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ASSESSING THE CUMULATIVE EFFECTS OF WATER MANAGEMENT BY THE MINING INDUSTRY IN RANGELAND ENVIRONMENTS

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THE ISSUES BEING ADDRESSED

The Pilbara region of WA alone contributes about $10 billion in export earnings from mining iron ore. The industry is expanding in the region with many new prospects being developed. While each project is assessed for its environmental impact separately, it is apparent that in rangeland environments with many mines in close proximity, there may be cumulative impacts of altered hydrology on regional landscape values. Activities and infrastructures that can change surface and groundwater conditions include dewatering, abstraction, waste dumps, linear infrastructure, evaporative ponds and mine voids. In the Pilbara, specific impacts on water dependent biodiversity are linked to mine dewatering and discharge of groundwater to surface water systems.

Both industry and regulators have effective strategies, management tools, processes and scientific information for site-specific assessment of impacts. There is a need to integrate the individual company-by-company approaches into the regional context so that cumulative impacts in time and space can be assessed and managed. This requires a framework that can enable the impacts to be interpreted in a regional context, and then managed to conserve regional values.

PROJECT OBJECTIVES

The objectives of the project, which was commissioned by the Western Australian Department of Water and funded by the Natural Heritage Trust are to collect natural resource and environmental data, and to develop tools at regional scale to assess cumulative impacts on water and vegetation assets. The Project aims ultimately to result in improvements in the data routinely collected by industry and regulators and the use of such data in effectively managing the cumulative impacts of altered hydrology through licensing mechanisms and on-ground management.

THE CENTRAL PILBARA

The study area of 6,158 square kilometres is located approximately 120 km north east of the town of Newman and includes the central area of the Hamersley Range, and an area of the Fortescue River Valley, south of the Fortescue Marsh (see Figure 1). The sub-region includes three existing iron mines (BHP Billiton Iron Ore’s Mining Area C and Yandi Mines, and Rio Tinto Iron Ore’s Yandi Mines), with other mines being developed. The vegetation includes Acacia sparse woodlands, hummock and tussock grasslands between tall shrubs and sparse woodlands. The area contains a nationally significant wetland (Fortescue Marsh), part-groundwater fed streams (Weeli Wolli Creek) and important Indigenous heritage values (ANRA 2007, DEWR 2005). Groundwater occurs in valley alluvium, calcrete, Robe pisolite, and fractured sedimentary rock aquifers. It is generally abundant and potable (Johnson and Wright 2001). There is significant groundwater / surface water interaction in the area, especially in creeks and rivers where the groundwater is typically 5 m below the surface.

THE APPROACH BEING TESTED

The central project tool is the application of Geographic Information Systems (GIS) to interpret and present all available spatial data, and then to use the tool to interrogate the interpreted data to determine the impacts of altered hydrology from multiple developments at spatial scale in the area. The approach being tested is to visualise the results in a series of map queries, conceptualised in the flow diagram below (Figure 1).

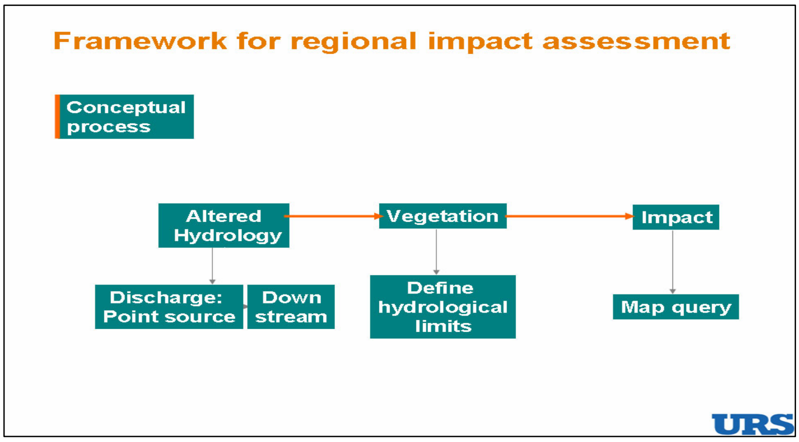

Figure 1. Conceptual framework for regional impact assessment.

As a consequence of detailed site-by-site accumulation and interpretation of bio-physical data for mining developments, the Pilbara is relatively 'data rich' for a rangeland environment. It has also been the subject of some regional scale investigations of topography, geomorphology, soil types, hydrology and drainage patterns, digital elevation modelling, rangeland land systems and vegetation, and biodiversity surveys. Cadastral data are available for mining leases and mining activity, linear infrastructure, pastoral lease boundaries, groundwater licenses, and abstraction data. Available 'data layers' in the public domain have been incorporated into the GIS.

DEFINING SURFACE WATER AND GROUNDWATER DEPENDENT ECOSYSTEMS AT SPATIAL SCALE

The initial objective is to use available data to describe and define spatially areas of land within the study region that have:

- A high level of dependency on overland sheet flow, flooding and/or regular inundation for ecological functioning;
- A high level of dependency on shallow seasonal and/or permanent presence of groundwater and permanent surface pools for ecological functioning; and/or
- A high level of sensitivity to excess surface flows from groundwater discharge.

This is being followed by a consideration of how this information, used in conjunction with groundwater data may contribute to identification and management of cumulative impacts.

Presenting and interpreting the vegetation data for its sensitivity to altered hydrology

The available spatial information at regional scale comes from Beard (1975) and Van Vreeswyk *et al*. (2004). The information contained within the reports is co-dependent, in that the work done by Beard has mapped vegetation types and Van Vreeswyk *et al.* (2004) have described land units and ecological site types and mapped land systems as repeatable patterns.

None of these spatial resources have mapped specifically areas of land that have a high dependency on surface and/or groundwater flows. Therefore the approach used relies almost entirely on interpreting land system descriptions in Van Vreeswyk *et al.* (2004) for the ecological site types that are likely to be dependent on surface and groundwater flows in sustaining those types, and the land units within each land system that support these vegetation types.

The approach uses the following steps.

1) Selection of **ecological site types** likely to have a high reliance on overland flow to maintain ecological functioning. These tend to be extensive, gently sloping washplans that support patterned vegetation in drainage foci, with run-off sustaining vegetation in often groved foci.
2) Selection of **ecological site types** likely to have high dependency on surface flows plus a possible or potential high dependency on shallow groundwater presence and/or river pools to support ecological functioning. This assumes that shallow groundwater stores are maintained from

recharge *in situ* (i.e. from stream flows) and from sub-surface inflow from surrounding landscapes. These types tend to be terminal drainage foci and sumps and the riparian zones.

3) A suggested rank ordering of the above ecological site types for the degree of sensitivity to alteration of surface and/or groundwater hydrology. This has not been used in spatial presentation.
4) Identification of the **land systems** located in the region, the areas of each, and the **land units** within each land system whose location in the landscape and geomorphology suggests that they are likely to have a high dependency on overland flows, flooding and inundation. In most cases these units support ecological site types with a high reliance on surface water flows.
5) Identification of the **land units** whose location in the landscape and geomorphology suggests that they are likely to have a high dependency on surface water flows, and potentially a high level of reliance on shallow groundwater that is recharged *in situ* and from sub-surface inflows, using criteria provided by Eamus et al. (2006) as a guide. While it is easy to recognise major streamflow units in lower parts of the landscape, it is less easy in considering the reliance on groundwater levels in narrow drainage lines in land systems higher in the landscape.
6) Using the **area of each land system**, and the **percentage of the area occupied by units** in each category (surface flow dependent only, surface and groundwater dependent assumed), the area of each land system that is assumed to be dependent on surface flows and the area dependent on surface flows and the presence of shallow groundwater can be calculated.
7) Presentation of this material spatially.

The products to date

Spatial presentation of the relative reliance on vegetation on surface water flows (Figure 2) and groundwater (Figure 3). GIS techniques using these data in conjunction will all other data sets can be used to query the likely impacts of disruption to overland flow, and drawdown of groundwater levels on the vegetation resources in the area, as a precursor to more detailed investigations.

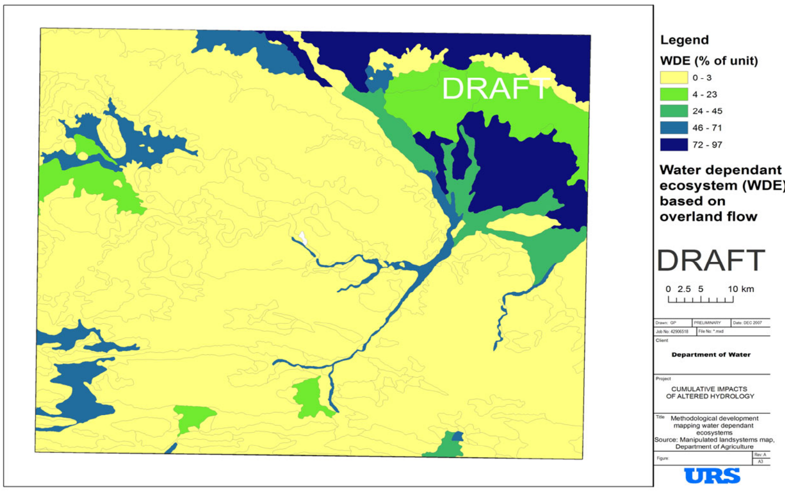

Figure 2. Modified land system map to represent percentage of each land system with surface water flow dependent ecosystems, Focus Study Area (Data Source: Modified data from the Department of Agriculture) DRAFT MAP

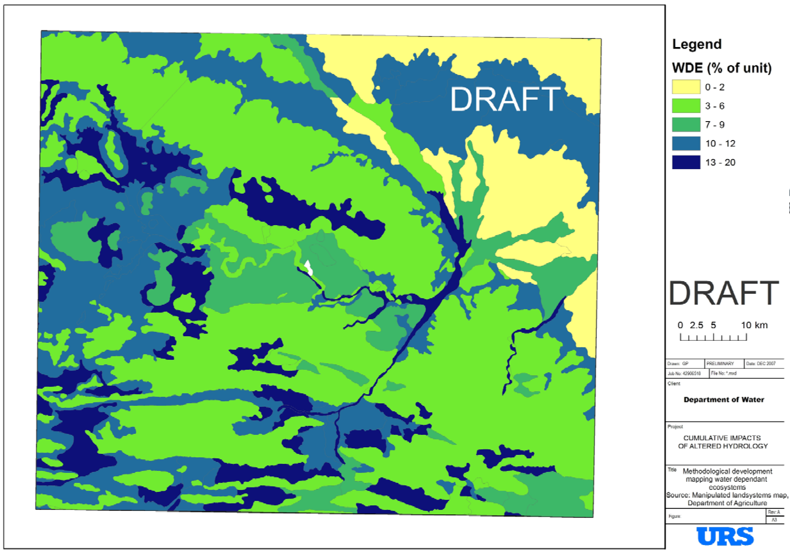

Figure 3. Modified land system map to represent percentage of land system with potential reliance on groundwater presence for ecosystem functioning, Focus Study Area (Data Source: Modified data from the Department of Agriculture) DRAFT MAP

CONCLUSIONS

This is a work in progress. The next step will be overlaying an assessment of the level of altered hydrology to the areas of potential high impact, and testing how well the approach can define hydrological hazards to vegetation resources in a case study within the region. Finally, this use of rangeland inventory and condition data for the Pilbara highlights its value in providing regional connectivity between more focused site-by-site information assembled by individual companies.

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REFERENCES

ANRA (2007) Biodiversity Assessment – Pilbara, Table of wetland values. Australian Natural Resources Atlas (ANRA), Department of Environment, Water, Heritage and Art.

Beard, J.S. (1975) Vegetation Survey of Western Australia - Pilbara. Explanatory Notes and Map Sheet 5, 1:1000000 series. Vegetation Survey of Western Australia. University of Western Australia Press, Nedlands.

Department of the Environment and Water Resources (2005), A Directory of Important Wetlands in Australia Factsheet, Department of Environment, Water, Heritage and Art.

Eamus D., Froend, R., Loomes, R., Hose, G. and Murray, B. (2006). A functional methodology for determining the groundwater regime needed to maintain the health of groundwater-dependent vegetation. *Australian Journal of Botany* 54, 97-114.

Johnson S.L., and Wright A.H. (2001) Central Pilbara groundwater study: Water and Rivers Commission, Hydrogeological Record Series, Report HG8, 102p.

Van Vreeswyk A.M.E., Payne A.L.,. Leighton K.A and Hennig P. (2004) 'An Inventory and condition survey of the Pilbara region, Western Australia.' Technical bulletin no. 92, Department of Agriculture, Western Australia.