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SKM

Browse LNG Development

APPRAISAL OF THE JAMES PRICE POINT MONSOON VINE THICKET AND DRAINAGE BASIN VEGETATION WATER DEPENDENCE

ADDENDUM - NDVI

- Rev.1
- 18 May 2012

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Limitation Statement

The sole purpose of this report and the associated services performed by Sinclair Knight Merz ("SKM") as part of the Consolidated Environmental Services ("CES") contract was to undertake an addendum appraisal study of the James Price Point monsoon vine thicket and drainage basin vegetation water dependence as part of the Browse Liquefied Natural Gas (BLNG) Downstream Development. This study was conducted in conjunction with the client in accordance with the scope of services set out in the contract between CES and the Client, Woodside Energy Limited (Woodside). That scope of services was developed with the Client. This review is to provide information in relation to the likelihood of presence of Bilby in the area of the Downstream Development, the likely preferred habitats and to provide a status and summary of the current knowledge in relation to the species in the study area.

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1. Addendum

1.1. Overview

Remotely sensed data have been processed to gain a better understanding of potential groundwater use by evergreen and deciduous monsoon vine thicket (MVT) at the James Price Point coastal area due to the absence of on-site ecological and hydrogeological investigations. A normalised difference vegetation index (NDVI) was calculated for Landsat images selected to represent end of wet and dry seasons (Table 1).

Table 1 Landsat image capture dates for NDVI analysis

Year	Wet season	Dry season
2001	28 March	7 November
2003	19 April	5 November
2005	15 March	22 August
2008	7 March	2 November

An atmospheric correction was applied to each Landsat image prior to calculating the NDVI to normalise comparisons between seasons and years.

The overarching assumption in this analysis is that inter- and intra-annual changes in NDVI are due to vegetation response to changes in the availability of water. It is assumed that for regions where there is low variability in NDVI between wet and dry seasons, that vegetation has consistent photosynthetic activity owing to its access to a relatively constant source of water (potentially groundwater). Dressel *et al*. (2010) presents a time series MODIS vegetation index (EVI) showing consistent annual photosynthetic activity of red gum forest in comparison to variable annual photosynthetic activity of pasture.

NDVI, however, is subject to a number of variables that can complicate this analysis, including:

- Micro-climates
- Vegetation type
- Vegetation density
- Reflectance
- Soil type

- Soil evaporation
- Soil salinity
- Groundwater salinity.

1.2. Climate

Monthly rainfall for the years Landsat data was captured for NDVI analysis is presented in Figure 1 and Table 2 summarises the rainfall conditions preceding the dates selected to represent end of wet and dry seasons for NDVI analysis.

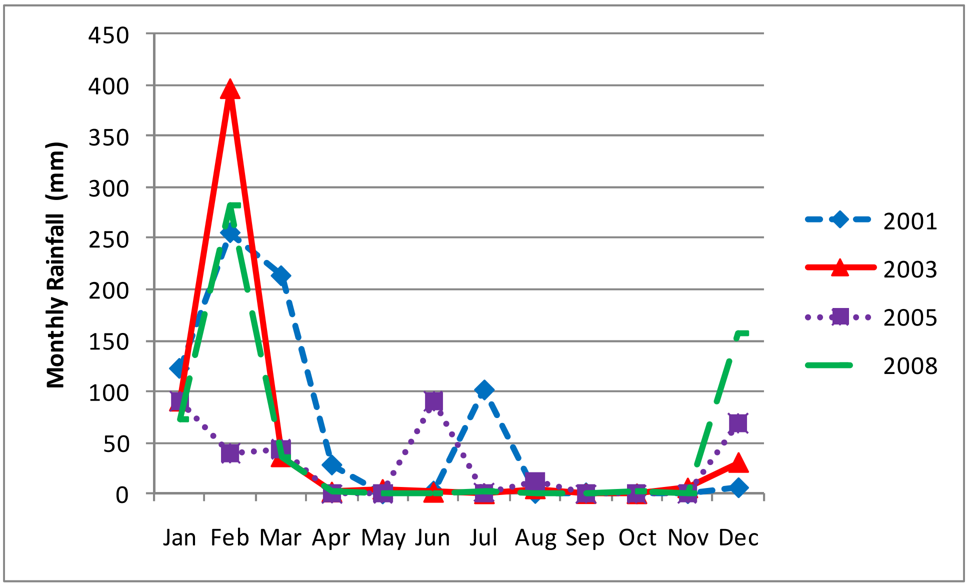


Figure 1 Monthly rainfall totals at Broome Airport (Station # 3003) for years that Landsat images were captured

Table 2 Summary of climate conditions preceding dates selected to represent end of wet and dry season for NDVI analysis

Year	Wet season rainfall	Dry season rainfall
Average 603 mm/yr (1941 to 2010)	▪ 537 mm (Dec- Apr)	▪ 14 mm (Aug – Nov)
2001	▪ High 2001 wet season rainfall, 730 mm (Dec 2000 – March 2001) ▪ Higher than average annual rainfall occurred for the five years preceding 2001	▪ Dry season rainfall <2 mm (Aug – Nov) – 4 months ▪ Late commencement of dry season
2003	▪ Average wet season rainfall, 533 mm (Dec 2002 – March 2003) ▪ Rainfall was lower than average during 2002	▪ Dry season rainfall 13 mm (Apr - Oct) – 7 months
2005	▪ Low wet season rainfall, 253 mm (Dec 2004 – Apr 2005) ▪ Rainfall was higher than average during 2004	▪ Dry season rainfall 12 mm (Jul – Nov) – 2 months ▪ Late commencement of dry season ▪ Image only available for beginning of dry season (Aug)
2008	▪ Lower than average wet season rainfall, 478 mm (Dec 2007 – Apr 2008)	▪ Dry season rainfall 9 mm (Apr – Nov) – 7 months

1.3. Vegetation

The end of season average NDVI differences in vegetation communities in relation to distance from the coast have been presented in Figure 7-3 and Figure 7-4 of the main report (SKM 2011). These communities are likely to exist in these discrete areas due to a combination of climatic (coastal effects), hydrological (inundated vs. non inundated areas), soil (texture, salinity) and hydrogeological (depth to water, groundwater salinity) conditions.

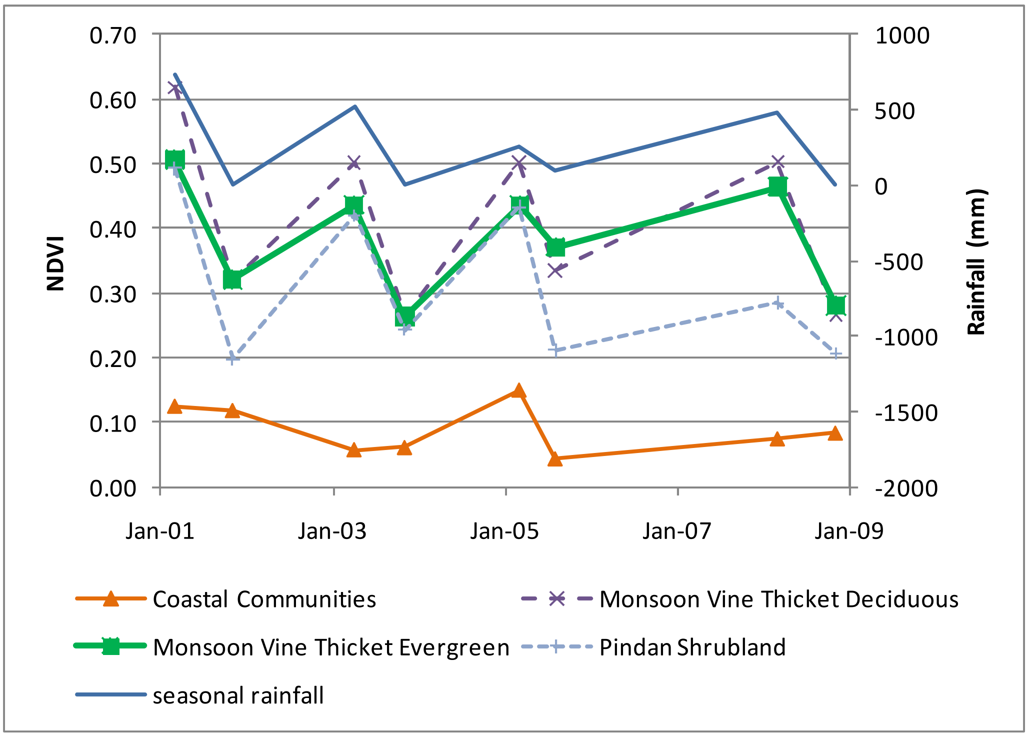
1.4. NDVI Analysis

The NDVI for 2001, 2003, 2005 and 2008 has been presented (Figure 2 in this report and Figure 7-3 and 7-4 of the main SKM 2011 report). Figure 2 represents the end of wet and dry season average NDVI and the intra-annual differences. These data show that the highest NDVI during each wet season analysed occurs in the deciduous section of the MVT, whereas on average, the highest NDVI during the dry season tends to occur in the evergreen section of the MVT. Coastal vegetation communities experience the lowest NDVI during all wet and dry season analyses.

The seasonal changes in NDVI are high across most of the vegetation communities, with the marked exception of the coastal vegetation communities which have a consistently low NDVI. This appears to be due to sparse vegetation over sandy beaches.

The patterns of photosynthetic activity (NDVI) seem to be largely driven by rainfall. There are four distinct trends in NDVI:

- Consistently low NDVI and low intra-annual variation in NDVI characteristic of the Coastal Communities
- Moderate NDVI with high intra-annual variation in NDVI characteristic of the Pindan Shrubland as well as the Buffel Grassland, Open Forest and Open Woodland (not presented in plot for simplicity)
- High NDVI with moderate intra-annual variation characteristic of the evergreen MVT
- High NDVI with high intra-annual variation characteristic of the deciduous MVT



- **Figure 2 Average end of wet and dry season NDVI for James Price Point vegetation communities compared to total rainfall in the four months preceding image capture**

1.5. Implications for Sources of Water Accessed by Vegetation

It is assumed that the consistently low NDVI of the Coastal Communities reflects the characteristics of the sandy beaches rather than vegetation communities.

The evergreen MVT maintains a high NDVI and has relatively low variation in intra-annual NDVI, indicating that it has a more consistent source of water than the other vegetation communities. This could potentially be because deeper soil stores and/or groundwater provide a more consistent source of water to evergreen MVT. This feature could also be caused by large differences in the water holding capacity of and/or salinity of soils between MVT evergreen communities and areas covered by other vegetation types.

While deciduous MVT exhibits similar variations in NDVI to the Pindan Shrubland-type communities, the NDVI is consistently higher, indicating consistently higher water use in deciduous MVT than Pindan Shrubland-type communities. This may purely be because deciduous MVT becomes inundated by surface water seasonally and stores more water in the soil profiles (different soil textures). However, the consistently high NDVI exhibited by deciduous MVT is similar to evergreen MVT at the end of the dry season, which could be due to access to deeper soil

stores and/or groundwater, and the much higher variation in NDVI is due to opportunistic use of surface water when available and leaf loss during dry seasons.

It is assumed that the Pindan Shrubland-type communities do not have access to groundwater due to their high variation in intra-annual NDVI values and landscape position.

Field validation is required to confirm the sources of water used by MVT. Where NDVI is relatively high in all of the end of wet and dry season snapshots (e.g. areas where the drainage lines intersect the MVT) provides a good indication of where to commence field investigations.

1.6. References

Dressel P E, Clark R, Cheng X, Reid M, Terry A, Fawcett J and Cochrane D 2010. Mapping Terrestrial Groundwater Dependent Ecosystems: Method Development and Example Output. Victoria Department of Primary Industries, Melbourne VIC. 66 pp.

Sinclair Knight Merz (SKM) 2011. Appraisal of the James Price Point Monsoon Vine Thicket and Drainage Basin Vegetation Water Dependence. Report produced for Woodside Energy Ltd.