Phenological Assessment of Darling River claypan lakes using satellite imagery

Satellite データを用いたダーリング川沿い湿地のフェノロジー分析

○Kithsiri Perera[1] and Ryutaro Tateishi[2]

[1] Faculty of Engineering and Surveying and Australian Centre for Sustainable Catchments, University of Southern Queensland, West Street, Toowoomba 4350 QLD Australia. Tel; +61-7-4631-2543, E-mail; perera@usq.edu.au

[2] Centre for Environmental Remote Sensing (CEReS), Chiba University, 1-33 Yayoi-cho, Inage-ku, Chiba 263-8522, Japan Tel; 043-290-3850, E-mail; tateishi@faculty.chiba-u.jp

Abstract: Earth observation satellites with higher spatial resolution capability provide four or more image bands at less than 10m resolution and ideally suitable for conducting numerous land cover classifications, especially for small areas. This study uses AVENIR 2, SPOT, and DigitalGlobe images on multitemporal basis to examine the health of clay pan lakes associate with spontaneous wetlands in the Murray-Darling River Basin, Australia. These unique lakes along the river add an essential lifeline to numerous flora and fauna in harsh central Australian climate. A research conducted in 1996 estimated that there are 18,500 wetlands located within the basin. In another recent study, 98 waterbird species were recorded in these wetlands. The same study recorded that bird species like ibis and egrets have very high sensitivity for water level changes. However, extreme fluctuations in water levels are negatively affecting the health of these lakes and wetlands. Due to the ever increasing human activities such as irrigation, recreation, and changing land use of the river system and highly fluctuating river water regime and water quality, the spatial status of small linear shape lakes can be used as a phenological indicator to assess the river health. After a long drought spell, Darling River catchment received a huge amount of rainfall in last two years, causing dynamic environmental changes along the river. These changes can be affected to mapping aspects too, due to the expansion of wetlands associate with lakes. The study founded that high resolution satellite images can be counted as a good candidate to monitor small land cover features in these wetlands. Mapping detail land cover of selected lakes under number of extreme weather conditions like prolong drought and heavy rain will help to understand and evaluate spatial conditions of claypan lakes and the surrounding environment.

Keywords: *Darling River, Satellite data, Claypan lakes, river health, phenological indicator*

1. Introduction

One of the largest river basins of the world, Murray-Darling covers over 1 million square kilometres of land or about 14% of Australian landmass. From the economic point of view, the basin generates 39% of the Australian national income coming from agriculture (Murray-Darling Basin Authority, 2008). From the ecological point of view, the Murray-Darling system plays the leading role in Australian flora and fauna. The basin provides the breeding grounds for many species of waterbirds, freshwater fish varieties, apart from being the environment for a large number of trees and plants, at national level (Scott, 1997). In a 1996 study, 98 waterbird species were identified in the river system which has over 18,500 identified wetlands. The ecological value of these wetlands and small lakes (claypan lakes) along the wetlands in Darling River is immense. Seasonal changes of these wetland environments are important since they are behaving as indicators of the health of entire river system. Monitoring river and lake conditions and wetlands using satellite data is a well established field of research (Esa, 2004). Application of satellite images is a cost-effective method to monitor claypan lakes too, where ground access is costly or difficult due to the remoteness of these lakes and wetlands. Figure 01 shows the location selected for study, a claypan lake near Collarenebri, west to Gwdir Wetlands in New South Wales. The area is located on the Maclntyer River, within the upper catchment of Murray-Darling river system.

2. Climate regime and clay pan lakes

Like any other location, fluctuations in rainfall amounts have recorded in the Murray-Darling basin throughout the history. Figure 2 presents a graph produced from rainfall regimes recorded in Collarenebri rainfall station, the closest station to the selected study area. As a result of land cover changes after the arrival of European settlers, wetlands were affected adversely. Ecosystem related to wetland and clay pan lakes are ecologically vibrant in wet and dry cycles in water amount. However, this ideal wet and dry pattern has altered due to extreme weather conditions in recent decades (Scott, 1997).

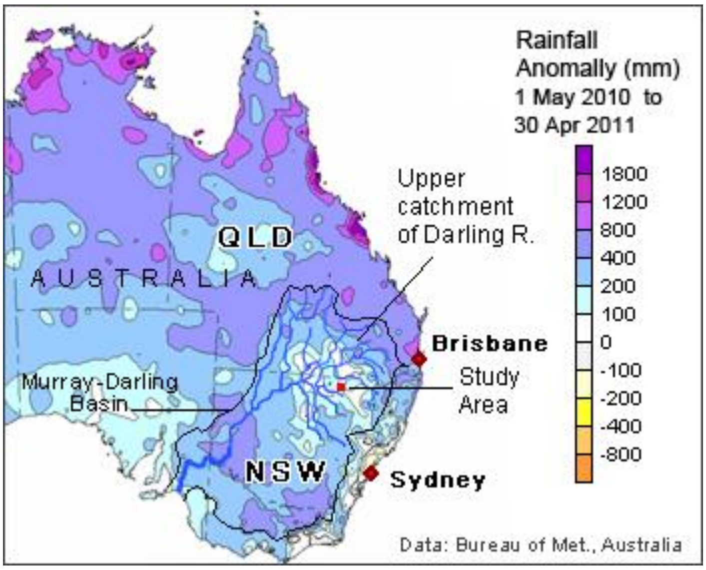

Figure 1. The study area (left). Australia including catchment of Darling River received heavy rainfall in recent months triggering an increase of river water flow.

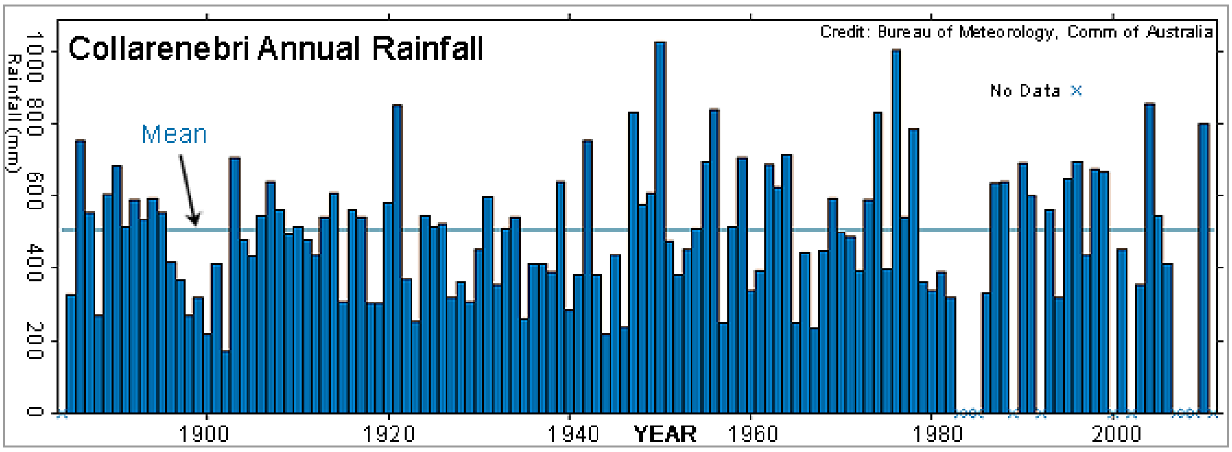

Figure 2. Historical rainfall fluctuations around study area.

Extremely dry and extremely wet climate conditions can be negatively affected for these lakes since such fluctuations are threatening to the survival of flora and fauna of the system. As an example, according to historical records, a moderate level waterbird breeding event may occur once in every other year. However, this rainfall pattern has drastically changed and now, wet-dry-wet cycle is successfully occurring only once in about 10 years. There were number of extremely wet seasons were recorded in recent years, but time span in small rainfall regimes became longer. Many studies have highlighted this change of river water flow and irregularities in rainfall pattern of Murray-Darling river basin (Kingsford and Thomas, 1995; Scott, 1997).

3. The case study

3.1 Monitoring and mapping

The impact of these climatic changes on wetlands and clay pan lakes was intended to monitor in this study using satellite images. The images in figure 3 present the study area extracted from, Digital Globe

(2004) and ALOS AVNIR-2 system (2007) (Geoscince Australia, 2011 and Google Earth, 2011) over an area closer to Collarenebri, NSW. The ALOS image was interpolated into Digital Globe image resolution for visual interpretation. The high to very high spatial resolution of the image displays the river, lake, expansion area of the lake and land cover in vicinity in fluctuations of rainfall. Images were selected to represent a wet season and a dry season (see table 1).

Figure 3. Visually interpreted images clearly show the changes in wetland and the human impact on the land surface, where large scale clearances have turned bush into grasslands.

Table 1. Rainfall amounts received in study area, with respective to each image date.

Image date	A month prior to image	3 months prior to image	6 months prior to image
2004 Mar 15 (Digital Globe)	218.8	279	386
2007 Feb 04 (ALOS)	58.7	147	239

3.2 Status of clay pan lakes

The figure 3 presents satellite images and two maps produced by visual interpretation. According to the primary object of the study, which is to monitor the conditions of a claypan lake, only a simple image interpretation was conducted. The interpreted maps highlighted the impact of rainfall regime on the clay pan lake located in the centre area of the image. Rainfall conditions within the last 30 days (table 1) of the each image date have a clear link with the wet land conditions. As it's clear in figure 3, when the extreme rainfall event occur in 2007, claypan lake has joined with the river flow temporarily, causing a significant alteration to its historical habitat. These irregularities, including severe droughts in wetlands may force its habitat to move from smaller clay pan lakes to more living-friendly wetlands in the river basin. These changes may cause significant phenological changes in clay pan lake environment. According to a CSIRO report (Scott, 1997), monitoring the habitat of wetlands needs long-term involvement. Even though satellite images are not capable to directly identify wetland habitat, the regular monitoring of land cover conditions will provide a voluble data source for most of the other studies dealing with wetlands. Apart from extreme climate impact, images showed the extensive clearance in bush (savannah type vegetation) around wetlands. Figure 4 shows these land cover changes in a close-up view of a sub-section of 2004 image.

Figure 4. The impact of land clearance on wetlands and clay pan lakes (A=Bush, B=Grass, C=boundary of clearance, D=affected wetland of section of the clay pan lake)

4. Conclusions and future research steps

A selected clay pan lake in Murray-Darling river basin was studied to establish the land surface change as a possible phenological indicator to evaluate the river environment. Manually interpreted satellite images obtained in wet and dry spells showed the drastic changes in clay pan lake and the surrounding wetland. This report only present a section of ongoing study and detail image interpretation will conduct together with field investigation in future research steps. A detail level phenological assessment can be followed after field investigations and field tours under wet and dry conditions are important in this aspect. The multitemporal analysis with more satellite images to represent number of rainfall regime will explain extent of fluctuations in wetland boundary and the clay pan lake conditions. With regards to use of satellite images, ALOS AVNIR-2 images can be counted as a good option with its 10 spatial resolution and low cost (JAXA, 1997). The study shows the application of satellite images as a cost-effective approach to monitor remotely located wetlands and clay pan lakes in the river basin.

Acknowledgements: Thankful to CEReS, Chiba University, Japan, for partly funding this work under cooperative research grant (P2010-1). Also, special gratitude is due to Dr K. MacDougal and Dr. A. Apan, Southern Queensland University, Australia, for institutional facilities and encouragements.

References

Esa. (2004). Monitoring River and Lake Levels from Space, esa bulletin 117 - February 2004, www.esa.int

Geoscience Australia, (2011). ALOS AVNIR-2 data, Satellite Imagery and Product Samples, http://www.ga.gov.au/earth-observation/accessing-satellite-imagery/samples.html

JAXA, (1997). ALOS Research and application project. http://www.eorc.jaxa.jp/ALOS/en/about/avnir2.htm

Kingsford, R. T. & Thomas, R. F.,(1995). The Macquarie Marshes in arid Australia and their waterbirds: a 50 year history of decline. Environment Management, 19(6): 867-878

Murray-Darling Basin Commission, (2005). River Murray System - Drought Update, Ref 05/1610

Scott, A. (1997). Relationship between waterbird ecology and river flows in the Murray-Darling Basin, CSIRO Land and Water, CSIRO