and, for the fairness of industry competition, individual media outlets are unable to create a monopoly on freely supplied information.

However, individual media outlets are able to positively influence image time in relation to their own website editing once information is available for download from the EOSDIS site through ensuring that the file size and scale is appropriate to provide relevant information but restricts the download of unnecessary information which increases waiting and editing times.

Ensuring the correct size and scale has been chosen will avoid the need for cropping and additional manipulation as well as decrease lag time based on the difference in file size. Finally, the components need to be presented in a manner that is suitable for the website application. An excessively large file will take much longer time to load for the consumer and potentially be unable to load at all on mobile devices.

3.5.4 Low cost

The cost relating to the production on media-GIS components is low because the information is freely available from the NASA sponsored website. This should mean that ongoing costs of delivering this information to the public in a timely manner that improves relevant information at the time of a disaster event and supports public safety are minor. Most media companies will already have access to editing software such as Photoshop and basic GIS software such as Google Earth. If not, Photoshop is relatively inexpensive and Google Earth is free software. Computer requirements are low and a typical computer should have no issue running the software. The highest cost associated with the initial implementation of including this data in relevant media reports is likely to be staff training to ensure they are competent with producing contents and analysing accessed data and images to an acceptable standard. There is more powerful GIS software available that can be of a much higher cost, however this level of software is generally not necessary for efficient, accurate and timely media-GIS reporting.

3.5.5 Reusability

Reusability is an important aspect of general media process as subsequent stories often compare and contrast disaster events and recovery aspects over time. This means "*all media-GIS contents must be systematically archived*"(Perera and Tateishi, 2012) upon story completion and should be stored in a database in a manner that is easily searchable for future reference. Timestamps are extremely important to identify the data correctly and to ensure the accuracy of future comparisons.

3.6 Conclusions

The requirements of the consumer and the media are evidently different than those of a spatial scientist or analyst. Significant scientific analysis or detailed exploration require extremely accurate data, but have less need for this data to be only hours old. In contrast, the media place more emphasis on the speed and cost of images and data, whilst being willing to sacrifice some level of accuracy and image quality. The highest available level of quality is not required for public understanding, however there remains a requirement for moderately high-level accuracy and aesthetic quality that effectively promotes an understandable and accurate overview of an unfolding situation to the public.

The following module now conducts a literature review of the analysis of more specific disaster types and applies this to media-GIS requirements. The disasters analysed include fire-based disasters such as bushfires and volcanic eruptions, floods and storm cells, earthquakes and drought.

Chapter 4: Methodologies for media-GIS Content Production

4.1Analysis of Worldview and GIBS products

Worldview allows users to "*interactively browse global satellite imagery within hours of it being acquired.*"(EOSDIS, 2015) As previously mentioned, the system is managed by GIBS, the 'Global Imagery Browse Services' which allows the user to utilize many imagery products that represent 35 'visualized scientific parameters' monitored by the NASA Earth Observing System. The imagery products can be broken up in to three groups; multiband imagery, science parameter visualisations and utility layers.

4.1.1 Multiband Imagery

Multiband imagery is created by processing multiple spectral bands into an RGB, Red-green-blue or True-colour, composite image. Depending upon which layers are selected and how they are visualised different aspects of the image will be accentuated and become more apparent. The image shown in Figure 4.1 shows an example of how ocean features can be emphasized through the use of bands 1, 3 and 4.

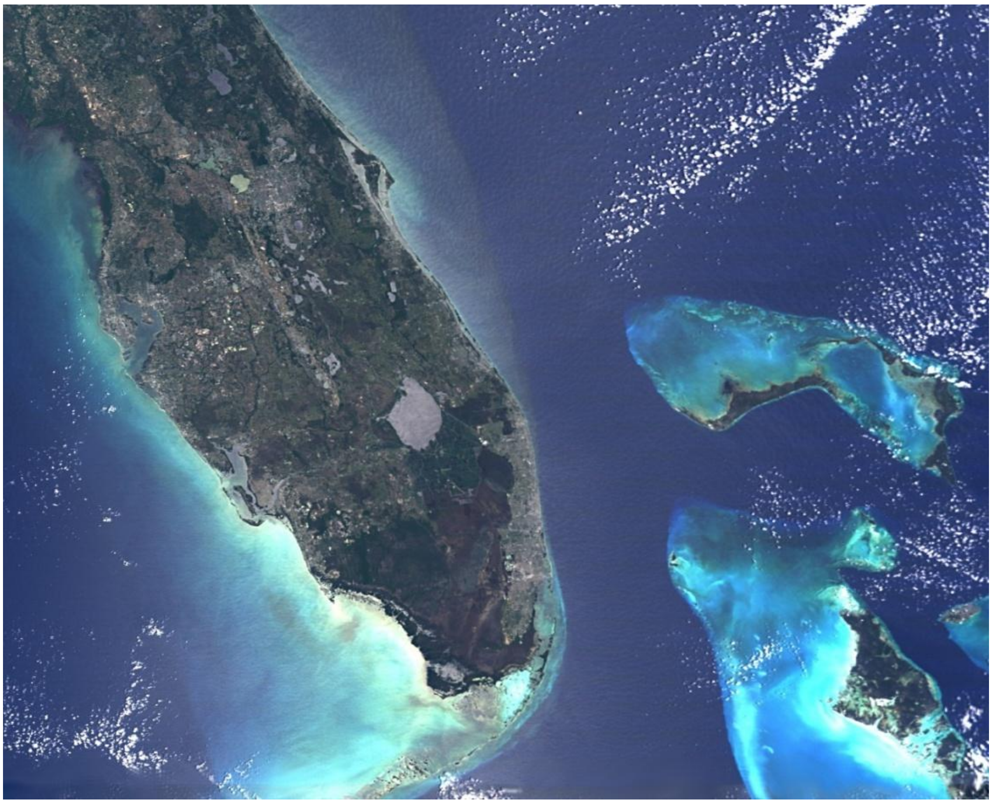


Figure 4.1: Example of MODIS image of Florida using bands 1, 3 and 4 to emphasize features in the ocean. (Taylor, D., 2014)

The MODIS satellites record imagery in 36 spectral bands (refer to MODIS technical specifications in Appendix B)however, only the first 7 bands are typically used to generate satellite imagery.

4.1.2 Science Parameter Visualisations

Similar to multiband images, science parameter visualisation maps scientific measurements by converting measured values into an RGB image. Each location is assigned a unique colour identifier base on the values measured. Figure 21 illustrates the concentration of Chlorophyll A in ocean waters. Chlorophyll A is produced by small floating plants in the ocean known as phytoplankton. The scale follows the visible spectrum where blue represents low amounts of Chlorophyll A and red represents high amounts if Chlorophyll A.

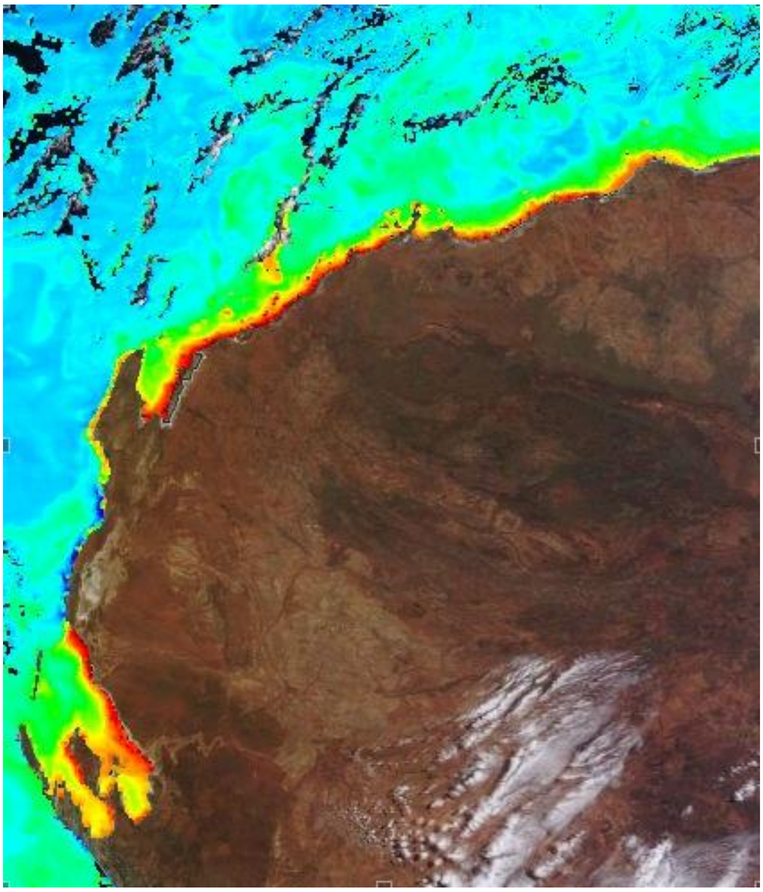


Figure 4.2: Chlorophyll A levels on the West Australian coastline on 27th August 2015 (NASA Worldview, 2015)

The visible spectrum of light can be seen in Figure 22 for reference. For the most part, these layers will not be useful when creating media-GIS contents as they provide more specialist information that is generally not required by the public. More detailed analysis and uses will be explored in section 4.2.

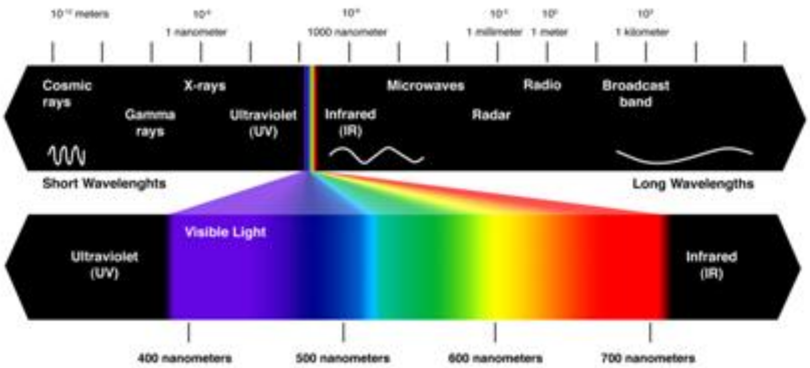


Figure 4.3: Visible spectrum of light shown in relation to Electromagnetic wavelength. (Source: http://atomicpuke.com/?page_id=54)

4.1.3 Utility Layers

Utility layers are designed to improve image clarity and view-ability. They contain data or imagery masks that can highlight or remove portions of an image and mapping aids such as graticules, the grid used in the geographic data system, and coastlines.

Appendix D contains a full list of the GIBS imagery products and related information. The following sections further investigate potentially useful products in relation to different types of natural disasters such as fires or floods.

4.1.4 Acquiring imagery from the Worldview utility

Acquiring an image from the Worldview utility is fairly straightforward. Figure 23 shows a screenshot of the webpage to identify the basic layout.

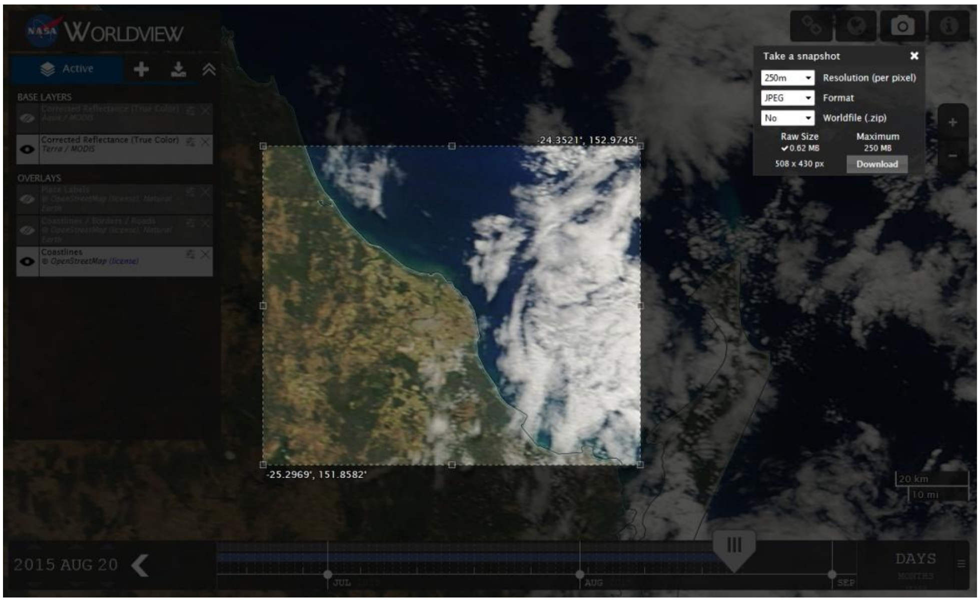


Figure 4.4: Screenshot of Worldview utility showing screen layout whilst taking a 'snapshot' (NASA Worldview, 2015)

To begin, the user needs to manipulate the map to the appropriate area and select the layers required for a specific point in time. The most current images will automatically display, however, older images can be obtained by moving the slider at the lower portion of the screen backwards. Data is available from the 8th of May 2012 onwards. Navigation around the map is simple and follows the same generic controls as most online maps such as Google Maps. Layer selection is completed through the second tab on the left hand side control panel.

Once the user has selected the appropriate layers and area a 'snapshot' can be taken using the third button in the top right corner of the screen. The screen will then show a highlighted area of the map, which can be adjusted along with other settings such as resolution and format. Typically, the highest resolution possible would be appropriate but, depending on file size, a higher resolution may be needed. Resolution ranges from 250 metres to 10 kilometres. There are four formats that can be used; JPEG, PNG, GeoTIFF and KMZ.

JPEG and PNG are both simple image files and are fairly interchangeable. JPEG typically offer lower file sizes but at the loss of some quality to the PNG. A TIFF image is a more flexible image format that allows additional information to be included within the image file. The GeoTIFF, more specifically,

> *"have geographic (or cartographic) data embedded as tags within the TIFF file. The geographic data can then be used to position the image in the correct location and geometry on the screen of a geographic information display"* (Ruth, M 2011).

Finally, the KMZ file is a zipped KML file, which *"can contain placemarks featuring a custom name; the latitudinal and longitudinal coordinates for the location, and 3D model data."* (Techtarget, 2010) These files were specifically developed for use with the Earth Viewer software that became Google Earth.

4.2 MODIS applications for natural events

4.2.1 Literature relating to the use of MODIS for fire and volcanic events

Fire has been a necessity in human evolution. Initially, it provided us with the ability to cook our food, warmth and protection. It was necessary in countless social and technological advancements and is needed to continue the existence of our modern society. For this to be possible it requires management and control of the potential negative aspects of fire. Fire rapidly oxidises any potential fuel source and can emit dangerous particulates and gaseous pollutants. Burns, smoke inhalation and poisonous gases pose significant risk to human life. The dangers associated with being in close proximity to fire often make monitoring and analysis difficult.

As a result, *"remote sensing provides a powerful means of fire monitoring and disaster mitigation"* (Ichoku, C. et al, 2004). Justice et al (2002) outlined the MODIS fire products that were being developed that included an *"active location of burning fires and a burned area product to give the extent of burn scars over time"*. These products were *"designed to provide information for both global change science and practical applications"*(Justice &Korontzi,2001), (Kaufman et al., 1998) and (Kaufman et al., 1998). The active fire product can be seen in action in the fire and thermal anomalies layer in the worldview utility. An example of this was shown earlier in Figure 12.

Roy et al (2005) confirms the algorithm used to define the *"MODIS active fire product has been refined several times"* (Giglio et al., 2003, Justice et al., 2002b and Kaufman et al., 1998) and that a *"complementary MODIS algorithm defined to map fire-affected area has been developed and demonstrated in southern Africa"* (Roy, 2003 and Roy et al., 2002b). Roy, et al's (2005) *"global algorithm was implemented in the MODIS land production system as part of the standard MODIS land product suite"* (Justice et al., 2002b) and *"international collaborations are being made with* *regional networks of fire scientists and product users through the GOFC/GOLD program and the CEOS Land Product Validation Working group"*(Justice et al., 2003 and Morisette et al., 2002)

These programs are endorsed by NASA, utilizing the LANCE near real-time MODIS imagery which is also integrated into Worldview. The following list and details are provided by NASA:

- "*Global Fire Information Management System (GFIMS) - GFIMS is an operational version of FIRMS running at the United Nations Food and Agriculture Organization (UN FAO) where it complements the FAO's existing suite of projects that deliver near-real time information to ongoing monitoring and emergency projects, to other UN organizations as well as providing information to the general public.*
- *Global Observation of Forest and Land Cover Dynamics (GOFC-GOLD) - The GOFC/GOLD-Fire Mapping and Monitoring Theme is a project of the Global Terrestrial Observing System (GTOS) program, aimed at refining and articulating the international observation requirements and making the best possible use of fire products from the existing and future satellite observing systems, for fire management, policy decision-making and global change research.*
- *UN Global Fire Monitoring Center also provides MODIS-based fire data for the international fire community."* (NASA, 2015)

Similar to fire activity, volcanic activity is also heavily monitored through the MODIS satellites. Wright et al. (2002) outlined the *"robustness of MODIS as a hotspot detection tool for a wide range of eruptive styles at both permanently and sporadically erupting volcanoes"*. It identified that MODIS was an *"ideal source of data for automatically detecting and* *monitoring high-temperature volcanic thermal anomalies"*. This was reiterated by Noguchi et al. (2011) who agreed that *"MODIS is considered one of the best tools for monitoring volcanic activities"* (Wright et al., 2002 and Rothery et al., 2005).

Three static utility layers are available in Worldview that relate to volcanic activity. They show, geographically, the frequency and distribution of volcanic hazards (1980 - 2000), mortality risk and economic risk. This information is provided by the Socioeconomic Data and Application Centre (SEDAC). NASA (2015) also provide a list of potentially useful data sets for fires. They are:

- *"MODIS Fire and Thermal Anomalies (day and night)*
- *MODIS Corrected Reflectance True Color and Bands 7-2-1*
- *Aerosol Optical Depth:*
- *Land Surface Temperature (day and night)"* (NASA, 2015)

4.2.2 Literature relating to the use of MODIS for flood and storm events

Large storms and flooding often causes damage to buildings and property. During the immediate event, cloud coverage has an extensive impact on satellite imagery. This allows for extensive coverage of storm events, particularly cyclones or hurricanes but also hides much of what is occurring beneath the clouds. Satellite imagery is already well established in the media when monitoring storms.

Media weather reports typically show low-resolution satellite imagery within 1 - 2 hours of being taken. The Australian Bureau of Meteorology, for example, provides the image shown in Figure 23, which is supplied from the Japan Meteorological Agency and has been overlayed with Blue Marble surface imagery from NASA.

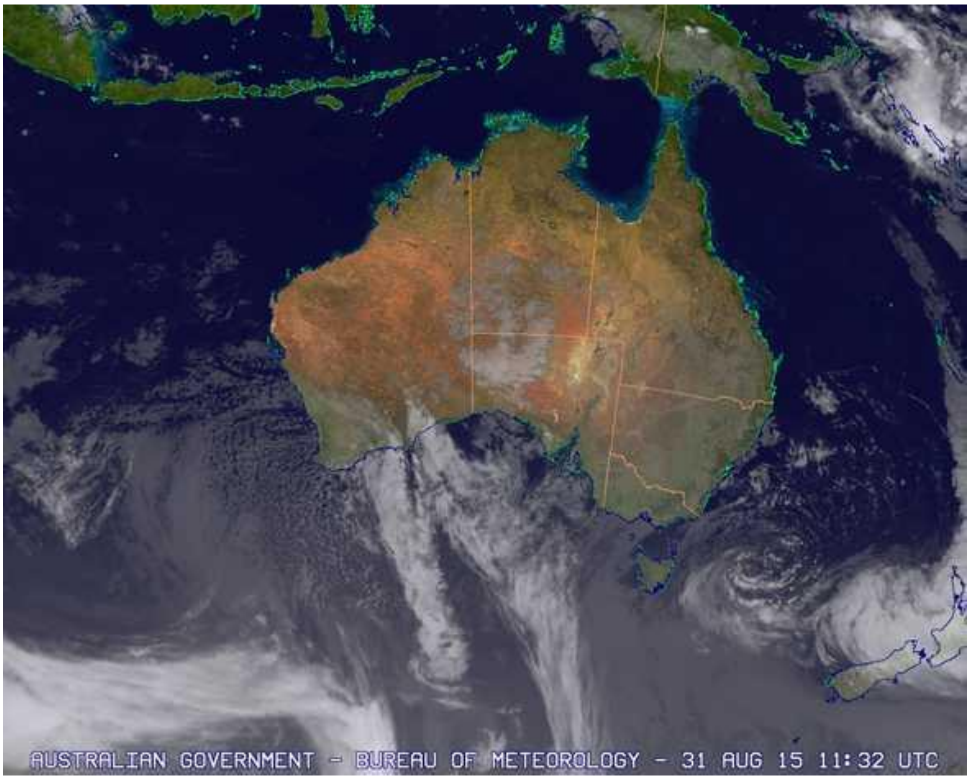


Figure 4.5: Satellite image from Australian Bureau of Meteorology (Australian Bureau of Meteorology, 2015)

Despite this, MODIS imagery would provide an improved image than the typical imagery used. MODIS imagery is higher resolution and can be focused on particular areas of interest. NASA currently uses MODIS data to *"revise or confirm 24-hour forecasts related to weather systems approaching the land from the oceans"* (NASA, 2015). NASA (2015) provides a list of potentially useful data sets for severe storms. They are:

- *"MODIS Water Vapor (day and night)*
- *Cloud Top Temperature (day and night)*
- *Cloud Top Pressure (day and night)."* (NASA, 2015)

Wei, M et al. (2010) and Min, A (2012) researched the relationships between storm structure and these layers. Min, A (2012) used MODIS utility layers to distinguish between cloud height and temperature to accurately determine the centre of a cyclone. Knowing the centre point of a storm assists in the prediction of the storm's scale and path, which if presented to authorities and the public, can give warning and allow time for preparation. Wei, M (2010) results reiterate this by concluding *"remote sensing information plays the valuable role to get the prediction message ahead of severe weather."*

Similar to the volcanic hazards, cyclone and flood hazards also have three static utility layers each that relate to flood and cyclonic hazards. They can show, geographically, the frequency and distribution of activity (1980 - 2000), mortality risk and economic risk. This information is provided by the Socioeconomic Data and Application Centre (SEDAC).

With regard to flooding, Perera (2012) identifies that '*in most of the cases, satellite images of flood incidents are fully covered with clouds'*. However, it states that 'w*hen the flood is prolonged, it's possible to obtain clearer images to show extent of flooded area, enabling to display first-hand information taken from space'.* (Perera, 2012)

Since its launch in 1999, MODIS satellite imagery has been analysed extensively by NASA and the Dartmouth Flood Observatory (DFO). According to Kwak et al. (2014) satellite images have a *"significant potential to predict the time, place and scale of a flood event, and can be very useful in emergency response efforts."*

Perera (2012) confirms that *"semi-real-time satellite images can be a very effective addition for media contents"* (USGS, 2011; Altan at el, 2010; Nakya et al, 2007, Perera & Pathirana, 2006). NASA (2015) themselves state that:

> *"mapping floodwater extent for active floods is critical for local and regional officials and for disaster relief organizations that need to ascertain where to focus their efforts."*(NASA, 2015)

which is reiterated by Martinis et al. (2013) stating:

"over the last decade, the utility of medium-resolution optical data, such as MODIS for inundation mapping and monitoring, has been demonstrated in numerous flood events by the work of the Dartmouth Flood Observatory."(Martinis et al., 2013)

This DFO program is described by NASA as:

- "*NRT Global MODIS Flood Mapping - NASA Goddard's Office of Applied Science (OAS) is working to operationalize near real-time global flood mapping using NRT MODIS data provided through LANCE. This work builds on the long-time expertise and efforts of the Dartmouth Flood Observatory (DFO) to map floodwater extent in detail for active floods. DFO provides additional detail, additional products, and archives of historical flood maps. The maps generated are available to governments and relief organizations. DFO also compiles yearly catalogs, maps, and images of river floods from 1985 to the present, primarily for researchers."* (NASA, 2015)

The potentially useful data sets recommended by NASA (2015) for flood events are:

- *"MODIS Corrected Reflectance True Color and Bands 7-2-1*
- *MODIS Land Surface Reflectance Bands 1-2-1*
- *AIRS precipitation (day and night)."* (NASA, 2015)

Much of the information required by local and regional officials and disaster relief can also be utilised by the media and presented to the public to assist in the event of a flood disaster. By presenting this information in the mass media Perera and Pathirana (2006) believe *"a positive boost can be expected in the field of flood relief operations and disaster mitigation efforts"*.

4.2.3 Literature relating to the use of MODIS for earthquakes and tsunamis

Due to the nature of earthquakes and tsunamis, there is less potential to utilize satellite imagery. Both tend to occur rapidly so satellite coverage is unlikely during the immediate event. However, it is, still important to have access to near real time satellite imagery for rapid analysis after the event.

One of the major after effects of earthquakes is assessing areas where there is a potential for further destruction coinciding with the inevitable aftershocks. Landslides, in particular have had a devastating effect in recent earthquakes. Yang, W. et al. (2013) acknowledges that *"research has confirmed the necessity of high-resolution satellite images in landslides identification"* which confirms the findings by Zhang, W. et al. (2010). Both reach primarily, the same conclusion that the semi-real time aspect of MODIS images make it an ideal source for preliminary information until high resolution observations are available.

Tsunamis are another potential after effect of an earthquake. Figure 4.6 shows MODIS imagery before and after the 2004 'Boxing Day' Tsunami that devastated Indonesia, Sri Lanka and the surrounding regions. The lower section of the image clearly shows heavy vegetation to the coastline taken on December 17. After the tsunami hits, a brown border runs along the coast, sometimes up to 3 kilometres deep. This brown border is

> *"could be deposited sand, or perhaps exposed soil that was stripped bare of vegetation when the large waves rushed ashore and then raced away. Another possibility is that parts of the coastline may have sunk as the sea floor near the plate boundary rose."* (NASA, 2007)

Belward, A. S. et al. (2007) found that:

> *"moderate resolution satellite imagery can provide rapid assessments of severe damage to land resources (though not cover type), as well as confirmation of non-affected areas, over very large geographical regions in the aftermath of natural disasters such as the tsunami."*(Belward et al, 2007)

Layers that have a potential use in vegetation analysis and flooding would most likely be the most effective for earthquake and tsunami events. These layers would be:

- *"MODIS Corrected Reflectance True Color and Bands 7-2-1*
- *MODIS Land Surface Reflectance Bands 1-2-1*
- *AIRS precipitation (day and night).*
- *MODIS Corrected Reflectance True Color*
- *Land Surface Reflectance Bands 1-2-1 and 1-4-3*
- *MODIS Snow Cover*
- *Land Surface Temperature (day and night)*
- *MODIS Vegetation Indices - Normalized Difference Vegetation Index and Enhanced Vegetation Index."* (NASA, 2015)

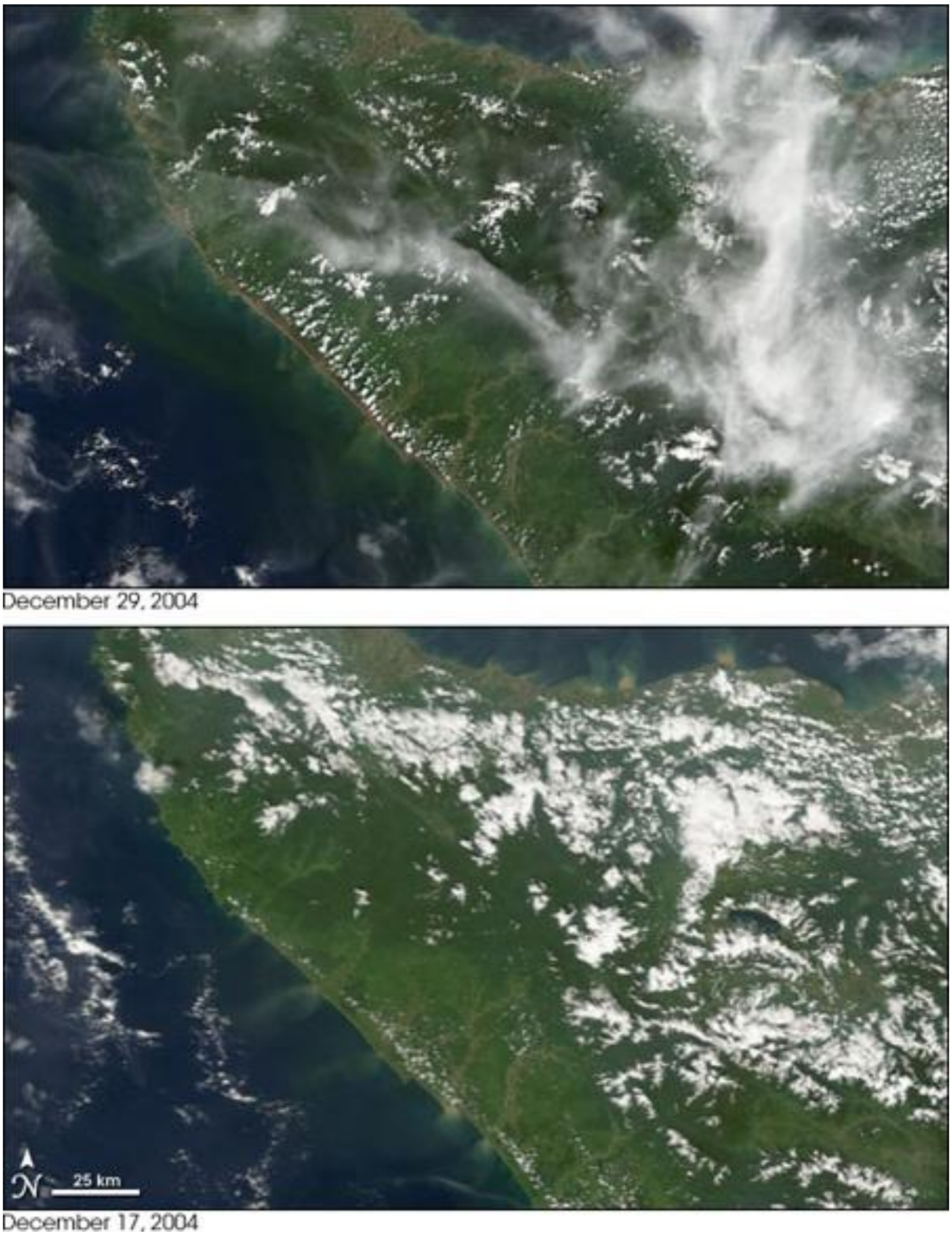


Figure 4.6: Tsunami Damage in Northern Sumatra. MODIS images of the Aceh province of northern Sumatra, Indonesia, on December 17, 2004, before the quake (bottom), and on December 29, 2004 (top), three days after the catastrophe. (NASA, 2005)

4.2.4 Literature relating to the use of MODIS for drought

Due to climate change, there has been an *"increased frequency and severity of drought episodes"* (Salinger et al., 2000).

> *"[Drought] impacts on both surface and groundwater resources, leading to reductions in water supply and quality, reduced*

ecosystem productivity, diminished hydro-electric power generation, disturbed riparian and wetland habitats, and reduced opportunities for some recreation activities" (Riebsame et al., 1991).

Unlike most natural disasters, drought tends to occur over a much longer period of time. This could make it seem that, in this situation, the semi-real time aspect of MODIS is irrelevant. Despite this, MODIS imagery has been heavily utilised in drought analysis and the need for real-time monitoring is outlined by Yan, N et al. (2011) stating that *"timely reporting of drought is important decision information for drought disaster prevention and mitigation."*

Jiang et al. (2013) outlines that:

> *"Soil moisture and vegetation growth are important indicators of drought events...Over past few decades, satellite-derived vegetation indices have been widely used in crop monitoring(Rasmussen 1998; Corresponding et al.2004a), biosphere modelling (Xiao et al.2005), and drought monitoring (Zarco-Tejada et al.2003; Hwang et al.2008)."*(Jiang et al, 2013)

NASA confirms that *"agro-climatic monitoring programs and global food security risks are monitored using MODIS NRT data from LANCE"* (NASA, 2015). One system that utilises MODIS for drought monitoring is the USAID Famine Early Warning Systems Network (FEWS NET) which provides daily reports on potential droughts and food shortages.

As with previous hazards, there are three static utility layers that relate to droughts. They can show, geographically, the frequency and distribution of drought hazards (1980 - 2000), mortality risk and economic risk. This information is provided by the Socioeconomic Data and Application Centre (SEDAC). NASA also provides a list of potentially useful data sets. For droughts:

- *"MODIS Corrected Reflectance True Color and Bands 7-2-1*
- *MODIS Land Surface Reflectance bands 1-2-1*
- *MODIS Snow Cover*
- *AIRS precipitation (day and night)."* (NASA, 2015)

For vegetation:

- *"MODIS Corrected Reflectance True Color*
- *Land Surface Reflectance Bands 1-2-1 and 1-4-3*
- *MODIS Snow Cover*
- *Land Surface Temperature (day and night)*
- *MODIS Vegetation Indices - Normalized Difference Vegetation Index and Enhanced Vegetation Index."* (NASA, 2015)

4.3Application to media-GIS content production

The previous sections illustrate how MODIS imagery has become an essential tool in the event of a natural disaster. There is extensive evidence presented in the literature to support this. The difficulty arises in translating the scientific research and analysis techniques to the production of media-GIS contents. A large proportion of the existing research depends on the use of formulas or complex analysis that is not appropriate for the creation of media-GIS contents but is useful in establishing MODIS as an appropriate data source. It also provides valuable insight to best utilize the scientific overlays and other layers available through Worldview.

The task then, is to relate this back to what was established in Chapter 3. It was outlined that media-GIS contents need to focus primarily on data presentation with some underlying data analysis and that the most emphasis should be placed on image variables such as "*size, value, texture, hue, orientation*, and *shape*." (Kraak, 1999). Contents also need to adhere to the five basic qualities of accuracy, high aesthetic quality, speed, low cost and reusability.

Maintaining quality starts at the initial capture of the image. Depending on image size the highest possible resolution should be used. Worldview has a maximum raw size of 250mb. The image shown in Figure 4.7represents the maximum raw data size at 250m resolution. The size of the image is 10561 x 8273 pixels which represents well over 3 million square kilometres. At this scale a single image could be produced to show approximately half of Australia's total land mass. Downloading as a jpeg took less than 30 seconds and the file size was reduced to 7.3mb. KMZ took approximately 2 minutes with a file size of 83mb and GeoTIFF took approximately 4 minutes with a file size of 124mb. For slower internet speeds the download time for this could be a lot higher but it is unlikely an image of this scale and resolution is necessary.

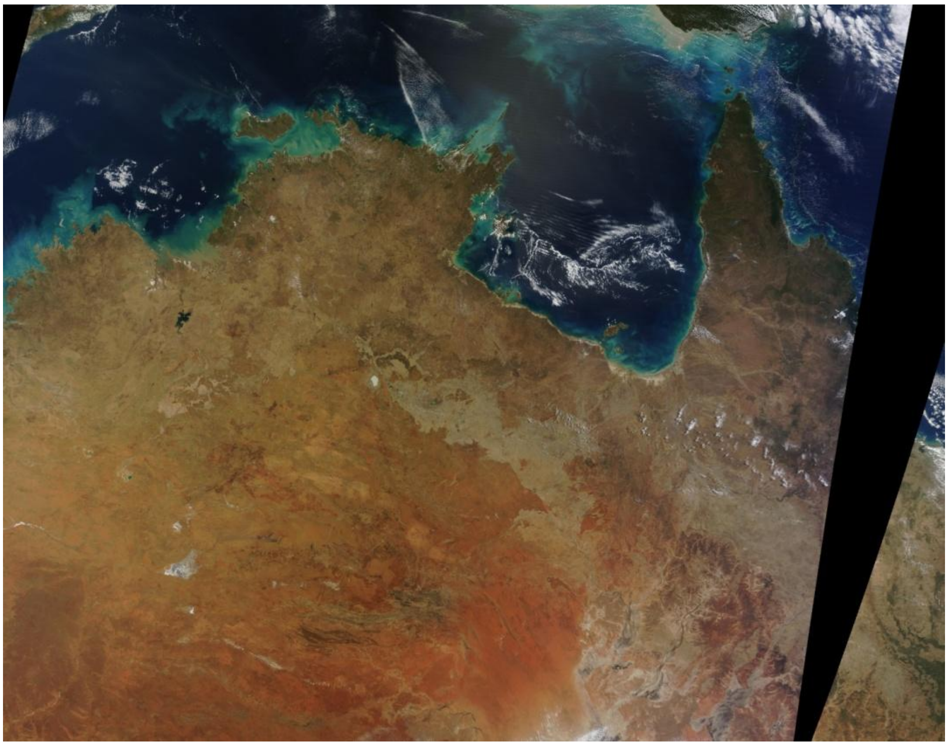


Figure 4.7: Maximum raw data size available through worldview. Image size is 10561 x 8273 pixels. (NASA Worldview, 2015)

As a general rule, the less an image is edited the higher the quality will remain. Resizing, orientating and other alteration can all lead to drops in image quality. A beneficial aspect of Worldview is that much of the editing can be completed prior to download. Figure 26 shows how overlays and other layers can be edited online. Practically all the image variables outlined by Kraak (1999) can be edited this way.

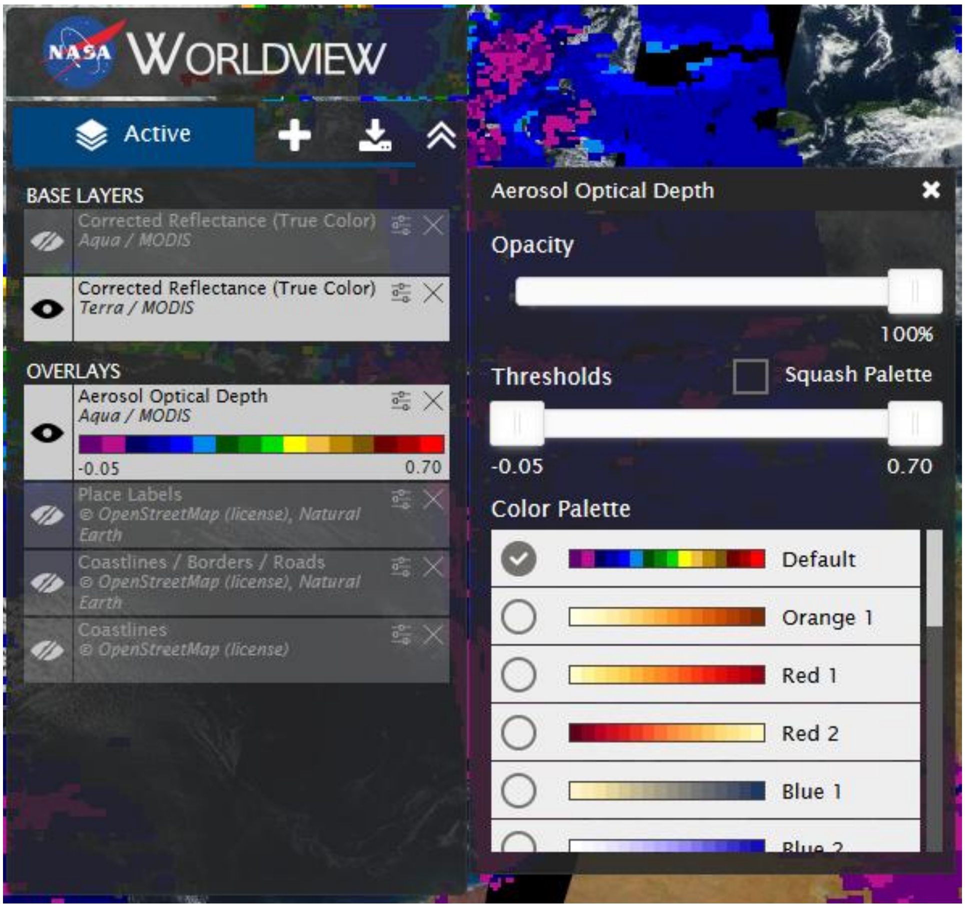


Figure 4.8: Editing of layers can be done through the Worldview menu. (NASA Worldview, 2015)

This being the case it is important to identify what aspects need to be edited after the image is acquired. Referring back to the image in Figure 25 there is a lot of information missing that could be important. All images should have a title, scale, date and a map inset showing the location of the image in a broader map as a minimum.

Geographic features such as towns and roads should be incorporated to assist the viewer's understanding of the image. This information can all be obtained by overlaying the image with GIS data that is freely available through Google Earth and other GIS programs.

Perera and Tateishi (2014) have outlined their method of creating media-GIS content. They use Photoshop, Google Earth and ArcMap software which is acquired in both the geoTIFF and KMZ formats. The *"TIFF image* *is used in graphic content and the corresponding KMZ file is used to display the same Tiff image on Google Earth."* (Perera and Tateishi, 2014)

Image editing was completed in Photoshop while GIS information was collected using Google Earth high-resolution images. Finally, *"both case studies were clipped in ArcMap and converted into KML (Keyhole Mark-up Language) format."* (Perera and Tateishi, 2014)

> *"GIS data extracted from Google Earth and graphical components such as text writing, arrows, polygons to show areas, and etc., were added in Photoshop. After the Photoshop editing, the image map is ready for WEB and print media applications.*(Perera and Tateishi, 2014)

With Worldview, the image can be downloaded directly in KMZ (zipped KML) format. This file can then be opened through Google Earth and will automatically be orientated to the correct geographic position. The image will overlay the original satellite imagery but won't cover the GIS information. This means that annotations, polygons and lines available through Google Earth can all be overlaid over the image. Additional GIS information can also be shown by adding extra KML files, most typically available from government agencies. Google Earth also allows for place marks, polygons and paths to be added to provide additional information.

This method streamlines the process discussed by Perera and Tateishi by removing the need to use ArcMap, or other GIS software, to combine the GIS information from Google Earth with MODIS imagery. Once the image is prepared with all necessary GIS information the image can be copied from Google Earth and imported directly in to an image-editing program such as Adobe Photoshop.

As the GIS data was already applied in Google Earth it does not need to be re-applied in Photoshop. As mentioned previously all images should have a title, scale, date and a map inset as a minimum. This can easily be added in Photoshop along with any additional text, arrows, etc that might be required.

With this, the image should be complete and is ready for use in media contents. Photoshop can export the image in many different formats. At this stage, a simple JPEG image should be sufficient for most uses and the quality can be adjusted depending on the output device i.e. TV, online, mobile, etc. A guide has been produced in Appendix F which provides a

The following chapter includes three case studies to illustrate this method and provide more detailed analysis of the media-GIS contents produced.

4.3.1 Mobile Content

It is also important to note, as was outlined by Perera (2012) that mobile content, for use with mobile devices, requires:

> *"the maximum image size of 320 pixels by 240 pixels which is the recommended size for large MMS (multimedia messaging service) video"* (Mobile marketing association, 2009) (Perera, 2012).

In addition:

> *"Mobile media demands graphic contents with small files size, which should be less than 100k to accommodate various capabilities in mobile phones and broader audience."*(Perera, 2012).

Modifying or reproducing contents to accommodate these restrictions can be completed with minimal time or effort.

4.4 Conclusion

MODIS imagery has been well established as an effective source of satellite imagery for many aspects of disaster monitoring and analysis. Whilst it lacks high-resolution imagery available from some other sources, it is substantially easier and faster to obtain than other options. Through the resources provided by NASA and EOSDIS, MODIS imagery is easily able to adhere to the five aspects highlighted as being important to the production of media-GIS contents.

The Worldview utility offers a free, simple to use service that allows users to produce GIS contents with minimal needs for editing or manipulation. This, in turn, removes the potential for the incorrect presentation of information that can have damaging consequences for the viewer. The process of preparing the GIS content has been simplified through the availability of a geographically aligned KMZ file format.

In addition to this, the volume of data that can be accessed through Worldview is substantial with numerous image bands and scientific overlays available to present alternative information to the viewer. Perera and Tateishi (2014) describe this well, stating:

> *"When the content is fresh, graphically attractive, and geographically accurate, viewers obtain a better understanding about nature of the disaster which may increase the public involvements in disaster mitigation efforts."*(Perera and Tateishi, 2014)

MODIS imagery, edited with Photoshop and Google Earth provide all the tools necessary to produce fresh, graphically and geographically accurate images.

Chapter 5: Case Studies

This chapter will analyse the application of the research outlined in Chapter 3 by using 3 case studies. The three case studies presented in this report are Tropical Cyclone Ita, which occurred in April 2014, the Adelaide wildfires, which occurred in January 2015 and the India-Pakistan Floods of September 2014. It was important that these events were recent to ensure that the EOSDIS worldview utility was relevant as imagery is only available as far back as May 2012.

Three very different disasters were chosen as case studies to assess the media-GIS content produced over a variety of events. One major difference is that the first and last case studies are large-scale weather events. They occur over a large area and, as such, the imagery is at a large scale. The second case study is a much smaller scale and focuses on a specific area. This should help in illustrating the flexibility of the MODIS satellite imagery and provide evidence to support its use in the production of media-GIS contents.

5.1 Case Study 1: Cyclone Ita

5.1.1 Introduction

Tropical cyclone Ita was a substantial storm system that affected the northeast Queensland coast, New Zealand and the island nations surrounding the Coral Sea. The weather event occurred between April 2nd to April 18th, 2014. It has been the most substantial cyclonic event to affect Australia thus far since the inception of the Worldview utility in 2012.

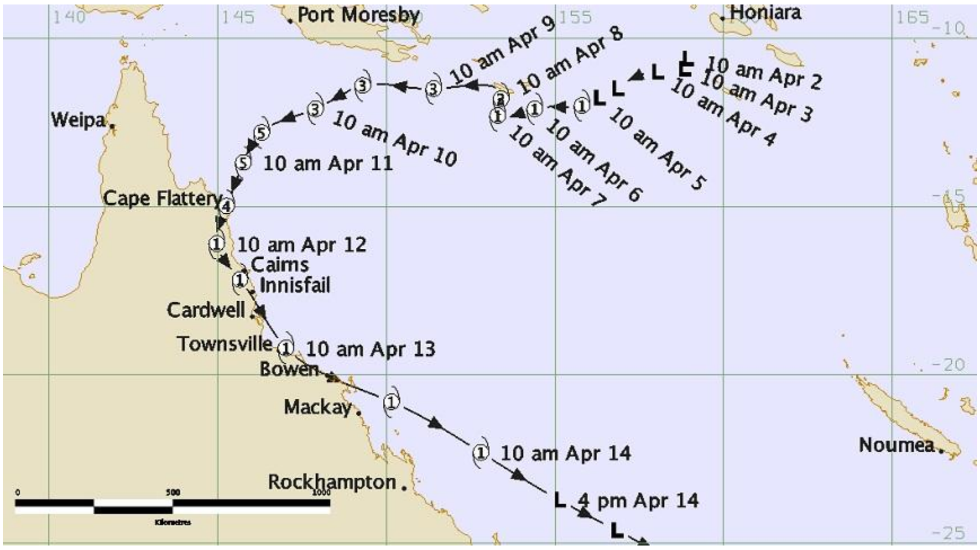


Figure 5.1: Provided by the Australian Bureau of Meteorology, this image depicts the formation and path of the system. (Australian Bureau of Meteorology, 2014)

5.1.2 Analysis of Disaster

On April 2nd, 2014, Tropical Cyclone Ita began forming as a tropical low southwest of the Solomon Islands. While the system intensified it brought heavy rainfall to the Solomon Islands that resulted in a significant flash flooding and was declared a disaster area by the UNOCHA (United Nations Office for the Coordination of Humanitarian Affairs) on April 4th.

According to UNOCHA (2014), *"At least 22 people were killed and over 50,000 affected – almost 10 per cent of the country's total population."*The Government of Solomon Islands later released the 'Rapid Assessment of Macro and Sectoral Impacts of Flash Floods in the Solomon Islands April 2014' report which estimated the economic impact of the floods to be SI$787.3 million (US107.8million) which was equivalent to 9.2% of the country's gross domestic product (GDP).

It stated:

> *"the sectors that sustained the highest level of damage were housing and transport; these accounted for 56% and 23% of damage, respectively. In contrast, the greatest economic loss is*

expected in the mining sector (50%) and the agriculture sector (31%.)"(Government of Solomon Islands, 2014).

Figure 5.2 houses damaged along the banks of the flooded Mataniko River in Honiara.(UNOCHA, Doyle, I., 2014)

Over the following days the tropical low strengthened and was officially classified as a tropical cyclone on April 5th. During this time the storm was positioned close to Papua New Guinea and resulted in the destruction of over a thousand homes and local food supplies.

The cyclone then proceeded to strengthen as it travelled towards the northeast Queensland coast. Ita reached category 5, the strongest category on the Australian scale, by April 11th. Thankfully, Ita weakened to a category 4 prior to landfall that occurred in a rural region with a low population density. This led to no serious injuries or fatalities in Australia.

Despite this, high winds and heavy rainfall resulted in widespread destruction and flooding.

The AON Benfield 'April 2014 Global Catastrophe Recap analysis of the economic impacts of Cyclone Ita found *"that only a small number of homes had sustained wind and flood damage"*
but proceeded to state that:

> *"the agricultural sector was heavily affected as crop losses were recorded from Mossman through the Herbert and Burdekin valleys. Total economic losses –almost entirely to the agricultural sector –were estimated at up to AUD1.1 billion (USD 1.0billion)." (AON Benfield, 2014)*

Cyclone Ita continued to move south along the Queensland coastline dumping heavy rainfall and causing significant flooding until the 13th of April when it changed direction to a south-easterly direction before transitioning back to a tropical low. Heavy rain continued as the low passed over New Zealand causing further flooding. According to the New Zealand Historic Weather Events Catalogue a further $55 million in damages were recorded.

In the end, Tropical Cyclone Ita directly caused the deaths of 22 people in the Solomon Islands and caused in excess of a billion dollars worth of damages to Australia and neighbouring countries. In Australia, the damage to the public was minimal but the economic impact was substantial.

5.1.3 Creation of Media-GIS content

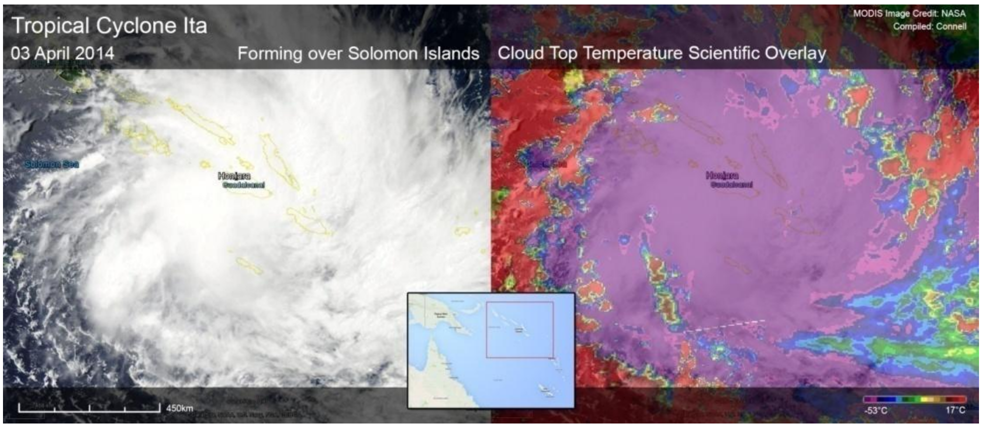


Figure 5.3: Media-GIS content showing true-colour image and cloud top temperature scientific overlay during the storm's formation over the Solomon Islands on 03 April 2014.

The media-GIS contents produced for Tropical Cyclone Ita are shown in Figure 5.3, 5.4, 5.5 and 5.6. All of these contents use true colour satellite data from either satellite depending on the most appropriate overlap. True colour is very suitable for illustrating storms as the white of the cloud is easily recognisable against the darker colours of the ocean and land beneath it.

Varying levels of opacity help to distinguish the thickness of the cloud however the image in Figure 5.5 has also included a scientific overlay from Worldview. The cloud top temperature is shown in a side-by-side image in order to prevent the dense colouration from obscuring the GIS information such as the outlines of the Solomon Islands, which can be seen in yellow.

Cloud top temperatures trend toward *"-45°C for light rain, -47°C for moderate rain and -50°C for heavy rain"* (Hanna, Schultz and Irving, 2008) From this, we can see that heavy rain is expected to be occurring across the majority of the storm.

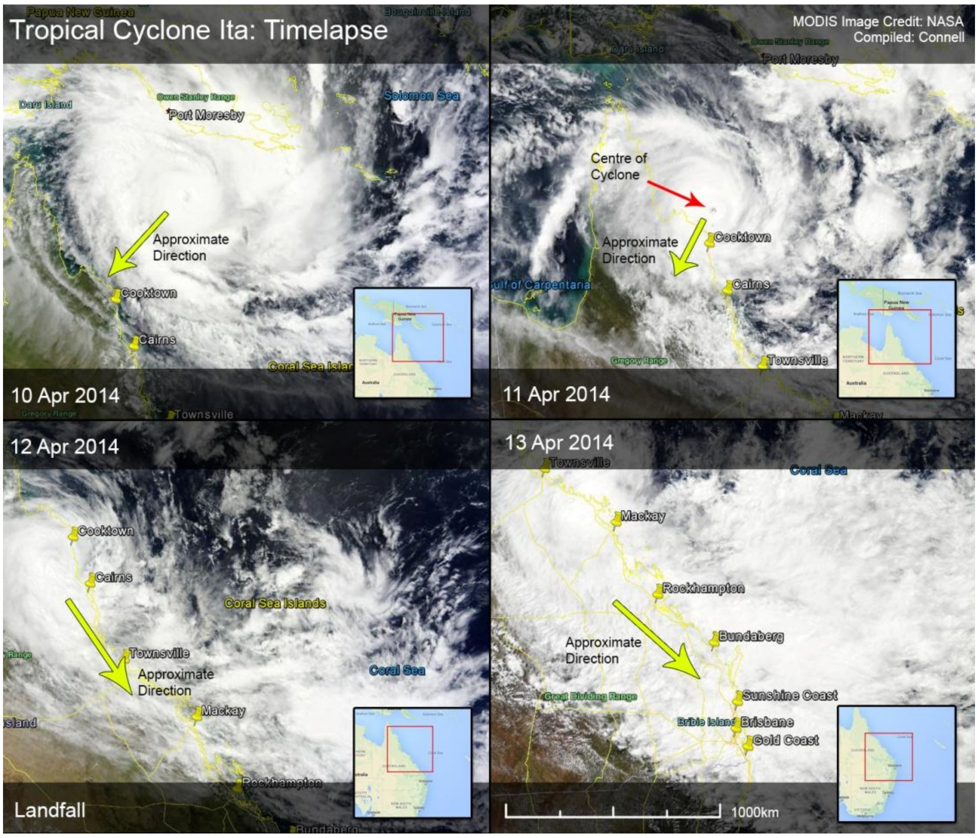


Figure 5.4: Media-GIS content providing true-colour images of the days surrounding landfall in far north Queensland and as the storm tracks south along the coastline. Approximate storm direction has been noted as a yellow arrow.

Figure 5.4 continues the use of multiple images to illustrate the direction of the storm over a 4 day period. This period focuses on the days surrounding the storm's landfall on the northern Queensland coastline. At this scale much of the GIS data is not displayed so additional placemarks denoting major population centres were placed along the path of the storm. Arrows indicating the eye of the storm and approximate direction were added to increase the information provided by the imagery.

During the event a single image could be used as opposed to the four shown depending on availability. For example, on the 12th of April, the first image could be used and, depending on satellite positions, potentially the second image. Irrespective of this, the days preceding this could also be used to provide a different timeline image from the 8th or 9th of April onwards.

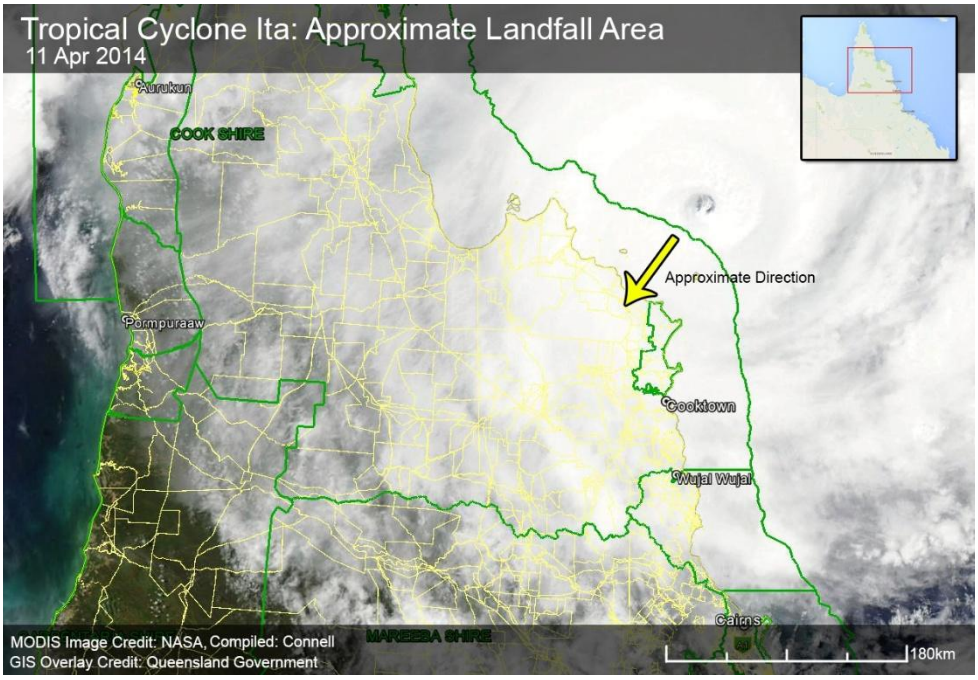


Figure 5.5: Media-GIS content with true-colour MODIS imagery and 'QLD Globe' overlay illustrating the landfall site in relation to property boundaries and government districts.

Figure 5.5 and 5.6 integrates the use of local government GIS data in addition to the GIS data provided in Google Earth. In this instance, it uses the QLD globe KML file, freely provided by the Queensland Government, which can be opened in Google Earth along with the satellite data. The image in figure 5.5 shows government localities and property boundaries.

One of the major contributing factors that minimised the destruction of Ita was the location where it made landfall. The closest population centre was Cooktown, which in itself has only a small population. The majority of properties around the site of the landfall are extremely large which can be seen in the image and represent agriculture and farmland.

The image in figure 5.6 shows a much smaller section of the image directly around the eye of the storm. The approximate direction and centre of the cyclone have again been labelled on the image.

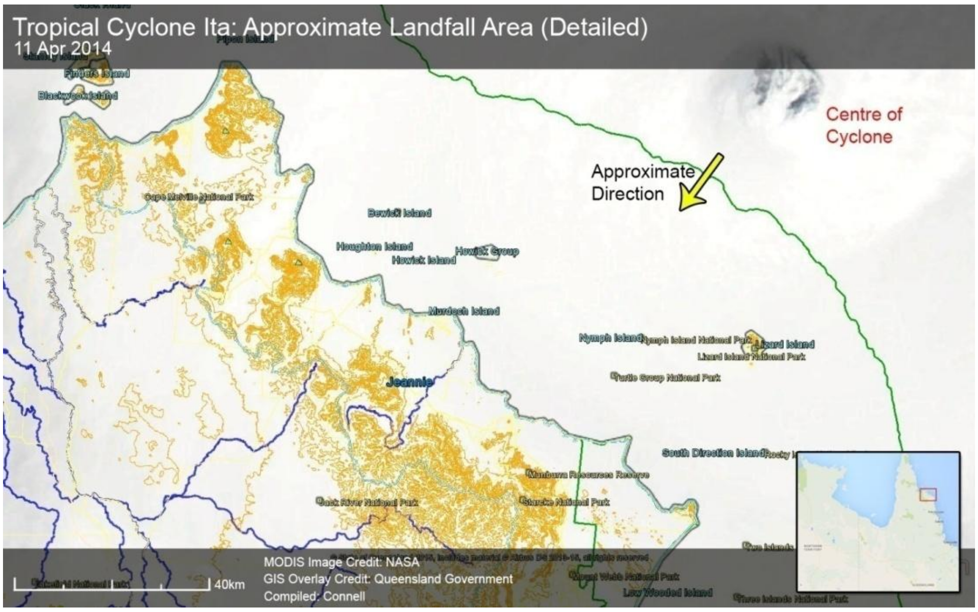


Figure 5.6: Media-GIS content with true-colour MODIS imagery and 'QLD Globe' overlay illustrating the landfall site in relation to property boundaries and government districts.

At this scale the cloud entirely shrouds the area beneath it. All information regarding the land must be provided by GIS data. At this scale, different aspects of the QLD globe KML file become available. All notable landmarks have been given annotations and contour lines and river systems can be shown.

Again, this image provides information of the lack of human population in the area. These 4 media-GIS contents provide valuable information to the public whilst maintaining a high visual appeal.

5.2 Case Study 2: Adelaide Wildfires

5.2.1 Introduction

Earlier this year, wildfires (often referred to as bushfires) were prevalent in South Australia prompting the government to declare a major emergency and ordering an evacuation of a number of locations. One of the most severely affected areas was the Adelaide Hills, which is examined more closely in this case study.

The Adelaide wildfires, when compared with other natural disasters, only caused minor amounts of damage. This case is important to demonstrate the flexibility of MODIS imagery and illustrate that a disaster does not need to cause catastrophic damage or loss of life to warrant the inclusion of media-GIS contents. This should help establish the appropriateness of MODIS imagery regardless of the scale of an event.

Figure 5.7: Damage in the Adelaide hills caused by wildfires in January 2015 (Source: http://www.rt.com/news/219615-australia-wildfires-blaze-south/)

5.2.2 Analysis of Disaster

The Adelaide wildfires initially started in the areas surrounding Adelaide on the 2nd of January 2015 and were extinguished by the 9th of January 2015.

The South Australian Police Force linked cause of the fire to a backyard incinerator in the Sampson Flat region.

Initial reports indicated extreme caution as a mix of high temperatures and adverse weather conditions had the potential to feed the fire towards high population areas in the Adelaide city. The South Australian police commissioner Gary Burns was quoted as saying, "*Residents in the Adelaide Hills are being confronted by a fire which hasn't been seen in the hills since the 1983 bushfires of Ash Wednesday*", an event which took the lives of more than 70 people.

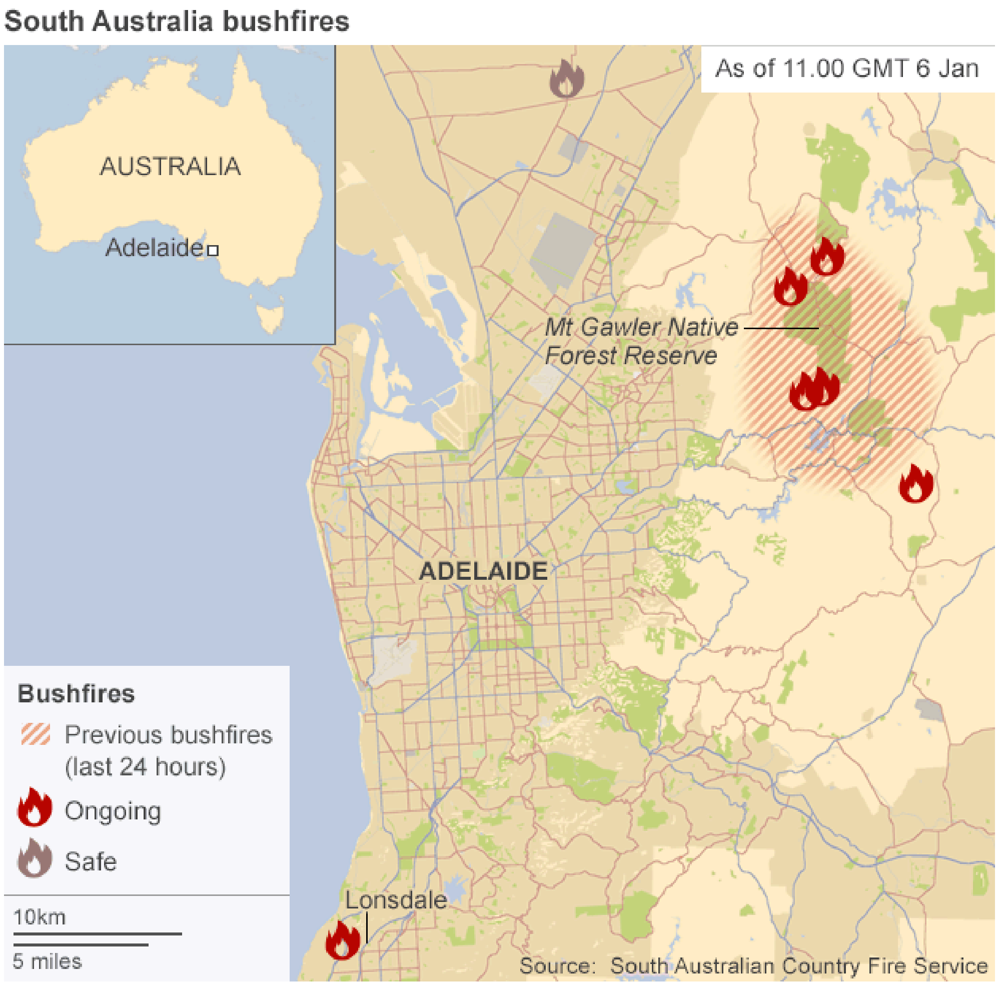


Figure 5.8: Map showing location of bushfires provided by the South Australian Country Fire Service (BBC News, South Australian Country Fire Service, 2015)

The blaze burned over 12,500 hectares of land and destroyed 27 houses and 125 outhouses and sheds. Thousands were displaced from their homes and 134 cases of medical treatment were required to treat fire related injuries. In addition, over a hundred sheep, livestock and other domestic animals were either lost in the blaze or had to be destroyed.

2000 fire-fighters and 14 aircraft were required to take control of the blaze and prevent its spread. South Australian County Fire Service was assisted by favourable weather conditions to contain and extinguish the fire by the 9th of January.

Although weather conditions minimised the effects that occurred as a result of the Adelaide Wildfires and prevented substantial damage from occurring, the resulting destruction caused widespread concern for the entire region and country as a whole. Effective use of media-GIS could have been used to assure the public and provide valuable information.

5.2.3 Creation of Media-GIS content

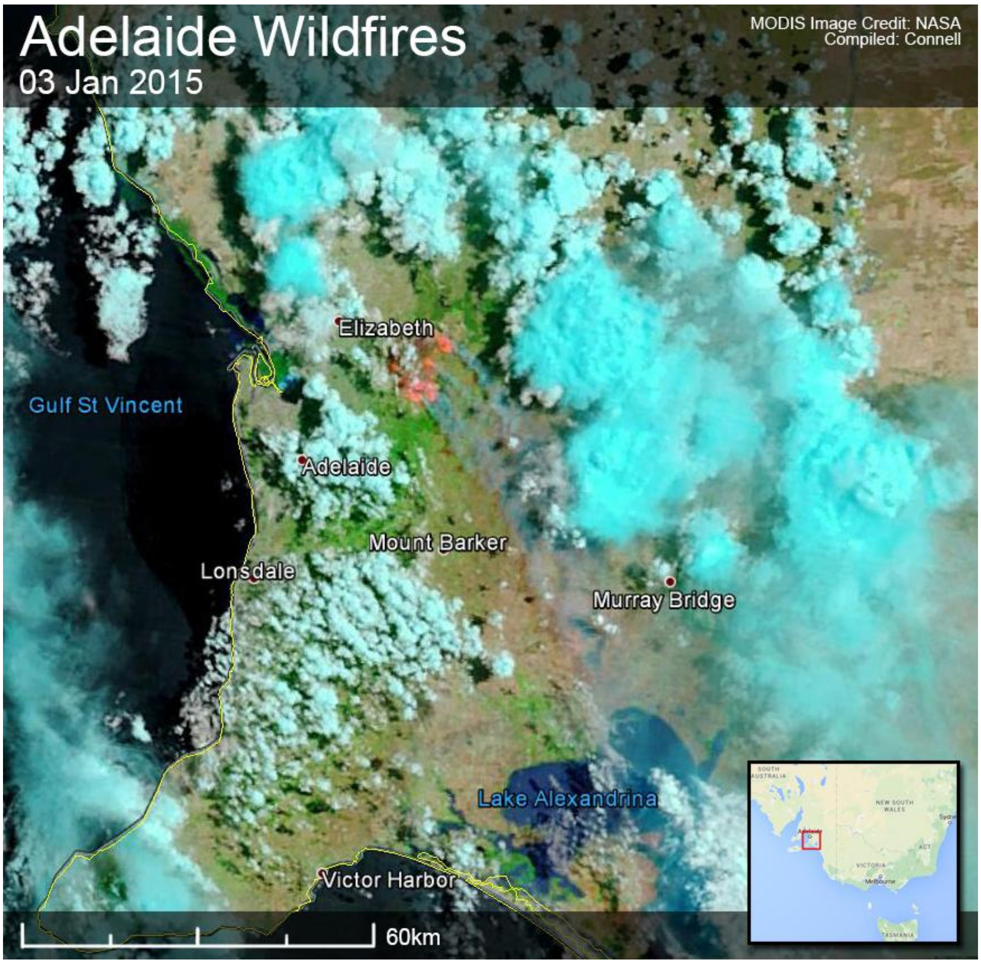


Figure 5.9: Media-GIS content using 'Corrected Reflectance (7-2-1)' MODIS imagery to accentuate fire and burn area colouration.

Media-GIS contents produced for the Adelaide Wildfires are shown in Figure 5.9, 5.10, 5.11 and 5.12. These four images utilize a much wider range of satellite data including multi-spectral imagery and scientific data visualisations. The image in figure 5.9 utilises 'Corrected Reflectance (7-2-1)' data. This only uses the data collected in the 1st, 2nd and 7th bands of the MODIS instrument. This has a major effect on the image as can be seen by the colouration. The white clouds now appear as blue, water is either black or navy and the vegetation appears as a vivid green. The most important aspect however is that the active flames appear in bright red and burnt areas appear as a darker maroon colouration.

GIS data denoting major population areas is shown with Adelaide and Elizabeth clearly shown in close proximity to the blaze. The information this image can provide is extensive. The size, scale and location can all be ascertained along with potential direction using the smoke direction as an indicator.

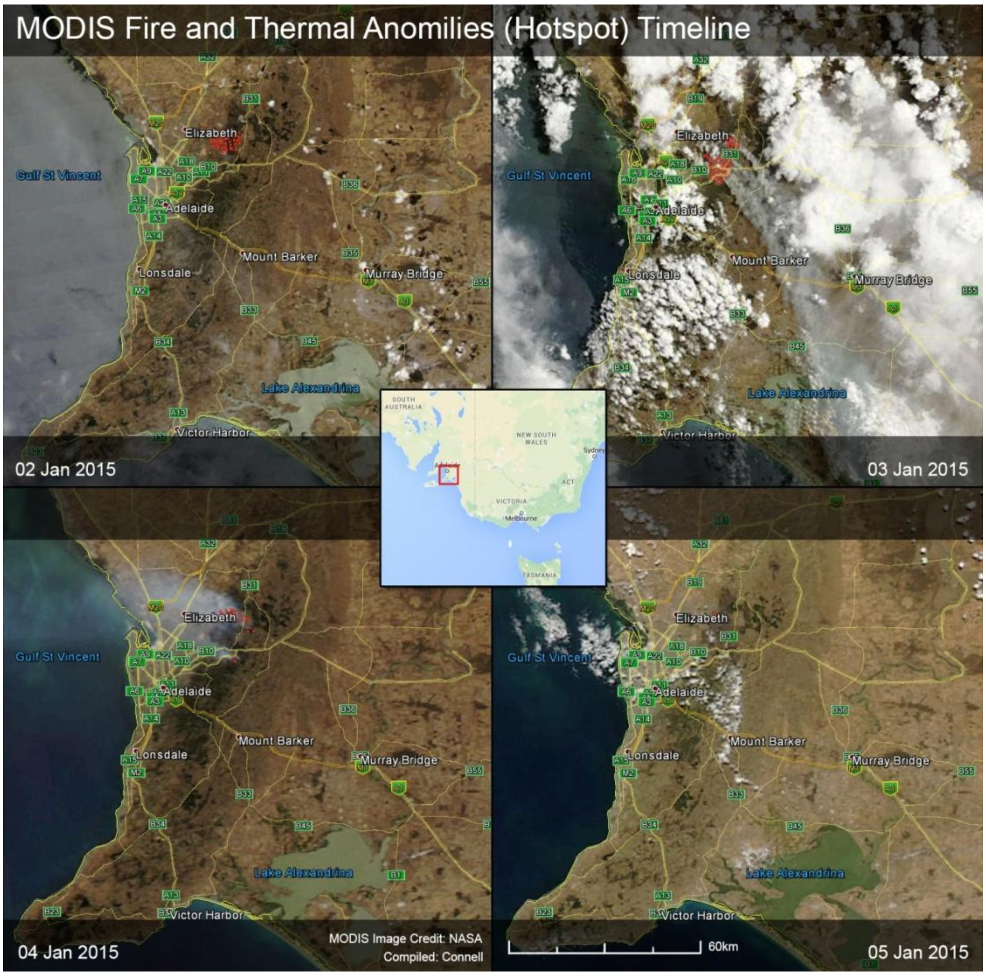


Figure 5.10: Media-GIS content illustrating 'MODIS Fire and Thermal Anomaly' detection on the peak days of the fire's activity. Smoke is clearly visible on the top right and bottom left images signifying a change in wind direction which contributed to the demise of the fire.

Similar to Cyclone Ita, a time line image has been created in Figure 5.10 of the initial start of the blaze to its eventual extinguishment. As with before, any one of these images could be used by itself or in conjunction with other images depending on availability.

This image illustrates the use of the 'Fire and Thermal Anomalies' layer available on Worldview, often referred to as 'Hotspot'. This layer identifies and marks thermal anomalies automatically as was discussed earlier in Section 4.2.1. Other useful information that can be gathered by the comparison of these four images is the change in wind speed and direction, which is shown in the smoke direction and the rain clouds visible on the 3rd of January. It was these two events that aided in the extinguishing of the blaze and mitigate the potential damage.

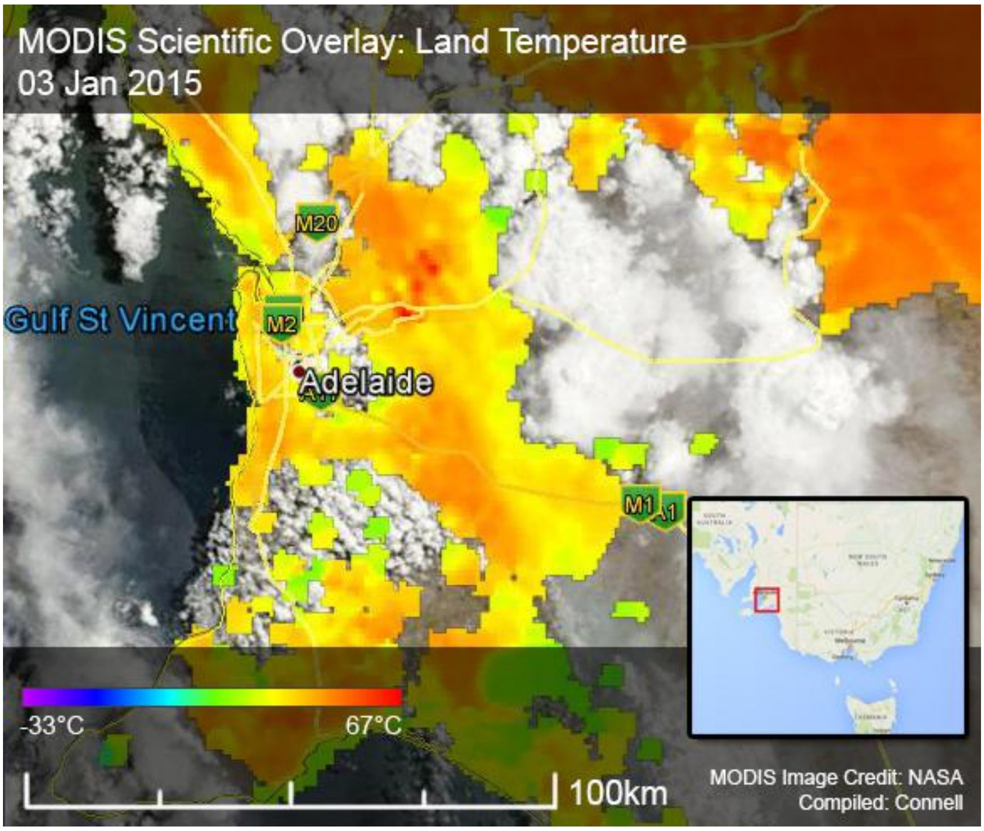


Figure 5.11: Media-GIS content with Land Temperature overlay. Areas with cloud coverage do not display data. The location of the fire can be clearly seen in red.

Figure 5.11 uses another scientific overlay, Land Temperature, to illustrate the location of the blaze through via a different method. A key is provided indicating the approximate temperatures against a colour indicator. This is a simple method of presenting data in an entirely visual format and requires little explanation to comprehend.

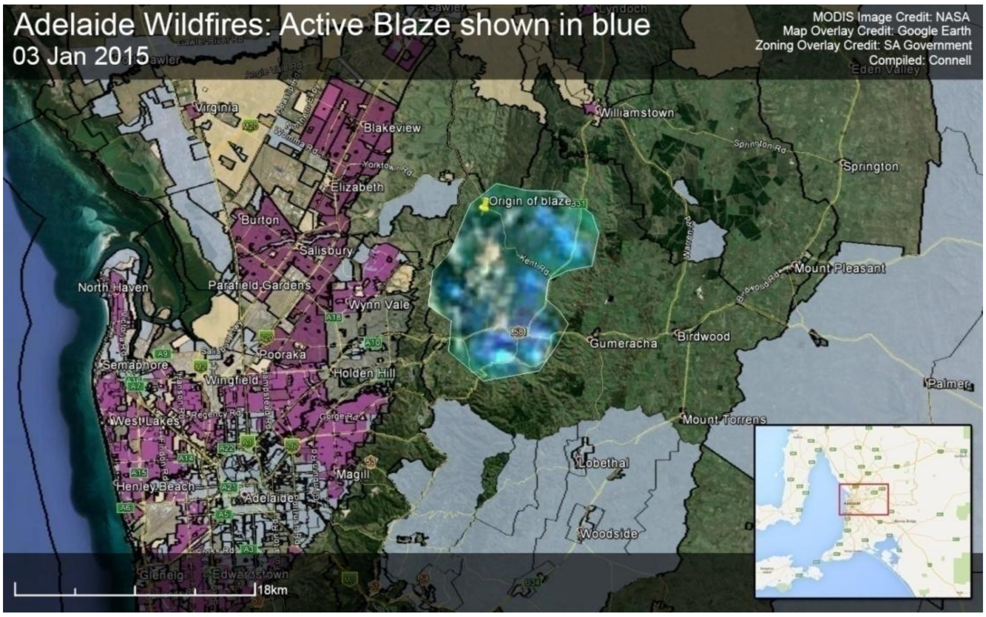


Figure 5.12: Media-GIS content with polygon of MODIS 'Corrected Reflectance (3-6-7)' imagery highlighting flame and burn area in blue overlayed with Adelaide City zoning information to show proximity between city limits and blaze.

Figure 5.12 uses 'Corrected Reflectance (3-6-7)' data. This only uses the data collected in the 3rd, 6th and 7th bands of the MODIS instrument. Instead of red, this shows the blaze in a vivid blue and is simply used in this example to illustrate the potential of other multiband image layers. Similar to the Queensland government, the South Australian government also provide freely available GIS data in the form of KML files. The KML file shown in figure 5.12 is the Adelaide city-zoning overlay. As shown in the image, the distance between the blaze and the outskirts of the Adelaide city zones was only a couple kilometres at most.

A noticeable drawback for this image was the scale. At this scale, the resolution of the MODIS data begins to become a problem. Image clarity is affected once the resolution decreases to values of approximately 50km or less in Google Earth. To rectify this issue the image was cropped around a polygon drawn along extents of the blaze and the high-resolution image background in Google Earth was shown.

5.3 Case Study 3: 2014 India-Pakistan Floods

5.3.1 Introduction

India and its surrounding regions are susceptible to *"the most prominent of the world's monsoon systems"* (Krishnamurti, T. N., 2015). This weather system brings heavy rainfall to the region from June to September each year. Typically, the heaviest rainfall occurs during the months of June and July with more variable and sporadic showers continuing on until September. Pakistan has suffered deadly floods from 2010 to 2014 around the same time each year.

Figure 5.13: Flooding in Srinagar roadways. (Hindustan Times, AFP Photo, 2014)

The 2010 floods, were the largest ever recorded in Pakistan and *"swamped 160,000 square kilometres (62,000 square miles) of land and cost the country nearly $10 billion. Around 1,800 people were killed and 20 million affected."* (NDTV, 2014)

The 2011 floods were less destructive while *"the floods of 2012 killed nearly 600 people and affected 4.6 million, while those in 2013 killed around 300 and affected some 1.5 million."* (NDTV, 2014)

5.3.2 Analysis of Disaster

In September 2014, during the final stage of the monsoon, heavy rainfalls occurred from the 2nd September for several days. The Pakistan Meteorological Department stated that "*during the first eight days in the month of September,"*...the country received..."*113 per cent above normal rainfall. The current September rainfall of Azad Kashmir &Gilgit-Baltistan is second highest September rainfall* (recorded by PMD). (PMD, 2014). This brought about widespread flooding along the Indus, Chenab and Jhelum river systems that flow through Pakistan and Northern India.

As a result of this flooding, an estimated 4065 villages were affected and over 700,000 people had to be evacuated. The National Disaster Management Authority in Pakistan stated that 367 people had been killed while India's death toll mounted to 284. Over 2.5 million people were affected as a result of the floods, which damaged 2.4 million acres of crops and killed over 9000 cattle contributing to billions of dollars in damages.

Figure 5.14: People awaiting rescue in Punjab Province in Pakistan during 2014 India-Pakistan Floods. (Rahat Dar/European Pressphoto Agency, New York Times, 2014)

In 2014, the Jammu and Kashmir, Gilgit-Baltistan and Punjab regions were the worst affected with Multan and Srinagar bearing the worst destruction in Pakistan and India, respectively. The GIS contents illustrate the destruction in these two areas in particular. In Multan, two towns along with 387 villages in the Multan District were inundated with floodwater. Over 268,000 people were affected and approximately 380,000 acres of cropped land was damaged. Srinagar, which has a population of over 900,000, recorded more than 200 deaths and required the evacuation of hundreds of thousands of people when large portions of the city were inundated with floodwater.

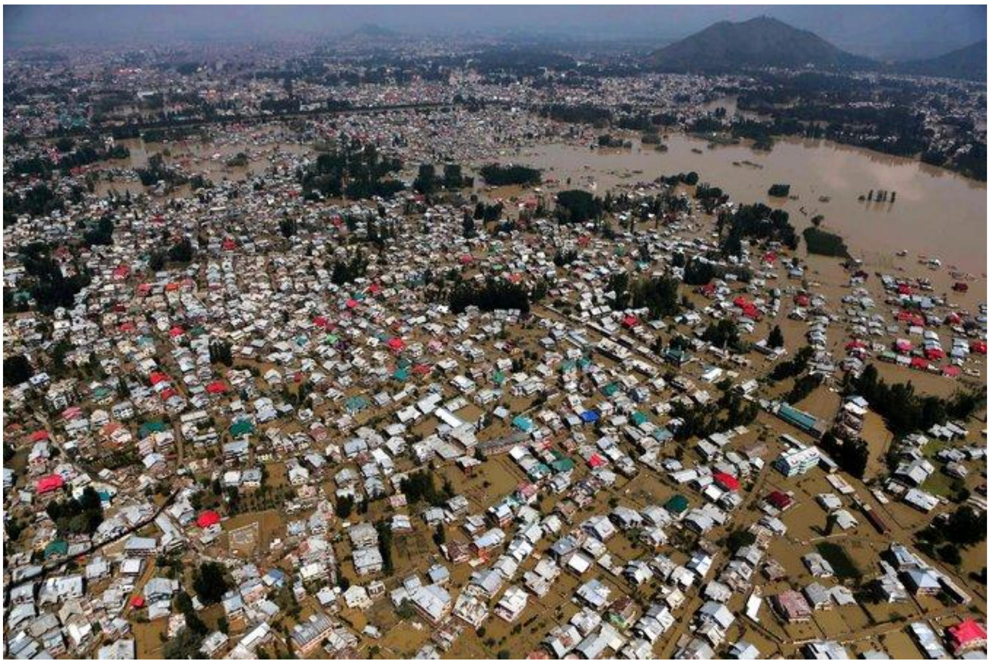


Figure 5.15:Aerial photograph of Srinagar taken on the 10th of September 2014. (Dar Yasin/Associated Press, New York Times, 2014)

5.3.3 Creation of Media-GIS content

Figure 5.16, 5.17, 5.18 and 5.19 are the media-GIS contents produced for the India-Pakistan floods of 2014. A KML file was not available, or could not be located, for this region. This being the case, only the GIS data provided by Google Earth was available as an overlay and additional information had to be added manually during the editing process.

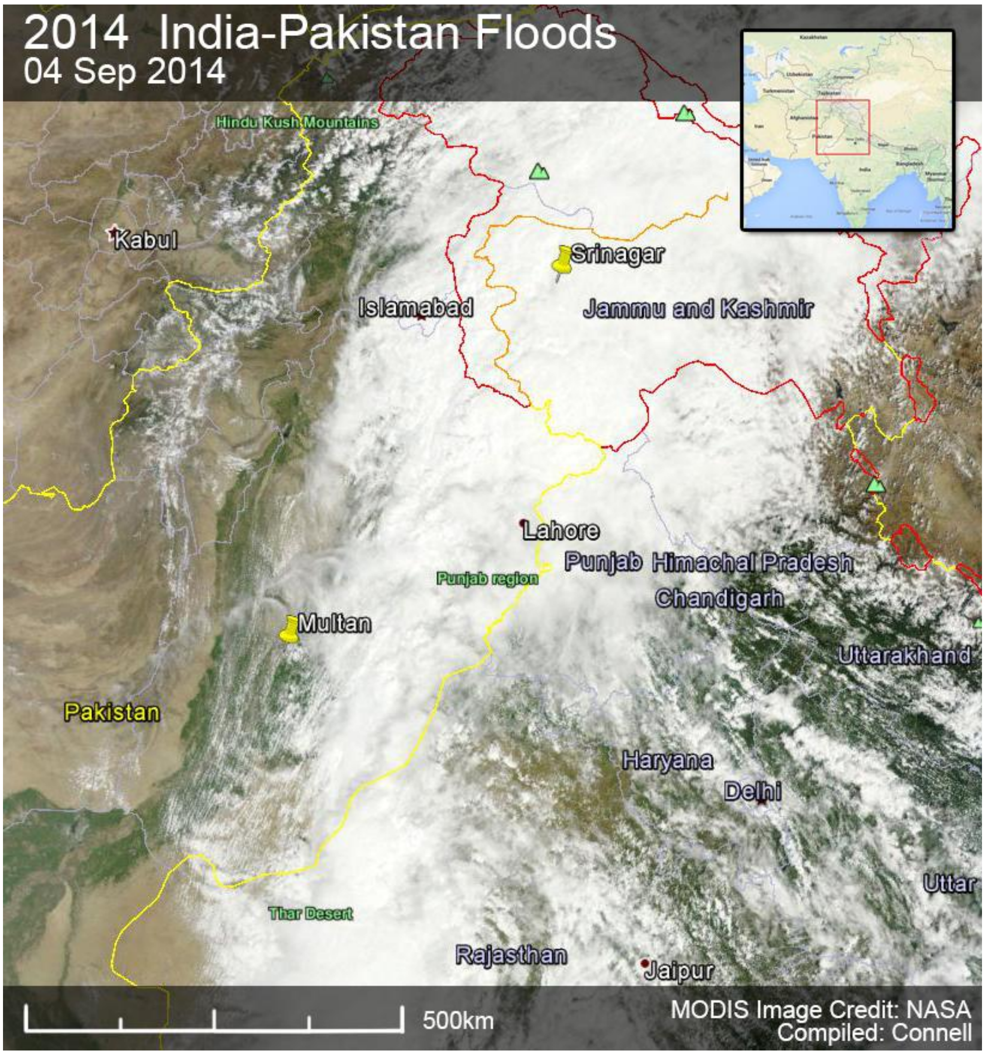


Figure 5.16: Media-GIS content showing true-colour MODIS imagery of storm event on the 4th of September 2014. The two focus areas, Srinagar and Multan, are noted through the use of placemarks.

Figure 5.16 is a true colour image showing the extents of the monsoon system that developed over Pakistan and Northern India. Country borders, major towns, government localities and the two worst hit areas are shown on the maps. It is interesting to note that yellow borders are relatively fixed whereas orange and red borders indicate areas of contest.

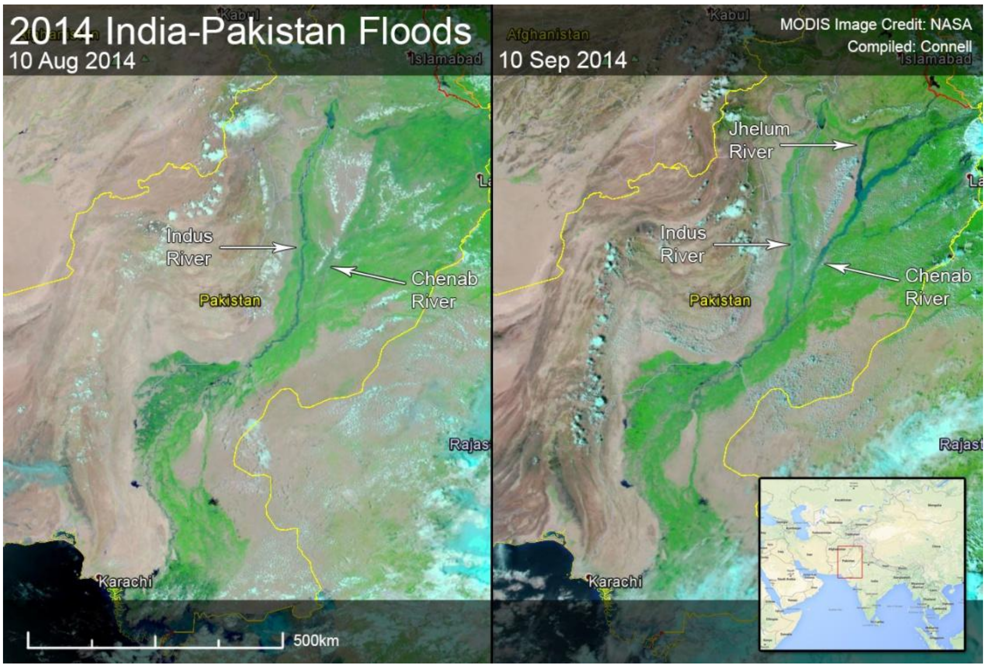


Figure 5.17: Media-GIS content using MODIS 'Corrected Reflectance (7-2-1)' imagery to clearly indicate water features. Images before and after the rainfall illustrate the change in water coverage. The major river systems through Pakistan have been labelled.

Figures 5.17, 5.18 and 5.19 all utilize the 'Corrected Reflectance (7-2-1)' data. As stated earlier, this only uses the data collected in the 1st, 2nd and 7th bands of the MODIS instrument. In true colour the river systems are a turbid brown colour and are not easily identifiable in the image. The bottom left corner of Figure 5.16 provides a good example where the river can be made out predominately by the green belt that surrounds it.

Due to the reflectance properties of water, using this layer, water appears either black or navy in colour, however, in instances where high levels of debris or silt is in the water the colours may tend toward a dark blue. Colouration of the flooding in figures 5.17 and 5.18 represent a high silt concentration in the water as it moves downstream toward the ocean in the south.

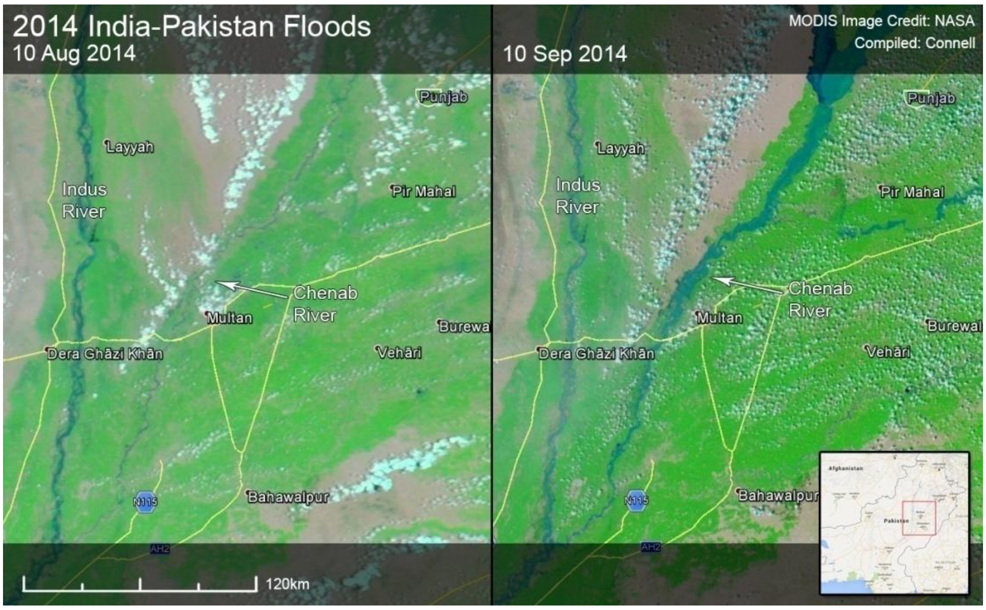


Figure 5.18: Media-GIS content using MODIS 'Corrected Reflectance (7-2-1)' imagery to clearly indicate water features. Detailed image of Multan region with place names and road networks included to show areas of higher population. Images before and after the rainfall illustrate the change in water coverage. The major river systems have also been labelled.

What figures 5.17 and 5.18 do show is a side by side image, one month apart, of the river systems that pass through Pakistan in varying scales. Figure 5.17 provides a more overall picture of the river system whilst figure 5.18 provides a close up image of the Multan region. In both images major rivers have been labelled to provide additional GIS information that wasn't available through the Google Earth layers.

Figure 5.19 is similar to the previous two figures in design. It utilises the same multi spectral image layer to, again, accentuate water in the image. As with previous time line images created a single image could be used by itself or in conjunction with other images depending on availability and the purpose of the story at time of writing.

The main purpose of using a time line in this instance is to indicate the state of the area before the deluge and then to show the slow dissipation of the floodwater in the region. Due to the scale of the image, the GIS data available was more extensive than the previous images. The major road networks are visible in and around the flooding and provide better evidence of higher population densities in the area.

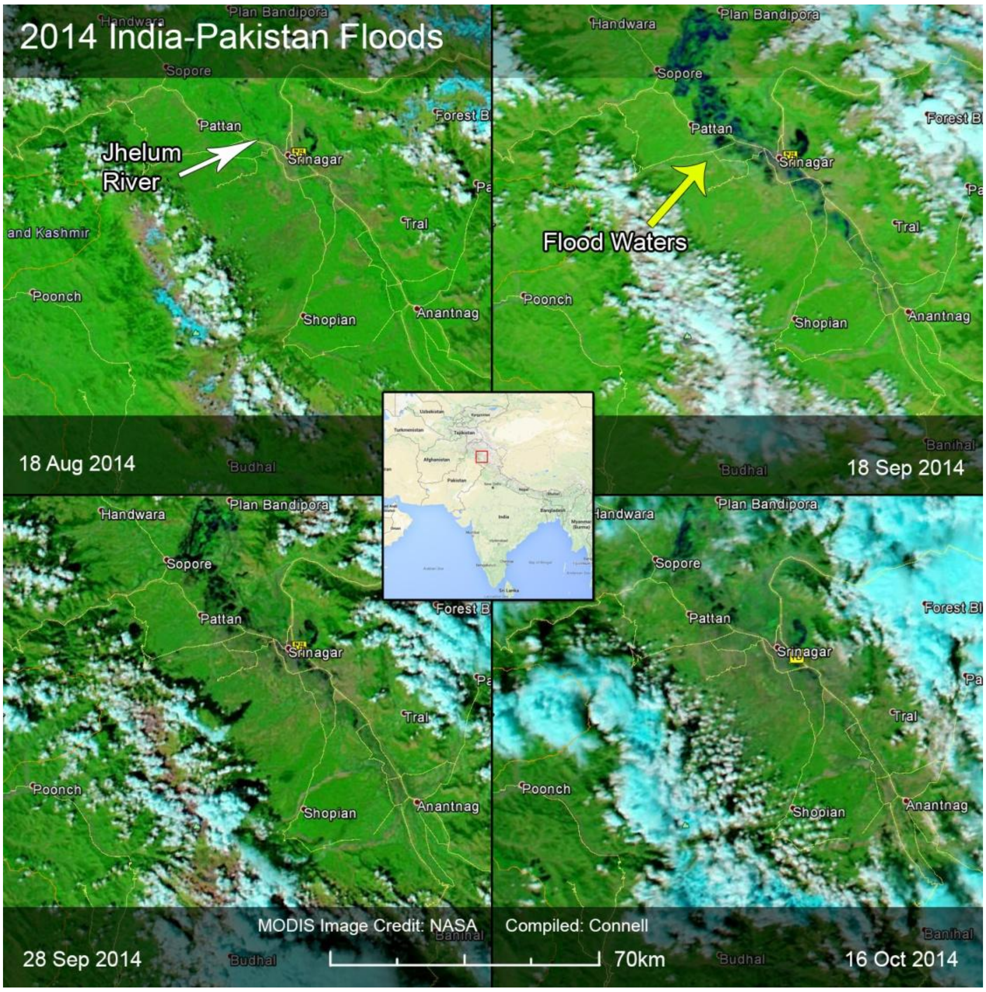


Figure 5.19: Media-GIS content using MODIS 'Corrected Reflectance (7-2-1)' imagery to clearly indicate water features. Several images of Srinagar and the surrounding areas throughout the course of the flooding to help illustrate the slow subsiding of water levels. Place names and road networks included to show areas of higher population.

5.4 Analysis of media-GIS production

The method followed to produce the media-GIS content in this report has some significant changes from previous methods. The most notable would be the ability to download straight in to a KMZ (zipped KML) format, which has removed the need to manually adjust the imagery to its correct geographic location. When loaded in to Google Earth the image is automatically overlaid in its correct position and geo-rectified to the correct scale. As the world is not a flat surface, this means that the edges of the image are tapered in slightly to accurately fit the spherical shape of the earth's surface. This is most noticeable on larger images and is shown in Figure 5.20.

Figure 5.20: Screenshot of Tropical Cyclone Ita satellite image overlaying the Google Earth Globe. Notice the shape of the image once it has been geo-rectified by the GIS software.

A number of benefits have become apparent from this change. Previously, GIS software such as ArcMap was used to geographically align imagery. The removal of an additional piece of software minimises costs, training and processing requirements. ArcMap itself is a GIS specific software and requires higher GIS knowledge and expertise to operate effectively. More than a typical media editor would be expected to know.

Previous reports have not explicitly outlined specifics for image layout and minimum specifications but a consensus on several elements was evident. The elements identified are a title, scale, date and a map inset. From a legal perspective it would also be ideal to include acknowledgements of data being used and to include the author's name, either on the image itself, or as part of an accompanying caption.

The elements mentioned previously, such as the titles, text and basic layout of the contents are mostly dependent on the editor, the medium being used and the news corporation itself. In the case studies a very simple approach was taken. The top and lower portions of each image had a black, 80% opaque box placed over them where white text and details could be added. The black and white colourations contrast well and make the information legible and aesthetically pleasing.

As these were not produced for a specific company or purpose there were no limitations on image size and scale. The images were saved at their maximum quality in JPEG format although this is fundamentally a small file size compared to many other image formats. Media sources that are already well established will most likely have specific criteria and branding requirements that will need to be included in their own content production.

Some areas where improvement could be made was in the creation of the scale bar and map inset. The scale bar was directly copied over from Google Earth with the original image but, due to its location in Google Earth, it most often fell outside the required area. Moving the scale bar in to a more appropriate position took away from the aesthetic appeal of the image as the background image would look out of place against the rest of the image. The solution used in this report was to manually re-draw the bar and labelling in a new layer over the top of the original. This method has some advantages in that the bar could then be moved anywhere around the media-GIS content, changed to any colour and modified if required but was one of the more time-consuming aspects of production.

Unlike the scale bar, the map inset could not copied. A screen shot could be taken of the image and copied across but this in turn had its own limitations. There was considerable time spent adjusting the settings of the map inset within the program to attempt to make this a viable option but options available within the program are limited and a quality product could not be achieved.

A more manual approach was used to rectify the issue. Using a web browser the correct location was displayed on Google Maps at a scale that allowed for a comprehensive map area to be shown. The image was then copied across to Photoshop. Using landmarks, a red box was added to mark the position of the satellite image on the map. The map could then be cropped and scaled down to an appropriate size for a map inset. Scaling from a high quality image to the lower quality image meant that the maximum amount of detail could be maintained. This approach was effective but time consuming. The scale bar and map inset both maintained high levels of quality but required the majority of the total time to complete.

The method used here is not necessarily a finished product and depending on the editor's knowledge and ability improvements or modifications could be made. It is hoped that this method will provide a backbone for media producers to utilise that is straightforward and promotes quality and accuracy. To achieve this goal, a simplified method of the production process was compiled in to an instructional booklet, which is available in Appendix F.

5.5 Observations and recommendations

A number of observations could be made when devising and implementing the methods used for the production process. An observation that was mentioned previously was the minimisation of programs required and a simplification of the overall process.

A negative observation was the limitation of the resolution of the MODIS data. The highest resolution available is 250m and the effects of this are most clearly seen in Figure 5.12. It was found that once the scale reached values of 50km or less in Google Earth that the image quality was no longer at an appropriate standard to provide clear information. It was at this point that the information become more of a hindrance and as such MODIS data would not be suitable for small scale contents. It is also important to note that some images are better quality than others. The specific cause of this is not stated but different factors appear to affect image quality at times. In this event there is potential for scales to be limited to a minimum 100km.

To remedy this, higher resolution data would need to be made available which, at this stage, is unlikely to be produced in the same costs and timeframe as MODIS data. It is especially unlikely that high-resolution data could be published using the methods and volumes that it is provided by Worldview. The important message to take from this is to understand the limitations of the resolution and to either remain at an appropriate scale or to adapt the production methods to limit the negative clarity of the imagery as was done with Figure 5.12.

It also became apparent that in order to fully utilise media-GIS contents an editor requires at least some GIS knowledge. The most efficient way of implanting this knowledge is, at this stage, hard to decide and would most likely become more apparent as utilisation increases. It may be a simple case of issuing information booklets such as the one included with this report or it may require more lengthy education through courses or seminars. It is difficult to gauge how much education is required but it is evident that some education would be wise.

With regard to image aesthetics, regardless of how the image is laid out, it is important to maintain consistency across multiple contents. By ensuring a consistent product the audience can become more accustomed to the format. This, in turn, will improve the readability of the image and build a relationship with the audience. Once the audience is comfortable and accustomed to a specific format it will be less likely that they will turn elsewhere for their information. Perera and Tateishi (2014) reiterate this stating:

> *"When the public is having a high attention on the disaster news, these semi-real-time satellite image products will clearly increase the viewer's enthusiasm and commercial value of the news program.*

This effect can also contribute positively to disaster mitigation as was outlined by Perera and Tateishi (2014) who state that:

> *This is the important factor focused in this study. When the viewer is well informed with firsthand real-time data, public cooperation for disaster mitigation efforts improves positively"*

On the other hand, a format that is not clear and confusing to the audience would have the opposite effect and force audiences to search for other information sources. In order to avoid this, it became apparent that some form of checking or quality assurance would be required.

5.6 Quality Assurance

Appendix E contains a quality assurance checklist that covers the minimum requirements that are required for media-GIS content in the methods devised in this paper.

The primary goal of the checklist is to ensure consistency in all aspects of production. This includes checks in relation to the filing systems, dating, editing requirements, archiving and moderation. The checklist, in its current form, provides an excellent basis and can be tailored to suit specific business or editor needs.

5.7 Conclusion

The case studies provided valuable information behind the practicality of the MODIS satellite data and allowed for insight in to the potential positive and negative aspects of both the data and the production method devised in Module 4. From this insight, some quality assurance procedures and useful conclusions could be drawn.

Chapter 6: Conclusions

6.1 Introduction

It wouldn't require too big of a step in to the past to believe that the idea of two overlapping satellites, continuously streaming image data fully integrated with worldwide scientific measurements, was an idea from fiction. Coupled with this, the fact that this information is made available free and open to the public is a testament to amazing resource that is available to us today.

Whilst many in the scientific and GIS community have utilised this resource, other industries, such as the media, have yet to do so effectively. Research by Perera and Patharina (2006 & 2012), Perera (2010) and Perera and Tateishi (2012 & 2014) have focused on the potential of MODIS satellite data for the media industry and the work completed in this paper attempts to lead on from this research.

The aims, first stated in Chapter 1, were to evaluate the effectiveness of MODIS satellite data for the use in the media industry and develop a method for content production and quality assurance. Related literature has already established a link between the use of GIS in media contents and an increase in commercial appeal.

Coupled with this is the consensus that increased use of GIS also leads to better disaster management and mitigation. Perera and Tateishi (2014) surmise this well, stating, "*when the viewer is well informed with firsthand real-time data, public cooperation for disaster mitigation efforts improves positively"*.

Keeping these two parties in mind the production of media-GIS content needed to adhere to high levels of accuracy and aesthetic quality while minimising timeframes and costs. This required careful deliberation of MODIS data, production methodologies and quality assurance practices.

6.2 Conclusions

To accomplish the aims of this research considerable effort was undertaken to fully understand the data before attempting to create media-GIS contents for 3 case studies. The opening chapter explored the media industry itself and evaluated what GIS data was currently used to gain insight in to areas of possible improvement.

This research identified that current usage of GIS was severely limited in semi-real time and fairly limited in general. Some researchers expressed concern over the potential misrepresentation of data, predominately based on the lack of specific knowledge of most media representatives.

A thorough description of the MODIS instruments and data were presented in the second chapter to analyse the properties of the imagery provided by MODIS. Leading on from this, the third chapter provides a review of the current literature surrounding the production of media-GIS. Literature consensus identified five key aspects that were integral to production of media-GIS contents that were used to choose an appropriate source and MODIS data and design a production method.

The data source, Worldview, was chosen. The fourth chapter first provides a detailed description of the Worldview utility and evidence to why it was chosen. With the data source chosen, a production method was formed and critically reviewed to ensure the methodologies were rigorous.

Three case studies; Tropical Cyclone Ita (2014), the Adelaide Wildfires (2015) and the India-Pakistan floods (2014), were chosen to provide a broad range of natural disasters to test the production method. From this exercise many observations and recommendations were able to ascertained. Use of worldview allowed for a more streamlined production process than previous literature stated and identified savings in time and cost.

A minimum set of elements that were identified by previous literature was, for the most part, easily added to the imagery but potential room for improvements were identified in the editing of the scale bar and map inset.

Limitations with the resolution of MODIS data were identified as the scale decreased on the image but due to its other properties MODIS data is clearly the most effective source of satellite data for the production of media-GIS content where; limited time is available and cost needs to be minimised.

In conjunction with the views expressed by some researchers about the need for education or training the recommendation that basic education of GIS principles was is important was made. This led to the production of a guidebook, presented in Appendix F.

The guidebook is intended to be issued to media outlets as an instruction manual for producing media-GIS contents. It contains background information, a step-by-step guide and quality assurance checklists developed by this research. It is hoped that this will encourage an increase in the use of GIS within the media industry and provide a thorough production method and quality practices.

6.3 Further Research and Recommendations

As the use of GIS information and satellite data become more prevalent in the media it should be recommended that some research is undertaken to quantify potential negative costs (monetary or otherwise) and potential sources of error. It would also be ideal to identify if a minimum standard of training in basic GIS principles should be given and if this would have any improvement on content production.

It would be useful to discuss the instructional guide, refer to Appendix F, with representatives from the media industry in relation to its usefulness in the production of media-GIS. Further research could be conducted in the form of a survey to collate a wide range of opinions. It would be helpful to know the media's consensus on how they believe GIS contents could be best utilised by the industry.

Another potential development would be the production of an automated service tailored directly to the media industry. In the USA NASA in particular have many arrangements with government agencies to best utilize satellite data. The question for Australia is then if it would be possible for a government agency such as the Bureau of Meteorology to have an agreement to produce content that could be automatically provided to the Australian media, along with all the necessary information.

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APPENDIX A: Project Specification

University of Southern Queensland

FACULTY OF ENGINEERING AND SURVEYING

Research Project
PROJECT SPECIFICATION

FOR: **David John CONNELL**

TOPIC: PRODUCTION OF SEMI-REAL TIME MEDIA-GIS COMPONENTS OF NATURAL DISASTERS USING MODIS SATELLITE DATA

SUPERVISOR: Kithsiri Perera

ENROLMENT: ENG4111 - S1, 2014
ENG4112 - S2, 2014

PROJECT AIM: The project aims to produce Media-GIS graphic contents on two natural disaster incidents using semi-real time MODIS satellite imagery in order to analyse its quality and effectiveness base on three optimal goals; semi-real time contents, accuracy and high graphic standards.

PROGRAMME: **Issue A, 04/03/2015**

1. Complete a thorough analysis for the use of MODIS imagery in the media
2. Critically analyze the production process focusing on semi-real time contents, accuracy and high graphic standards.
3. Develop a set criteria for developing media-GIS contents.
4. Produce media contents through devised criteria using two recent natural disaster events.
5. Evaluate the appropriateness of MODIS imagery across different situations.
6. Analyze quality assurance across media platforms.
7. Design and implement QA procedures which will provide a clear and consistent results.
8. Submit an academic dissertation on the research.

Time Permitting

a. Evaluate possible improvements to industry standard practice and
b. potential for semi-automated processes

AGREED:
David Connell (Student) _ / _ /2015
_______________ (Supervisor) _ / _ /2015

Examiner/Co-examiner:_________________________

APPENDIX B:Technical Specifications of the MODIS instruments

Below are the technical specifications listed on the NASA MODIS website:

Orbit:	**705 km, 10:30 a.m. descending node (Terra) or 1:30 p.m. ascending node (Aqua), sun-synchronous, near-polar, circular**
Scan Rate:	20.3 rpm, cross track
Swath Dimensions:	2330 km (cross track) by 10 km (along track at nadir)
Telescope:	17.78 cm diam. off-axis, afocal (collimated), with intermediate field stop
Size:	1.0 x 1.6 x 1.0 m
Weight:	228.7 kg
Power:	162.5 W (single orbit average)
Data Rate:	10.6 Mbps (peak daytime); 6.1 Mbps (orbital average)
Quantization:	12 bits
Spatial Resolution:	250 m (bands 1-2) 500 m (bands 3-7) 1000 m (bands 8-36)
Design Life:	6 years

Images Provided

Primary Use	Band	Bandwidth	Spectral Radiance	Required SNR
Land/Cloud/Aerosols Boundaries	1	620 - 670	21.8	128
	2	841 - 876	24.7	201
Land/Cloud/Aerosols Properties	3	459 - 479	35.3	243
	4	545 - 565	29.0	228
	5	1230 - 1250	5.4	74
	6	1628 - 1652	7.3	275

	7	2105 - 2155	1.0	110
Ocean Colour/ Phytoplankton/ Biogeochemistry	8	405 - 420	44.9	880
	9	438 - 448	41.9	838
	10	483 - 493	32.1	802
	11	526 - 536	27.9	754
	12	546 - 556	21.0	750
	13	662 - 672	9.5	910
	14	673 - 683	8.7	1087
	15	743 - 753	10.2	586
	16	862 - 877	6.2	516
Atmospheric Water Vapour	17	890 - 920	10.0	167
	18	931 - 941	3.6	57
	19	915 - 965	15.0	250
Surface/Cloud Temperature	20	3.660 - 3.840	0.45(300K)	0.05
	21	3.929 - 3.989	2.38(335K)	2.00
	22	3.929 - 3.989	0.67(300K)	0.07
	23	4.020 - 4.080	0.79(300K)	0.07
Atmospheric Temperature	24	4.433 - 4.498	0.17(250K)	0.25
	25	4.482 - 4.549	0.59(275K)	0.25
Cirrus Clouds Water Vapour	26	1.360 - 1.390	6.00	150(SNR)
	27	6.535 - 6.895	1.16(240K)	0.25
	28	7.175 - 7.475	2.18(250K)	0.25
Cloud Properties	29	8.400 - 8.700	9.58(300K)	0.05
Ozone	30	9.580 - 9.880	3.69(250K)	0.25
Surface/Cloud Temperature	31	10.780 - 11.280	9.55(300K)	0.05
	32	11.770 - 12.270	8.94(300K)	0.05
Cloud Top Altitude	33	13.185 - 13.485	4.52(260K)	0.25
	34	13.485 - 13.785	3.76(250K)	0.25
	35	13.785 - 14.085	3.11(240K)	0.25
	36	14.085 - 14.385	2.08(220K)	0.35

[1] **Bands 1 to 19 are in nm; Bands 20 to 36 are in µm**

[2] Spectral Radiance values are (W/m^2 -µm-sr)

[3] SNR = Signal-to-noise ratio

[4]NE(delta)T = Noise-equivalent temperature difference

Note: Performance goal is 30-40% better than required

Note: Technical specifications sourced from at http://modis.gsfc.nasa.gov/about/specifications.php (NASA, 2014)

APPENDIX C: NASA Data & Information Policy

NASA's Earth Science program was established to use the advanced technology of NASA to understand and protect our home planet by using our view from space to study the Earth system and improve prediction of Earth system change. To meet this challenge, NASA promotes the full and open sharing of all data with the research and applications communities, private industry, academia, and the general public. The greater the availability of the data, the more quickly and effectively the user communities can utilize the information to address basic Earth science questions and provide the basis for developing innovative practical applications to benefit the general public.

A common set of carefully crafted data exchange and access principles was created by the Japanese, European and U.S. International Earth Observing System (IEOS) partners during the 1990s and the early years of the 21st century. From these principles, NASA has adopted the following data policy (in this context the term 'data' includes observation data, metadata, products, information, algorithms, including scientific source code, documentation, models, images, and research results):

- *NASA will plan and follow data acquisition policies that ensure the collection of long-term data sets needed to satisfy the research requirements of NASA's Earth science program.*
- *NASA commits to the full and open sharing of Earth science data obtained from NASA Earth observing satellites, sub-orbital platforms and field campaigns with all users as soon as such data become available.*
- *There will be no period of exclusive access to NASA Earth science data. Following a post-launch checkout period, all data will be made available to the user community. Any variation in access will result solely from user capability, equipment, and connectivity.*
- *NASA will make available all NASA-generated standard products*

along with the source code for algorithm software, coefficients, and ancillary data used to generate these products.

- *All NASA Earth science missions, projects, and grants and cooperative agreements shall include data management plans to facilitate the implementation of these data principles.*
- *NASA will enforce a principle of non-discriminatory data access so that all users will be treated equally. For data products supplied from an international partner or another agency, NASA will restrict access only to the extent required by the appropriate Memorandum of Understanding (MOU).*
- *In keeping with the Office of Management and Budget (OMB) Circular A-130, NASA will charge for distribution of data no more than the cost of dissemination. In cases where such dissemination cost would unduly inhibit use, the distribution charge will generally be below that cost.*
- *Through MOUs and agreements with appropriate interagency partners, NASA will ensure that all data required for Earth system science research are archived. Data archives will include easily accessible information about the data holdings, including quality assessments, supporting relevant information, and guidance for locating and obtaining data.*
- *NASA will engage in ongoing partnerships with other Federal agencies to increase the effectiveness and reduce the cost of the NASA Earth science program. This interagency cooperation shall include: sharing of data from satellites and other sources, mutual validation and calibration data, and consolidation of duplicative capabilities and functions.*
- *NASA will, in compliance with applicable Federal law and policy, negotiate and implement arrangements with its international partners, with an emphasis on meeting the data acquisition, distribution, and archival needs of the U.S.*
- *NASA will collect a variety of metrics intended to measure or assess*

> *the efficacy of its data systems and services, and assess user satisfaction. Consistent with applicable laws, NASA will make those data available for review.*

The data collected by NASA represent a significant public investment in research. NASA holds these data in a public trust to promote comprehensive, long-term Earth science research. Consequently, NASA developed policy consistent with existing international policies to maximize access to data and to keep user costs as low as possible. These policies apply to all data archived, maintained, distributed or produced by NASA data systems. (NASA, 2011)

APPENDIX D: GIBS Imagery Products

Specifications sourced from https://wiki.earthdata.nasa.gov/display/GIBS/GIBS+Available+Imagery+Products.

D.1 Multiband Imagery

D.1.1 Corrected Reflectance

Platform	Instrument	Imagery Layer	Imagery Resolution	Sensor Resolution	Format	Projections
Terra	MODIS	Corrected Reflectance (True Colour)	250m	500m, 250m	jpeg	Geographic, Polar, Web Mercator
Terra	MODIS	Corrected Reflectance (Bands 7-2-1)	250m	500m, 250m	jpeg	Geographic, Polar, Web Mercator
Terra	MODIS	Corrected Reflectance (Bands 3-6-7)	250m	500m, 250m	jpeg	Geographic, Polar, Web Mercator
Aqua	MODIS	Corrected Reflectance (True Colour)	250m	500m, 250m	jpeg	Geographic, Polar, Web Mercator
Aqua	MODIS	Corrected Reflectance (Bands 7-2-1)	250m	500m, 250m	jpeg	Geographic, Polar, Web Mercator

Note: Bands 1 & 2 have a sensor resolution of 250m. Bands 3 - 7 have a sensor resolution of 500m and Bands 8 - 36 is 1km. Band 1 is used to sharpened band 3,4,6 and 7.

D.1.2 Surface Reflectance

Platform	Instrument	Imagery Layer	Imagery Resolution	Sensor Resolution	Format	Projections
Terra	MODIS	Land	500m	500m	jpeg	Geographic

		Surface Reflectance (True Colour)				, Web Mercator
Terra	MODIS	Land Surface Reflectance (Bands 7-2-1)	500m	500m	jpeg	Geographic, Web Mercator
Terra	MODIS	Land Surface Reflectance (Bands 1-2-1)	250m	250m	jpeg	Geographic, Web Mercator
Aqua	MODIS	Land Surface Reflectance (True Colour)	500m	500m	jpeg	Geographic, Web Mercator
Aqua	MODIS	Land Surface Reflectance (Bands 7-2-1)	500m	500m	jpeg	Geographic, Web Mercator
Aqua	MODIS	Land Surface Reflectance (Bands 1-2-1)	250m	250m	jpeg	Geographic, Web Mercator

D.1.3 Earth at Night

Platform	Instrument	Imagery Layer	Imagery Resolution	Sensor Resolution	Format	Projections
Suomi NPP	VIIRS	Earth at Night 2012	500m	750m	jpeg	Geographic, Web Mercator

D.2 Science Parameter Visualizations

D.2.1 Atmosphere - Aerosol Optical Depth

Platform	Instrument	Imagery Layer	Imagery Resolution	Sensor Resolution	Format	Projections
Aura	OMI	Aerosol Index	2km	25km	png	Geographic, Web Mercator
Terra	MODIS	Aerosol Optical Depth	2km	10km	png	Geographic, Web Mercator
Aqua	MODIS	Aerosol Optical Depth	2km	10km	png	Geographic, Web Mercator
Terra/Aqua	MODIS	MODIS Combined Value-Added Aerosol Optical Depth	2km	10km	png	Geographic, Web Mercator
Aura	OMI	Aerosol Optical Depth	2km	25km	png	Geographic, Web Mercator
Aura	OMI	Absorbing Aerosol Optical Depth	2km	25km	png	Geographic, Web Mercator

D.2.2 Atmosphere - Aerosol Optical Depth

Platform	Instrument	Imagery Layer	Imagery Res.	Sensor Res.	Format	Projections
Terra	MODIS	Brightness Temperature (Band 31, day)	1km	1km	png	Geographic, Polar, Web Mercator
Terra	MODIS	Brightness Temperature (Band 31, night)	1km	1km	png	Geographic, Polar,

						Web Mercator
Aqua	MODIS	Brightness Temperature (Band 31, day)	1km	1km	png	Geographic, Polar, Web Mercator
Aqua	MODIS	Brightness Temperature (Band 31, night)	1km	1km	png	Geographic, Polar, Web Mercator
Aura	MLS	Temperature at 46 hPa (Day)	2km	5km	png	Geographic, Web Mercator
Aura	MLS	Temperature at 46 hPa (Night)	2km	5km	png	Geographic, Web Mercator
Aqua	AMSR-E	Brightness Temperature 89Ghz Horizontal (Day)	2km	5-56km	png	Geographic
Aqua	AMSR-E	Brightness Temperature 89Ghz Vertical (Day)	2km	5-56km	png	Geographic
Aqua	AMSR-E	Brightness Temperature 89Ghz Horizontal (Night)	2km	5-56km	png	Geographic
Aqua	AMSR-E	Brightness Temperature 89Ghz Vertical (Night)	2km	5-56km	png	Geographic
GPM	GMI	GMI_Brightness_Temp_Asc	2km	4km	png	Geographic
GPM	GMI	GMI_Brightness_Temp_Dsc	2km	4km	png	Geographic

D.2.3. Atmosphere - Carbon Monoxide

Platform	Instrument	Imagery Layer	Imagery Resolution	Sensor Resolution	Format	Projections
Aura	MLS	Carbon Monoxide (CO) at 215 hPa (Day)	2km	5km	png	Geographic, Web Mercator

Aura	MLS	Carbon Monoxide (CO) at 215 hPa (Night)	2km	5km	png	Geographic, Web Mercator
Aqua	AIRS	Carbon Monoxide (CO) Total Column (Day)	2km	45km	png	Geographic, Web Mercator
Aqua	AIRS	Carbon Monoxide (CO) Total Column (Night)	2km	45km	png	Geographic, Web Mercator

D.2.4. Atmosphere - Cloud Top Temperature

Platform	Instrument	Imagery Layer	Imagery Resolution	Sensor Resolution	Format	Projections
Terra	MODIS	Cloud Top Temperature (day)	2km	5km	png	Geographic, Web Mercator
Terra	MODIS	Cloud Top Temperature (night)	2km	5km	png	Geographic, Web Mercator
Aqua	MODIS	Cloud Top Temperature (day)	2km	5km	png	Geographic, Web Mercator
Aqua	MODIS	Cloud Top Temperature (night)	2km	5km	png	Geographic, Web Mercator

D.2.5 Atmosphere - Cloud Top Pressure

Platform	Instrument	Imagery Layer	Imagery Resolution	Sensor Resolution	Format	Projections
Terra	MODIS	Cloud Top	2km	5km	png	Geographic, Web

		Pressure (day)				Mercator
Terra	MODIS	Cloud Top Pressure (night)	2km	5km	png	Geographic, Web Mercator
Aqua	MODIS	Cloud Top Pressure (day)	2km	5km	png	Geographic, Web Mercator
Aqua	MODIS	Cloud Top Pressure (night)	2km	5km	png	Geographic, Web Mercator
Aura	OMI	Cloud Pressure	2km	25km	png	Geographic, Web Mercator

D.2.6 Atmosphere - Dust Score

Platform	Instrument	Imagery Layer	Imagery Resolution	Sensor Resolution	Format	Projections
Aqua	AIRS	Dust Score	2km	45km	png	Geographic

D.2.7 Atmosphere - Nitric Acid

Platform	Instrument	Imagery Layer	Imagery Res.	Sensor Res.	Format	Projections
Aura	MLS	Nitric Acid (HNO3) at 46 hPa (Day)	2km	5km	png	Geographic, Web Mercator
Aura	MLS	Nitric Acid (HNO3) at 46 hPa (Night)	2km	5km	png	Geographic, Web Mercator

D.2.8 Atmosphere - Nitrous Oxide

Platform	Instrument	Imagery	Imagery	Sensor	Format	Projections

		Layer	Res.	Res.		
Aura	MLS	Nitrous Oxide (N2O) at 46 hPa (Day)	2km	5km	png	Geographic, Web Mercator
Aura	MLS	Nitrous Oxide (N2O) at 46 hPa (Night)	2km	5km	png	Geographic, Web Mercator

D.2.9 Atmosphere - Ozone

Platform	Instrument	Imagery Layer	Imagery Res.	Sensor Res.	Format	Projections
Aura	MLS	Ozone (O3) at 46 hPa (Day)	2km	5km	png	Geographic, Web Mercator
Aura	MLS	Ozone (O3) at 46 hPa (Night)	2km	5km	png	Geographic, Web Mercator

D.2.10 Atmosphere - Precipitation

Platform	Instrument	Imagery Layer	Imagery Resolution	Sensor Resolution	Format	Projections
Aqua	AIRS	Precipitation Estimate (Day)	2km	45km	png	Geographic, Web Mercator
Aqua	AIRS	Precipitation Estimate (Night)	2km	45km	png	Geographic, Web Mercator
GPM	GMI	GMI_Rain_Rate_Asc	2km	4km	png	Geographic
GPM	GMI	GMI_Rain_Rate_Dsc	2km	4km	png	Geographic
GPM	GMI	GMI_Snow_Rate_Asc	2km	4km	png	Geographic
GPM	GMI	GMI_Snow_Rate_Dsc	2km	4km	png	Geographic

D.2.11 Atmosphere - Sulphur Dioxide

Platform	Instrument	Imagery Layer	Imagery Resolution	Sensor Resolution	Format	Projections
Aura	OMI	Sulphur Dioxide (Lower Troposphere)	2km	25km	png	Geographic, Web Mercator
Aura	OMI	Sulphur Dioxide (Middle Troposphere)	2km	25km	png	Geographic, Web Mercator
Aura	OMI	Sulphur Dioxide (Upper Troposphere / Stratosphere)	2km	25km	png	Geographic, Web Mercator
Aura	MLS	Sulphur Dioxide (SO2) at 147 hPa (Day)	2km	5km	png	Geographic, Web Mercator
Aura	MLS	Sulphur Dioxide (SO2) at 147 hPa (Night)	2km	5km	png	Geographic, Web Mercator
Aqua	AIRS	Sulphur Dioxide (SO2) Index (Day)	2km	45km	png	Geographic, Web Mercator
Aqua	AIRS	Sulphur Dioxide (SO2) Index (Night)	2km	45km	png	Geographic, Web Mercator

D.2.12 Atmosphere - Water Vapour

Platform	Instrument	Imagery Layer	Imagery Res.	Sensor Res.	Format	Projections
Terra	MODIS	Water Vapour (Day)	2km	1km	png	Geographic, Web Mercator
Terra	MODIS	Water Vapour (Night)	2km	1km	png	Geographic, Web Mercator
Aqua	MODIS	Water Vapour (Day)	2km	1km	png	Geographic, Web Mercator
Aqua	MODIS	Water Vapour (Night)	2km	1km	png	Geographic, Web Mercator
Aura	MLS	Water Vapour (H2O) at 46 hPa (Day)	2km	5km	png	Geographic, Web Mercator
Aura	MLS	Water Vapour (H2O) at 46 hPa (Night)	2km	5km	png	Geographic, Web Mercator

D.2.13 Cryosphere - Freeze/Thaw

Platform	Instrument	Imagery Layer	Imagery Res.	Sensor Res.	Format	Projections
Aqua	AMSR-E	Daily Landscape Freeze/Thaw (AMSR-E)	2km	25km	png	Geographic
DMSP	SSM/I	Daily Landscape Freeze/Thaw (SSM/I)	2km	25km	png	Geographic

D.2.14Cryosphere - Sea Ice

Platform	Instrument	Imagery Layer	Imagery Res.	Sensor Res.	Format	Projections
Terra	MODIS	Sea Ice	1km	1km	png	Geographic, Polar, Web Mercator
Aqua	MODIS	Sea Ice	1km	1km	png	Geographic, Polar, Web Mercator

D.2.15Cryosphere - Snow Cover

Platform	Instrument	Imagery Layer	Imagery Res.	Sensor Res.	Format	Projections
Terra	MODIS	Snow Cover	500m	500m	png	Geographic, Polar, Web Mercator
Aqua	MODIS	Snow Cover	500m	500m	png	Geographic, Polar, Web Mercator

D.2.16 Land - Land Surface Temperature

Platform	Instrument	Imagery Layer	Imagery Res.	Sensor Res.	Format	Projections
Terra	MODIS	Land Surface Temperature (Day)	1km	1km	png	Geographic, Web Mercator
Terra	MODIS	Land Surface Temperature (Night)	1km	1km	png	Geographic, Web Mercator
Aqua	MODIS	Land Surface Temperature (Day)	1km	1km	png	Geographic, Web Mercator
Aqua	MODIS	Land Surface Temperature (Night)	1km	1km	png	Geographic, Web Mercator

D.2.17 Ocean - Chlorophyll

Platform	Instrument	Imagery Layer	Imagery Res.	Sensor Res.	Format	Projections
Terra	MODIS	Chlorophyll A	1km	1km	png	Geographic, Web Mercator
Aqua	MODIS	Chlorophyll A	1km	1km	png	Geographic, Web Mercator

D.2.18 Ocean - Sea Surface Temperature

Platform	Instrument	Imagery Layer	Imagery Res.	Sensor Res.	Format	Projections

Terra & Aqua	MODIS	Sea Surface Temperature (Infrared)	1km	1km	png	Geographic, Web Mercator
Coriolis	Windsat	Sea_Surface_Temp_Infrared	500m	25km	png	Geographic
Numerous	Numerous	Sea_Surface_Temp_Microwave	16km	16km	png	Geographic

D.3 Utility Layers

D.3.1 Data/Imagery Masks

Platform	Instrument	Imagery Layer	Imagery Res.	Sensor Res.	Format	Projections
N/A	N/A	Land Water Map (Open Street Map)	250m	250m	png	Geographic, Polar
N/A	N/A	Land Mask (Open Street Map)	250m	250m	png	Geographic, Polar
MODIS	Terra	Data-No Data Mask	250m	250m	png	Geographic, Web Mercator
MODIS	Aqua	Data-No Data Mask	250m	250m	png	Geographic, Web Mercator
MODIS	Terra and SRTM	Water Mask	250m	250m	png	Geographic

Note: The water mask layer is static and does not change over time.

D.3.2 Digital Elevation Models (DEMs)

Platform	Instrument	Imagery Layer	Imagery Res.	Sensor Res.	Format	Projections
ASTER	Terra	Global Digital Elevation Model (GDEM)	30m	30m	png	Geographic

D.3.3 Reference Layers

Platform	Instrument	Imagery Layer	Imagery Res.	Sensor Res.	Format	Projections
N/A	N/A	Graticule	250m	250m	png	Polar
N/A	N/A	Coastlines	250m	250m	png	Geographic, Polar
MODIS	Terra	Blue Marble	500m	500m	jpeg	Geographic, Polar, Web Mercator
MODIS	Terra	Blue Marble with Shaded Relief	500m	500m	jpeg	Geographic, Polar, Web Mercator
MODIS	Terra	Blue Marble with Shaded Relief and Bathymetry	500m	500m	jpeg	Geographic, Polar, Web Mercator

Note: The Arctic Coastlines are generated based on information available at OpenStreetMap© under the Open Database License. Antarctic Coastlines are generated based on information available through the SCAR Antarctic Digital Database.

Note: All 3 Blue Marble layers are created from the August 2004 jpeg images.

APPENDIX E: Quality Assurance Checklist

The following pages show a quality assurance checklist that was devised in the attempt to maintain content quality and consistency across the production process. It includes pre and post production aspects as well as specific production requirements.

Media-GIS Content: Quality Assurance Checklist			
Editor Details			
Name:		Date:	
Pre-edit Information			
Source of MODIS data:			
Date image recorded:			
Format/s downloaded (circle):	JPEG PNG GeoTIFF KMZ		
Recorded as (file name):			
Editing Checklist			
Google Earth			
Is the appropriate GIS data overlay displayed?			Y N
Are all annotations legible?			Y N
Have all place marks and additional information been added?			Y N
Has an appropriate scale been chosen?			Y N
If any of the answers were No, list reasons why:			
....			
Are any overlays used? List:			
Has a key been provided for overlay?			Y N
If No, why?:..			
Adobe Photoshop			
Does the content have a title?			Y N
Does the content have an accurate scale bar?			Y N
Does the content have an inset map?			Y N
Are all contents dated as per image recorded date?			Y N
Is the image credited?			Y N

Is the editor credited?	Y N
If any of the answers were No, list reasons why:	
…………………………………………………………………………………… ……………………………………………………………………………………	
Has additional editing content been added in Photoshop?	Y N
If additional editing has been added, list below:	
…………………………………………………………………………………… …………………………………………………………………………………… …………………………………………………………………………………… …………………………………………………………………………………… ……………………………………………………………………………………	
Post-edit Checklist	
Output file name:	
Output file type (circle):	JPEG PNG PSD PDF
Image size:	
Image resolution:	
Confirmation	
Signed:	Date:

Media-GIS Content: Secondary Check		
Moderator Details		
Name:	Date:	
Moderator Checklist (Review previous checklist)		
Is the previous checklist accurate?		Y N
Is **no** additional work required?		Y N
If any of the answers were No, list reasons why and return to editor:		
....		
Confirmation		
Signed:	Date:	

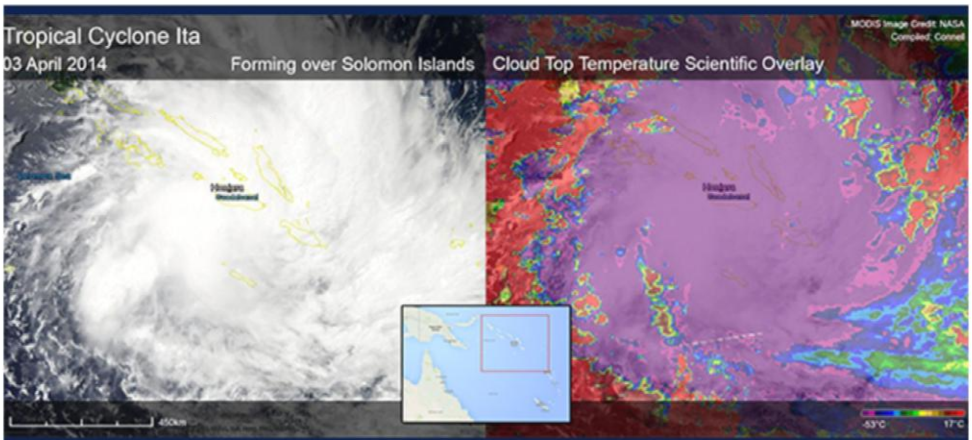
APPENDIX F: A Guide to the Production of Media-GIS Content for Natural Disasters: Integration of near real-time MODIS satellite data in media graphic production

This document is designed to be compiled as an information booklet to be handed out to media companies. It provides valuable information regarding the implementation of MODIS satellite data into media-GIS contents. It includes a step-by-step production guide and quality assurance checklists amongst all the necessary information necessary to compile high quality, accurate media-GIS contents.


A Guide to the Production of
Media-GIS Content for Natural Disasters
Integration of near real-time MODIS satellite data in media graphic production
Image Credit: NASA
Prepared by David Connell

A Guide to the Production of Media-GIS Content for Natural Disasters:
Integration of near real-time MODIS satellite data in media graphic production

Contents



Purpose

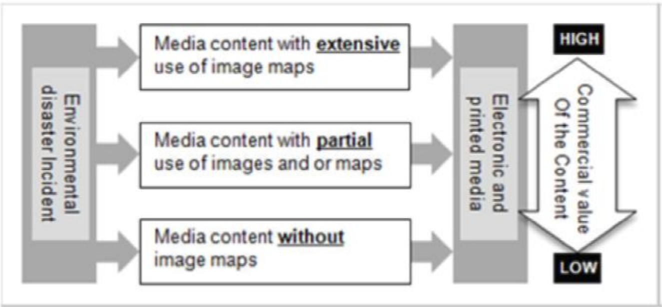
The purpose of this guide is to introduce the use of MODIS Satellite data into GIS (global information system) based media content. The content included in this guide focuses on images that can be integrated in to print or web-based media.

Included is a brief introduction, background information about MODIS and its associated resources, a step by step guide to content production and quality assurance protocols.

Introduction

Trends in global internet access and media distribution have meant that information is rapidly available to the public, often from multiple sources, of which many may not be evidence-based, or underpinned by accurate information and technology . This has created a demand for high quality, accurate information from reputable sources.

Research by Perera and Patharina (2006 & 2012), Perera (2010) and Perera and Tateishi (2012 & 2014) have highlighted the benefits of the integration of media-GIS content to both the public and media providers.

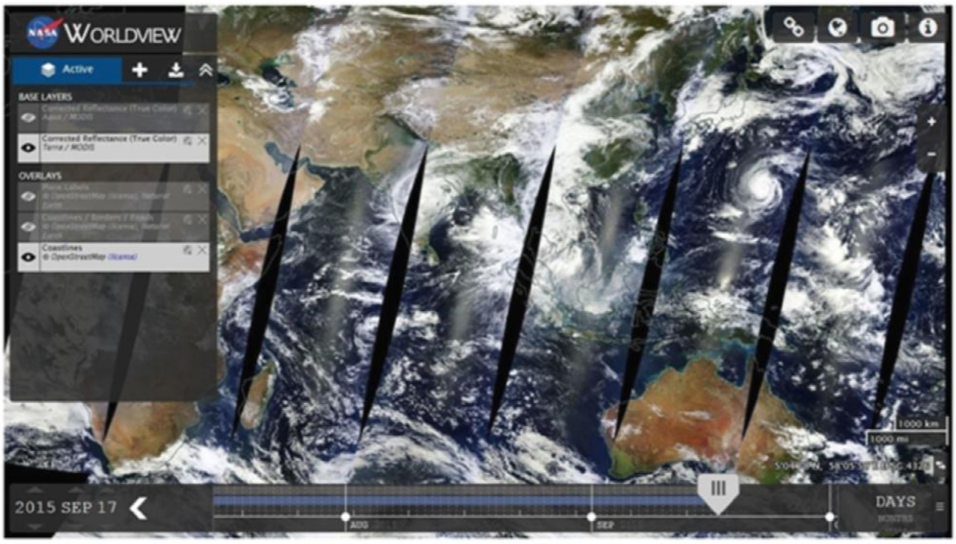


Relationship between commercial value related to the use of image maps (Perera, 2010)

The most prominent source of near real-time satellite data is MODIS satellite data. MODIS data is a freely available resource that is most effective where time and costs need to be minimized. This document provides valuable information regarding the implementation of MODIS satellite data into media-GIS contents.

Benefits

MODIS satellite data is the most effective source of satellite data for use by the media industry for many reasons.



NASA Worldview. Source of MODIS data, available at https://earthdata.nasa.gov/labs/worldview/

Benefits of MODIS satellite data:

- Readily available
- Cost effective (data is free)
- Time sensitive (semi real-time)
- Simple to use
- High accuracy
- Moderate resolution and scale quality

Conditions of Use and Associated Costs

MODIS data
The use of MODIS data falls under the NASA data and Information Policy which is available online on the NASA website.

> *NASA promotes the full and open sharing of all data with the research and applications communities, private industry, academia, and the general public. The greater the availability of the data, the more quickly and effectively the user communities can utilize the information to address basic Earth science questions and provide the basis for developing innovative practical applications to benefit the general public.* (NASA, 2011)

GIBS (Global Image Browse Services)
Use of GIBS products such as Worldview should also be acknowledged. GIBS is operated by the NASA/GSFC/Earth Science Data and Information System (EOSDIS, https://earthdata.nasa.gov) with funding provided by NASA/HQ.

Associated Costs
As data is provided free, associated costs are negligible. Two editing programs are necessary for production. Google Earth, the first, is also free. An image editing program (such as Photoshop), the second, will need to be purchased.

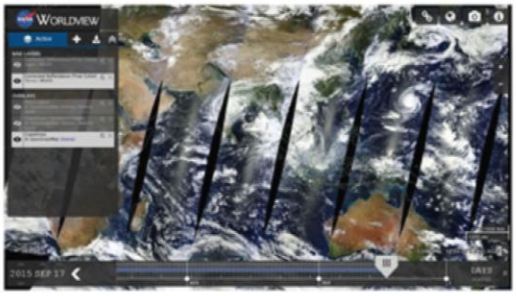
Production Guide

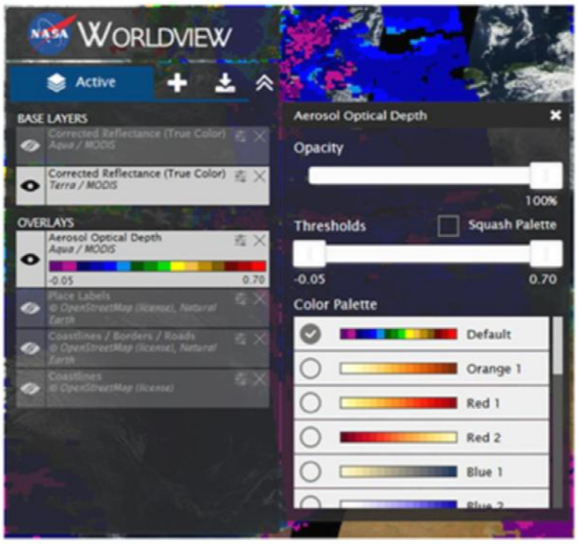
The following pages provide a detailed step by step guide to produce media-GIS content using Worldview and MODIS satellite data.

Step 1

Open Worldview at https://earthdata.nasa.gov/labs/worldview/

Controls are similar to many GIS software. Most should be familiar with Google Maps. With this in mind, navigate to the area required.





Step 2

Select the appropriate date by adjusting the date in the bottom left corner (refer above) and layers by clicking on the + symbol (refer left). Layers can be toggled on or off. For a full list of layers and information regarding their purpose refer to the GIBS specifications.

These can be found at https://wiki.earthdata.nasa.gov/display/GIBS/GIBS+Available+Imagery+Products.

A note about the GIBS layers

Typically, multiband imagery is very useful at accentuating particular features such as water features, fires, etc and has the most relevance to the production of media-GIS contents.

Some scientific parameter visualisations and utility layers may be useful but most don't provide information that would be of use to the general public.

To provide a full list of layers would be impractical, however NASA provide a list of potentially useful data sets depending on the type of disaster:

For fires: Fire and Thermal Anomilies, Corrected reflectance True Colour, Corrected reflectance Bands 7-2-1, Aerosol Optic Depth, Land Surface Temperature.

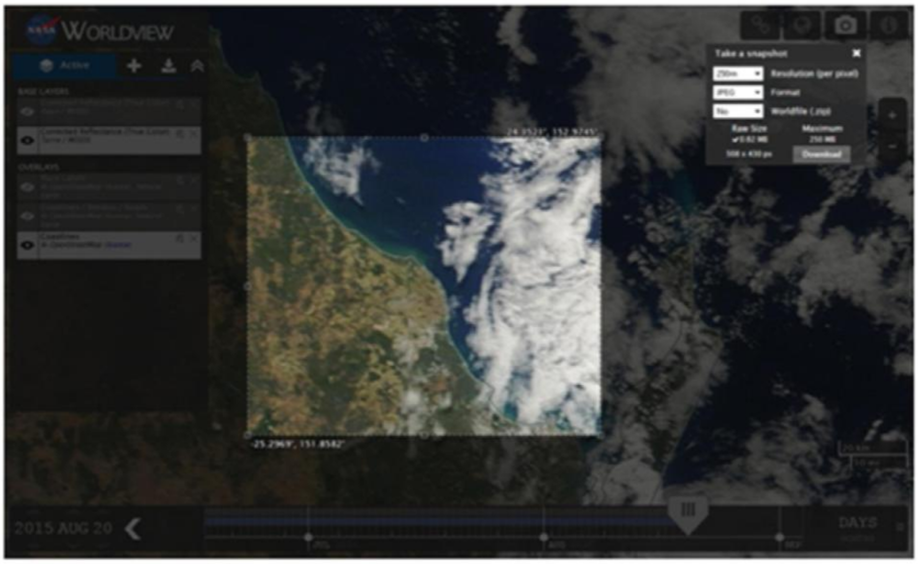
For storms: Corrected reflectance True Colour, Water Vapour, Cloud Top Temperature, Cloud Top Pressure

For floods: Corrected reflectance True Colour, Corrected reflectance Bands 7-2-1, Corrected reflectance Bands 1-2-1, AIRS Precipitation.

Vegetation Analysis: Corrected reflectance True Colour, Corrected reflectance Bands 7-2-1, Corrected reflectance Bands 1-2-1, Snow Cover, Land Surface Temperature, Vegetation Indices.

Step 3

Once all layers are selected the image can be downloaded as a snapshot. This is done by clicking the image of the camera towards the top right corner of the screen.

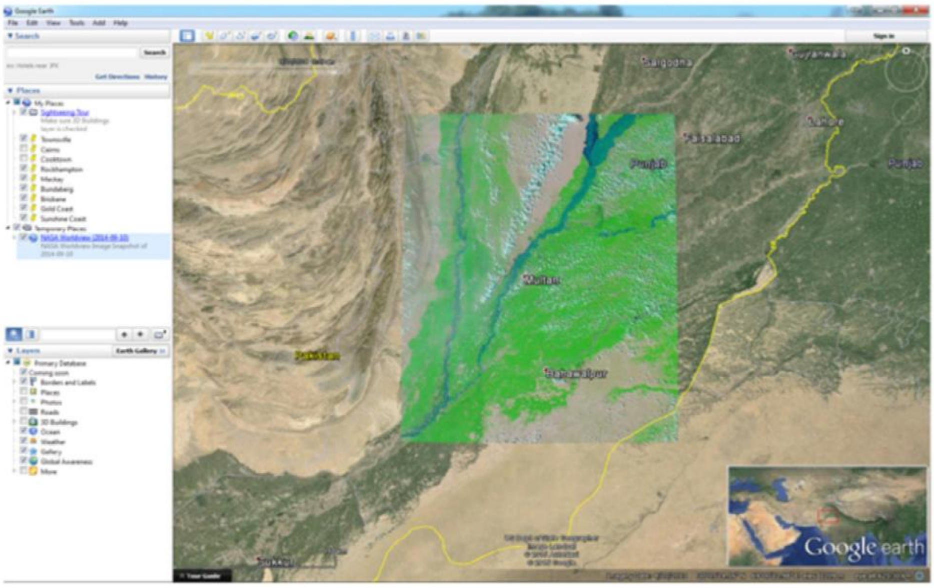


Select the area by adjusting the box. All unshaded areas will be downloaded. Resolution should be 250m (if image file is too large this can be adjusted higher), format should be KMZ and a zip is not required.

Click download and store in the appropriate directory. Once downloaded rename file to appropriate file name system.

Step 4

Open Google Earth. Select File > Open and open the image saved from Worldview. The image will automatically overlay on to the Google Earth image.



This image is a corrected reflectance 7-2-1 image of the Pakistan river system during significant flood events in September 2014. The MODIS image outline can be easily seen against the original Google Earth image.

Step 5

Placemarks and other useful information can be added using the top menu bar directly above the image. Layers can be toggled on and off using the left hand side drop down menus and additional GIS files can be added by selecting File > Open and the respective GIS file. In the state of Queensland, QLDglobe.kml file is freely available from the QLD government website (refer overleaf).

A note about additional GIS files

As mentioned, additional GIS files can be added to an image. The following image shows the information provided by QLDglobe compared to the standard Google Earth

Google earth image with all GIS overlay layers on

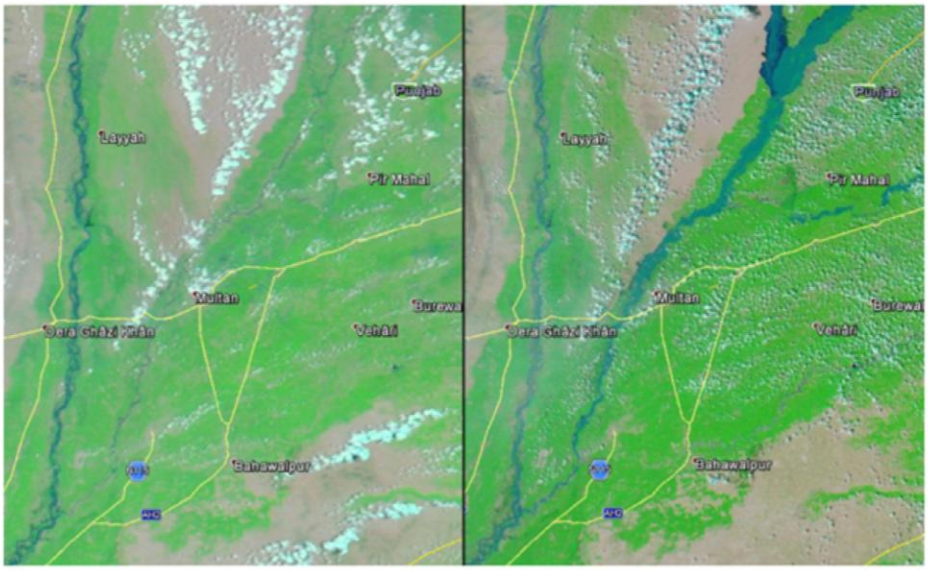
Same image with QLD Globe open and all layers on.

Step 6

Once the image is prepared in Google Earth an appropriate scale needs to be selected. Google Earth's scale bar is shown in the lower left corner of the screen. The zoom should be adjusted until a whole number is acheived on the scale bar.
Tip: Hold the Alt key and adjust the scale by pressing the + and - keys on the keyboard.

Step 7

The image can be copied by selecting Edit > Copy Image and pasted directly in to Photoshop.

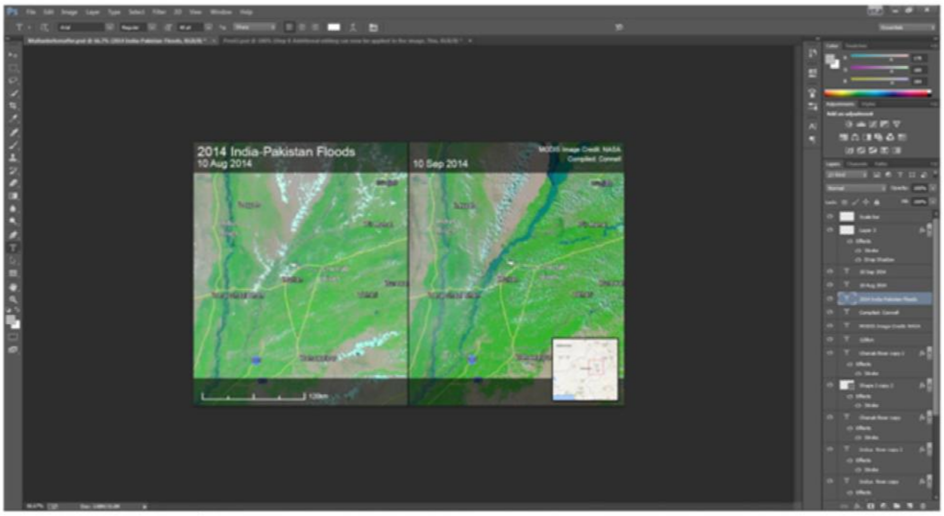


Same image as earlier copied in to Photoshop and Placed next to identical image recorded one month earlier.

Step 8

Additional editing can now be applied to the image. This should typically include, as a minimum, a Title, Date, Scale bar (copied from Google Earth), Map inset and acknowledgements.

In addition to this it may also include arrows and annotations, circling of key information, keys regarding scientific overlays and more.

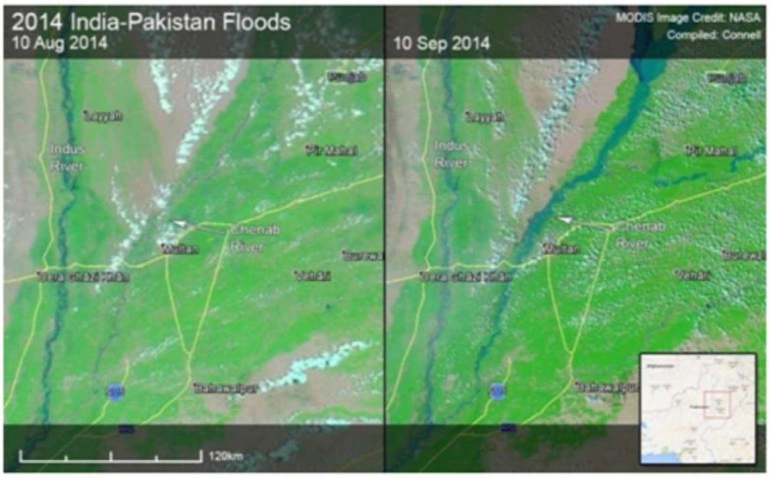


Same image again with additional edits. This image has the minimum requirements specified and also has an arrow and annotation pointing towards the flooded river. It is important to devise a consistent scheme that should be applied to all GIS contents to provided the viewer with a consistent source of information and improve readability.

In this instance a simple opaque black background and white text was used. This provides all the necessary information without detracting from the main image.

Step 9

Ensure the image is saved under the appropriate file name before 'flattening' the image by selecting Layer > Flatten Image and once 'flattened' save as a JPEG for easy implementation.



Final image with all editing completed. The image has been 'flattened' and saved as a JPEG.

Step 10

All imagery should be archived so that it can be recalled and compared at a later date.

Production Checklist/Quality Assurance

Quality of a product is an important aspect and, as such, it is important to devise a system to maintain a high level of quality.

The following pages provide a comprehensive 'Quality Assurance Checklist'. This checklist was devised by me personally and should provide all the necessary checks to ensure high quality and consistent media-GIS content. It may be used either 'as is' or with some modification to suit your particular needs.

Media-GIS Content: Quality Assurance Checklist			
Editor Details			
Name:		Date:	
Pre-edit Information			
Source of MODIS data:			
Date image recorded:			
Format/s downloaded (circle):	JPEG PNG GeoTIFF KMZ		
Recorded as (file name):			
Editing Checklist			
Google Earth			
Is the appropriate GIS data overlay displayed?		Y	N
Are all annotations legible?		Y	N
Have all placemarks and additional information been added?		Y	N
Has an appropriate scale been chosen?		Y	N
If any of the answers were No, list reasons why:			
....			
....			
Are any overlays used? List:			
Has a key been provided for overlay?		Y	N
If No, why?:...			
Adobe Photoshop			
Does the content have a title?		Y	N
Does the content have an accurate scale bar?		Y	N
Does the content have an inset map?		Y	N
Are all contents dated as per image recorded date?		Y	N
Is the image credited?		Y	N
Is the editor credited?		Y	N
If any of the answers were No, list reasons why:			
....			
....			

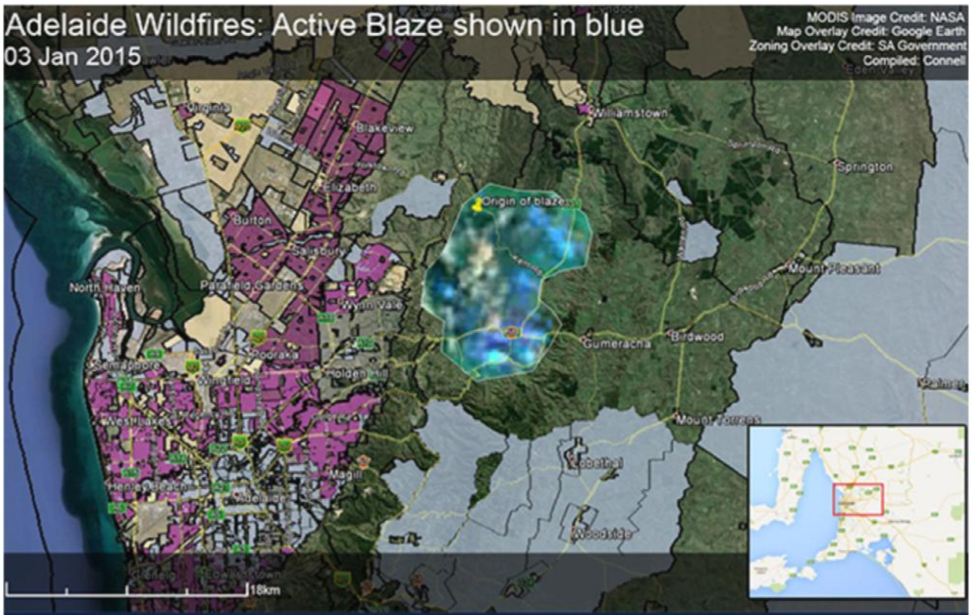
Has additional editing content been added in Photoshop?	Y N
If additional editing has been added, list below:	
....	
....	
....	
....	
....	
Post-edit Checklist	
Output file name:	
Output file type (circle):	JPEG PNG PSD PDF
Image size:	
Image resolution:	
Confirmation	
Signed:	Date:

Media-GIS Content: Secondary Check	
Moderator Details	
Name:	Date:
Moderator Checklist (Review previous checklist)	
Is the previous checklist accurate?	Y N
Is **no** additional work required?	Y N
If any of the answers were No, list reasons why and return to editor:	
....	
....	
Confirmation	
Signed:	Date:

Conclusion

MODIS satellite data is a relatively simple and straightforward source of satellite data. Worldview, in particular provides a service that minimises the potential misrepresentation of data. This negates any potential consequences and opens up the use of GIS data to wider community.

In conjuction with this guide, geographically accurate and informative GIS contents can be produced which will not only provide valuable information to the viewer but also increase commercial appeal. Ideally, through the use of satellite data, the goal is to promote and empower the media industry which will lead to increased awareness of natural disasters and assist in preparation, mitigation and recovery.



Acknowledgement/Disclaimer

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