White Paper

Advanced Agricultural Weather & Fire Intelligence

Modelling & Visualisation

Creation of an Advanced Weather Intelligence (AWI) Platform to provide a robust "forward-in-time visualisation" of both opportunity and threat modelling for decision support.

> *"If a big-data ensemble, (weather - topography - demographics - cropping cycles etc.) decision support suite was created, we could empower decision makers from governments through to the farm paddock in real-time, improving outlooks and optimising resources as well as helping to mitigate risk. In the unlikely scenario that a fire or flood emergency occurred, the platform itself would provide timely escape options, pushed through to end-users…"* *David Miles (Director Miles Research)*

This paper is to outline a "first step" in the process of harnessing big-data modelling across disparate disciplines, to deliver advanced visualisation decision support, to clients and regional stakeholders.

The aim of the collaborative project to demonstrate viability from an agri-business perspective, (ie. to be self-funding) as well as to provide "an advanced visualisation" from an emergency management perspective, allowing the 'testing' of real-time, interactive, 4D event visualisation, for in-crisis framework.

The key to project success is forward-in-time modelling of weather in conjunction with <u>all</u> known datasets which impact on opportunity and threat, rather than presenting weather simply as a 'stand-alone advisory' - which is a present Bureau Of Meteorology (BOM) practice.

The AWI project will culminate in a proof-of-capability platform which will become an industry demonstrator.

Agricultural Commercial Foundation

Interpreted intelligence ahead of the time-horizon will assist both private and public industry, in pursuit of planning and optimising operations with respect to weather and the environment. Within the agricultural sector, crop and farming cycles and vulnerabilities change throughout the growing season and important decisions are often made without a complete awareness across all relevent datasets, by simply looking at weather.

Limited verses 'unlimited' data

Current bureau practice involves separated departments for long range climate modelling, compared to the modelling of short term forecasts, different data-sets and different graphical outputs all of which must be interpreted, rather than a seamless transition *(and therefore a seamless 'whole data model' and visualisation)* that mimics the real world.

Although there has been considerable improvement in accuracy and resolution of meteorological forecasting, including the ability to predict weather event pathways, intensity and timeframes, BOM visual outputs consist in predominantly "2D meteorological symbolism" and require interpretation by meteorologists for the general public.

Most news services provide interpreted "weather forecasts" via a meteorologist or "weather girl" who provides a "interpreted synopsis" of developments. In contrast modern highly developed, graphical 3D children's interactive games, allow users to enter a visual world, where decisions may be based on familiar, visualised realities dynamically presented. With recent increases in accessibility to "big-data" resources and processing, it would seem therefore beneficial that industry develop a "new middle ground visualisation standards" for environmental modelling, to permit layering of rich content and swift navigation of vital information for stakeholders.

The proposed demonstrator project will aim to bring together the necessary bandwidth of agri-business related data and present live visualisation of overlapping geospatial and time-synchronised modelling. This 'demonstrator' would be a real-world working platform, identifying both opportunity and risk - including hail, frost, heat threats against crop vulnerability cycles, as well as live fire threats.

The demonstrator platform could be presented to government, private industry and the general public via both a signature visualisation 'data-wall' as well as being transitioned for client access via mobile smart-phones, tablets and PDA's.

Weather Intelligence Modelling

Severe weather events continue to present a challenge in both in frequency and destructive force. From a commercial perspective services into the severe weather pre-emptive modelling market could attract major clientele across many sectors.

Data from Munich Re's NatCat Services puts the 30-year global-loss annual average at US$ 130 billion.[1] According to a 20-year analysis produced by the UN Office for Disaster Risk Reduction (UNISDR), 90% of global disasters are weather related.

Globally, bushfires seem to be compounding in size and intensity - more often now we hear of them described by experts as mega-fires.[2] Scientists and climate analysts generally agree that these trends will continue. Cyclones / hurricanes, tornadoes, drought, flooding, fires and temperature variability extremes will continue to remain a considerable threat to global population centres and high priority assets, such as nuclear reactors.

What has improved though is our ability to forecast, observe, model, and communicate. At the observation interface *(surface, atmospheric and space based)* technologies have leapt forward considerably. Geostationary and orbiting satellite instrumentation has seen an increase in both granularity sensed and breadth of spectrum calibrated. Swath (of-land-ocean) overlap has increased to allow a whole-of-planet awareness with improved temporal cycles and meteorological data sharing and collaboration across the political and religious divide.

Disparity

Despite significant developments, the following dramatic example reveals **a failure of current meteorological 'best practice' to accurately foresee real-world threat levels** in the US: Hurricane Sandy - October 22, 2012

> Hurricane Sandy was initially estimated to be a '1-2 billion USD damage-event.' Re-insurers predicted its impact as a possible 5-10 billion USD exposure.[3] Sandy made land-fall in on October 29 in New Jersey, just to the northeast of Atlantic City, as a post-

[1] Ref. Munich Re NatCat Services. In 2015 around 22% of all global losses occurred in North America (included, Central America and the Caribbean) causing around 800 fatalities. Monetary impact was estimated at around US$ 30 billion, with ten of the 230+ events valued at over the US$ 1 bn threshold. These events included winter storms, severe storms and floods in both USA and Canada. The total burden of loss for USA alone came to US$ 24 bn.

[2] Ref. Bartlett 2003, The *Mega-Fire* Phenomenon: Some Australian Perspectives

[3] See Ref. http://www.eqecat.com/catwatch/hurricane-sandy-insured-losses-initial-estimate-5-billion-more-2012-10-29/

tropical cyclone with hurricane-force winds. Hurricane Sandy delivered to the US, a post-event estimate damage bill of 71 Billion USD.[4]

Due to lack of any accessible assimilation of forecasting storm and wave-surge data with population demographics, infrastructure vulnerability and topographical - geographical information, there could be no accurate forward awareness of the massive scale of impact by Hurricane Sandy on landfall.

The proposed demonstrator aims to bridge this gap in current meteorological modelling verses real world event-threat.

Technology Improves Survivability

Human survivability depends on pre-disaster preparedness, whether via protective infrastructure / systems, programs of population evacuation and decision support information dissemination - that may reduce human exposure to the disaster. Vital life-saving contributions of emergency services personnel and NGO's in post-disaster response, also dramatically reduces human losses. Pre-disaster preparedness requires accurate forecasting and information dissemination. Advanced warning information is now more readily communicated via digital media across high-risk communities, providing for a "new level of pre-disaster awareness" of converging threats - warnings. In this context the contribution from social networking will continue to play an important role both informally and as an enabler for enterprise systems.

Advanced Intelligence *(ahead-of-event)*

With higher speed computing now readily accessible, it is theoretically possible to equip emergency managers / leaders / fire vehicles (etc.) with a new kind of '**disaster intelligence,**' delivered *(before-during-&-after disasters)* via live interactive infographics-feed, from a dedicated operations centre. The information systems from specialist sources, agencies and corporates would feed into highly specific algorithms which analyse terrestrial, human

[4] Wikipedia URL: http://en.wikipedia.org/wiki/Hurricane_Sandy

Author's comment: This stark disparity between initial estimate verses actual damage loss, reveals that current modelling lacks vital infrastructure – vulnerability metrics and cannot interpret meteorological and oceanic storm surge data properly. Such real-time weather and ocean dynamic data must be assimilated with topographical terrain, infrastructure, time-based hydrology modelling etc., to allow for human vulnerability estimates, to be calculated (and PUBLIC WARNED) ahead of real time events. Essentially, presently the (disparate) data all exists, but our daily warnings are still all provided by meteorologists who model weather not infrastructure, human vulnerability and landfall impact.

population impacts along with vulnerabilities across: infrastructure, cropping, environmental, wildlife, traffic flow etc - all ahead of the event time-horizon.[5]

Such a facility once proven could become a standard 'base-line' requirement for emergency / agricultural / business / events weather management and response, given the value of pre-disaster population preparedness.

Drawing deeply on available inter-government supplied data;[6] collaborating with technology leaders from the private sector; applying best practice data assimilation[7] and using leading-edge supercomputing to traverse 'whole-of-event' and environmental awareness, risks, scenarios - ahead of the 'event time-horizon' for population preparedness, evacuations etc.

In addition to creating new data-mining algorithms that take advantage of improved space based observations and where situational data is limited such as local surface weather within a firefighting crisis, new ruggedised solid-state *(ie. no moving parts)* weather data transducers - 'nodes,' could be positioned in/on each fire-truck, *and even with each man or woman firefighter* - that would allow for life-saving wind and temperature vortex data capture and analysis etc via the operations centre during a crisis - uploading to managers and teams live safety exit options, fire modelling / threat visualisations, management tactics etc. *(Ref. e.g.: Linton, Victoria. Further developments are then possible towards fire-proofing fire-fighters.. Future discussion points.)*

Combined, interpreted and presented, early intelligence like this could be accessed via a govt-access / EMV / public-access "data-wall," similar to that used by Formula-1 Racing teams, perhaps also delivered to the desks and vehicles of managers / authorities like stock-exchange trade data - or via secure PDA / Smartphone / Laptops.

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[5] The description "event time-horizon" is used here to describe the time of commencement of an event's material impact on community or local environment

[6] For example The European Centre for Medium-Range Weather Forecasts (ECMWF) is an independent intergovernmental organisation supported by 34 states.

[7] Author's note: Where no analytical algorithms exist, inventing them - eg. Infrastructure algorithm to develop with Google allowing us to scan existing street-view data - ie construction material / veneers / trees, to allow disaster "vulnerability estimate" to be created. This can then provide an instant threat or risk estimate from an approaching storm.

Summary and Conclusion

A new threat-based warning system *(calibrated against cropping, asset and infrastructure vulnerability)* is proposed, which combines client interests and asset exposures to weather. When considering emergency threats such as fire and flooding, a realistic decision support intelligence can be accessed at multiple levels depending on stakeholder and user system-privileges.

Whilst general seasonal intelligence can be offered in return for client positioning and cropping data, within the demonstrator, in the future Mobile phone / tablet / PDA applications and in-app purchases may be used to generate further funding for capital works and creation of dedicated facilities.

The commercial opportunity for this leading-edge demonstrator project is a focus on **delivery of combined threat and opportunity analysis** and also world leading forward modelling inter-sector *(multi disciplinary),* emergency threat visualisation.

In summary, the proposed AWI decision support demonstrator will combine current and historic raw meteorological data feeds, coupled with highly sophisticated graphic output from predictive modelling to significantly increase accuracy, predictability and future scaling towards a global service. It will present dynamic surface, atmospheric and satellite data mapped against an accurate topography model and will include layers such as demographic, infrastructure and human - environmental vulnerability data.

Such a project will empower the whole gamut of industry and government decision makers with cognitive-friendly visualised 'whole-data,' ahead of real-time and at the speed-of-light.

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