Improving Australia's Dispersant Response Strategy

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Abstract

Australia, fortunately, has had fewer major maritime and offshore oil and gas sector oil spills than many other countries. So, it has rarely needed to use its modern chemical dispersant stockpiles in response to major maritime and offshore oil and gas sector oil spills. Consequently, Australia has had very limited opportunity to collect and analyze data from "spills of opportunity" to document the real-world effects and impacts of oil spills on its risk its environments. International experience and research can partly fill this gap, but not all is relevant, transferable or credible. The Australian Maritime Safety Authority (AMSA) has three distinct roles about dispersants: gatekeeper, responder and advisor. AMSA has commissioned independent scientific and research studies to better understand, evaluate and communicate the safety hazards and environmental risks in Australian waters. Ongoing studies are addressing a number of knowledge gaps including health hazards, eco-toxicology and real-time in-situ monitoring. The results from these and future projects will improve dispersant policy, procedure, purchase, use, monitoring and communications. AMSA's coordination of this research by a number of independent agencies provides greater clarity and confidence to managers, users, decision-makers, stakeholders and the general public about all aspects of the dispersant response strategy.

1. Background

1.1. A Pragmatic Dispersant Strategy

Since the 1970s, chemical dispersant application has been a front-line response strategy for maritime and offshore petroleum oil spills in Australian waters. This was a pragmatic solution to the twin tyrannies of Australia's large maritime and land areas, and the long distances from response stores to likely spill sites. Australia's dispersant use policy has essentially remained unchanged for many years. In response to public concerns and scientific controversy raised over the efficacy and potential detrimental effects of dispersants used following the 2010 Gulf of Mexico oil spill much of the detail is under review. The outcome (and ongoing intention) of this program is to better understand and manage the opportunities and risks chemical dispersants offer in spill response under Australia's new 2014 *National Plan for Maritime Environmental Emergencies* (AMSA 2015a), often referred to as *the National Plan*.

The basic parts of the Australian dispersant strategy, as outlined in Irving (2013), have not changed. The new knowledge will add improvements. The national dispersant inventory is being checked to ensure acceptable effectiveness and active hazards management. Acceptance on to the National Plan register will be refined based on new knowledge. Every product must still meet acceptable safety, effectiveness and eco-toxicology requirements. Response use practice through the fixed-wing aerial capability is also being refined.

The more important change will be how managers and responders use the new knowledge to engage with stakeholders and the community. Better information will assist the decision to use dispersant in a response, by taking account of all the relevant circumstances: opportunities; constraints; rules; and expectations. Monitoring response effectiveness will be improved. Engaging with sceptical stakeholders should be easier.

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1.2. The Australian Context

Unlike other large countries (Canada and the USA) Australia has the added complexity of being the island continent. Australia covers six separate ocean climate zones (Equator to Antarctica). It is influenced by three oceans (Indian, Southern and Pacific) and four major currents (Leeuwin, East Australian, and the Pacific Ocean South Equatorial and Indian Ocean South Equatorial)[i]. Six other maritime jurisdictions (Indonesia, France, New Zealand, Solomon Islands, Timor Leste and Papua New Guinea) share boundaries. The Australian extended jurisdiction Exclusive Economic Zone (EEZ) covers more than 8.2 million square kilometres; making it the world's third largest. Australia's 60,000 km mainland coastline and over 12,000 islands (GA, 2015) add more complexity.

Shipping accounts for more than 99% by weight of Australian trade (DIRD, 2015). Each year, Australia's 70 ports receive more than 28,000 international port calls. Overall, Australian shipping traffic is expected to grow by 50% over the next 20 years. But new ports in Queensland may increase shipping in the north east area by up to 80% over the next 10 years (AMSA, 2013a).

The offshore petroleum sector is modest by world standards. Oil reserves are estimated to be around 3.9 billion barrels (0.2% of world reserves) and annual production is decreasing (180 million barrels in 2014). Liquefied natural gas production has grown by 200% over the past 20 years. Gas exports increased in value by more than 400% over the same period (Deloitte, 2013).

The growth has resulted in extra maritime traffic into and through remote, highly sensitive, coral and mangrove dominated areas, such as the Great Barrier Reef, the west and northwest of Australia. This has changed the national (and regional) spill risk and threat profiles, requiring further consideration of dispersant as a primary response strategy (DNV, 2011).

1.3. Influential Local, Recent Experience

Over the past decade, dispersant has been used only twice in Australian spill response operations – each quite distinctive. In August 2009, the *Montara* wellhead platform in the Timor Sea began discharging an estimated 400 bbl of crude each day. This lasted for 105 days until the wellhead was capped. Over the first two weeks 44,000 litres of chemical dispersants were sprayed from the air. Over the next two months a further 132,000 litres was sprayed from vessels. (AMSA, 2010). Public and political questions and concerns raised during the response and after at the independent *Montara* Commision of Inquiry (MCoI, 2011). The report noted that: "*The Inquiry concurs with the decision that was made to use dispersants in this case given the need to avoid oil impacting on Ashmore Reef and Cartier Island and the coastline of Western Australia. The decision was consistent with information available to AMSA at the time.*" Nonetheless, recommendations from the Inquiry have been implemented to improve the way chemical dispersants are considered for use in Australia.

In April 2010, the 230 metre-long bulk coal carrier *Shen Neng 1* ran aground on Douglas Shoal, in the Great Barrier Reef, about 40 nautical miles east of Great Keppel Island. The ship's fuel tanks ruptured to spill approximately four tonnes of fuel oil. Although at a much smaller scale than the *Montara* response the location was more sensitive and newsworthy. Concerned that the spill was much larger than first reported, around 5,000 litres of dispersant was applied from the air during the following two days (GBRMPA, 2011). This resulted in a dispersant to oil ratio of 1.2:1.

Amongst responders and scientific advisers, this high dispersant to oil ratio raised questions, as did the use of dispersants in a clearly shallow coral-dominated ecosystem. The 2011 *Impact Assessment* report on the incident (GBRMPA, 2011) raised concern about the potential for dispersants to maintain the toxicity of the fuel oil while dispersing this over a wider area. It did not mention the net environmental benefit from the significant dilution effect. The potential toxicity of dispersants alone on corals was given scant note.

Both incidents (and their respective reports) were influential in evolving National Plan dispersant strategy. Both were also prescient of the public and technical concerns to come out of the unprecedented amounts of chemical dispersant used in the *Deepwater Horizon* response in the Gulf of Mexico, beginning in April 2010.

1.4. The *Deepwater Horizon* Effect

Media interest and reporting on dispersant use, risk and hazard has reached new heights following the *Deepwater Horizon* incident response. The media has reported on many investigations and reviews, research and scientific reports, and generated much speculation about dispersant use and effects. One such report provided a significant catalyst and context for change in Australia.

In August 2013, the Australian *60 Minutes* programme televised an international media "exposé" of dispersants, their use and effects. The presenters drew parallels between the risks and hazards associated with dispersant use in and around the Gulf of Mexico during the *Deepwater Horizon* incident response and dispersant use in Australia (60 Minutes, 2013). This broadcast drove public opinion. The information presented in the broadcast, and the conclusions drawn and presented, were alarming for many viewers. AMSA (and NOPSEMA) responded to community interest and concern with the best technical information available to them at the time. However, both were unprepared for the level and intensity of the interest, and for the diversity of concerns raised.

For AMSA, this unprecedented public interest in dispersants reinforced the general view that the knowledge requirements for maintaining an Australian chemical dispersant response strategy for use in maritime spills had increased. The apparent effort worldwide after the *Deepwater Horizon* response by many other international response agencies and organisations reinforced this view.

2. Changes and Improvements

2.1. New Institutional Arrangements

In 2010 the review began of the 2000 Australian *National Plan to Combat Pollution of the Sea by Oil and Other Hazardous and Noxious Substances* - the world of oil (and chemical) spill risk and response in Australia (and worldwide) had evolved (AMSA, 2012a).. This proactive initiative was underpinned by numerous reports, including a new national spill risk assessment (DNV, 2011) and the recommendations from the *Montara Inquiry* (op. cit.) as accepted by Commonwealth Government (DRET, 2011). These included recommendations on improvements to the scientific capability for spill preparedness and response (including better understanding of the need for, use of and monitoring of dispersants) and changes to the offshore petroleum sector.

In 2012 the new National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) was created to improve regulation, management and compliance in the offshore petroleum sector. How the offshore sector is managed has implications for improvements in dispersant preparedness for maritime response, and vice versa.

2.2. Defining the Information Need

Under the Australian National Plan, AMSA has three main roles related to dispersants:

- **Gatekeeper –** determining dispersant acceptability for National Plan response use;
- **Responder –** user of dispersant in an AMSA-led response; and
- **Advisor –** provider of technical, risk and benefit information about dispersants to all other National Plan dispersant users and interest groups.

The changes associated with Australia's chemical dispersant capability wrought over the intervening period (and which continue to occur), fall into four general, but overlapping, categories, driven in large part by a combination of new local and international knowledge:

- **Risk assessment –** through improved responder technical knowledge, understanding and capability;
- **Management –** through improved management of dispersant acceptance, acquisition, management and application;
- **Science –** through improved development, recognition and use of local and international science knowledge and capability, including response phase (Type I or situational awareness) monitoring capabilities**;** and
- **Public knowledge –** through improved public and stakeholder information availability and understanding.

This paper will focus on the key new knowledge and capabilities within Australia and how these are being implemented. New international knowledge has also influenced Australian changes. But much of this is already well known from the international scientific and oil spill literature.

Across AMSA's three dispersant-related functions (Gatekeeper, Responder, Advisor), four issues arise that AMSA (and its National Plan partners and stakeholders) considers need to be addressed. So improving knowledge about these will improve engagement with concerned communities and stakeholders:

- **Hazards to human health –** managers, responders and the general public;
- **Hazards to marine ecology and environment –** the toxicity of the dispersants and/or their constituent chemicals to marine life, and in particular Australian marine life;
- **Effectiveness of dispersant response monitoring –** responders and decision-makers need better and more timely information about the operational window for the use of dispersants, methods of application and their potential effectiveness; and
- **Information and knowledge transfer –** a timely and wider understanding of the complex nature of the whole dispersant operation and its risks and benefits.

In 2013, AMSA responded to these four issues by seeking the expertise and advice of two of Australia's peak expert bodies in their respective fields.

- **The National Industrial Chemicals Notification and Assessment Scheme (NICNAS) –** the Australian government's regulatory body for industrial chemicals, administered by the Australian Government's Department of Health.
- **The Commonwealth Scientific and Industrial Research Organisation (CSIRO) -** the Australian government's "trusted advisor" scientific research agency.

2.3. Human Health Hazard Assessment

AMSA has to address the risk to people within all three of its roles. As National Plan **gatekeeper**, health risk is one of the acceptance criteria, but is assessed primarily through existing safety data sheets. As **responder**, ASMA manages a significant nation-wide National Plan inventory of around 330 tonnes of various dispersant products, and in response would expect to use any and all of this safely and effectively. As an informed **advisor**, other response agencies rely on AMSA to support them and their decision-making for and use of response chemicals.

Potential for human health hazards occur at all stages of dispersant procurement, storage, transport, and use. Normally, dispersant is delivered and remains in sealed containers prior to spray operations. So an unplanned spill would be the only reason for exposure before dispersant was used. Exposure during spraying could arise from poor operational technique.

Primary exposure routes include inhalation, ingestion and skin contact, including eye contact (OSPR, 2013).

AMSA asked NICNAS, a Commonwealth health agency, to conduct a thorough and independent review of the health hazards from the 11 chemical constituents[ii] (six surfactants and five solvents) found in the seven dispersant products[iii] already accepted for use in the National Plan. The potential hazard associated with the whole product was not considered logistical reasons. Not all chemicals are present (or in the same amounts) in every dispersant product. This is what gives each product its unique effectiveness and effects. The two NICNAS reports are currently unpublished as AMSA has yet to present the full findings to the National Plan stakeholders. NICNAS will independently publish both later in 2015.

The initial hazard assessment (NICNAS, 2014a) established the toxicity of a chemical and identified the set of inherent properties that makes it capable of causing adverse effects. Using a six-step screening approach, NICNAS identified two chemicals (*Tall oil* and *Sorbitan monooleate*) to be of low human health concern. However, nine other chemicals were referred for further assessment.

For each of these nine chemicals quantitative toxicity values were set for their individual risk assessments, i.e. Lowest Observed Adverse Effect Level, and/or No Observed Adverse Effect Level, (NICNAS, 2014b). Publicly available international information on critical health effects was collated, including quantitative values for toxicokinetics, acute toxicity, irritation/corrosivity, sensitisation, repeat dose toxicity, genotoxicity, carcinogenicity, and reproductive toxicity. Analogue chemicals were used for chemicals with limited data.

Current Australian regulatory controls, such as the Australian Drinking Water Guidelines, Australian Food Standards, Standard for the Uniform Scheduling of Medicines and Poisons, the Hazardous Substances Information System (HSIS), and the Australian workplace classification criteria for health hazards, were also examined.

Of the nine fully assessed chemicals, only four were found to be hazardous to human health. All four are either currently controlled or are recommended for controls in the workplace. One chemical (*Dioctyl sodium sulfosuccinate*) is not currently classified for worker health and safety, but will now be recommended for classification and listing in the HSIS. The remaining four, currently unlisted under the HSIS system, are not recommended for hazard classification, as they were found not to be hazardous to human health.

AMSA will likely:

- Support the recommendation for adding one chemical to the HSIS;
- Require confirmation of NICNAS assessment for all constituent chemicals all of new dispersants under the National Plan Oil Spill Control Agents (OSCA) policy and process (AMSA, 2012b);
- Review all National Plan guidelines for procurement, storage, transport and operational application of dispersants; and
- Review all National Plan safety briefings and hazard assessments (e.g. job safety assessments) associated with dispersant activities;

AMSA has legislative responsibilities under Australian occupational safety law, as do all similar agencies. So, sharing National Plan advice is useful for all agencies.

The reports are currently unpublished, to allow time for assessment and response from AMSA and the National Plan stakeholders, but NICNAS will independently publish both later in 2015.

2.4. Ecological Toxicity Hazard Assessment

AMSA also has to address the risk to the environment within all three of its roles.

As National Plan **gatekeeper**, screening of oil spill response chemical products for ecotoxicology and biodegradation are key acceptance criteria. Applicants for National Plan dispersant acceptance must produce very specific Australian-oriented eco-toxicological test results of >10 mg/L for LC_{50} values for a number of selected local tropical and temperate fish and crustacean species. In addition, other taxonomic groups (e.g. molluscs, echinoderms, algae, macro-algae) are also tested for EC_{50} values (AMSA, 2012b).

As **responder**, ASMA will decide when to use dispersants or any other available oil spill response options, including natural attenuation. This process relies very much on an informed risk assessment based on a simple net [environmental] benefit analysis (N[E]BA) process under AMSA's operational application decision-support tool system (AMSA, 2013b). However, as will be commented on below, reliable information about likely real-world ecological effects of dispersants and oil/dispersant mixtures cannot be derived from laboratory bench-top toxicity tests. The few available local case studies do not adequately fill the information void.

As **advisor**, AMSA has a major role in addressing ecological risk. As the oil spill response community within Australia has limited first-hand experience on the use of oil dispersants, there is a reliance on AMSA, as the national spill response agency, to provide this expertise, in addition to their own local ecological knowledge. As decision-making and dispersant use is increasingly complex and controversial, AMSA has sought independent expert advice from CSIRO under the joint Scientific Support Agreement (AMSA, 2011). In this increasingly complex and controversial area, AMSA must ensure that there is no perception of it having a dispersant user bias at any stage where information is required.

To date, CSIRO has produced two reports for AMSA regarding Australian dispersant knowledge. Adams (2014) looks at how more information can come from the current bench-top screening tests. Current ecological risk from using dispersants is typically extrapolated from the results of species specific toxicity tests. So a considerable amount of the environmentally relevant toxicity data is underutilised which prevents comparison of the overall toxicity of different dispersants. Hook and Lee (2014) completed a literature review on dispersants and potential ecotoxicity associated with their use in the Australian context. The report used the large amount of international information available since the *Deepwater Horizon* response on *Corexit 9500A*, as well as the limited data for commercially available dispersants listed under the Australian registry. The report is an independent, expert reference document for AMSA (and the National Plan stakeholder) to use for future decision-making and education.

Adams (2014) applied species sensitivity distributions (SSD) constructed from the toxicity values from chronic tests, using statistical transformations based on the number of toxicity values available. This approach should provide an opportunity to estimate the concentration of a contaminant at which a pre-defined level of species (e.g. 95%) is likely protected (e.g. PC95). The SSD and PCx approach differs from the pass/fail criteria currently applied by integration of all available toxicity data to assess risk, not just the pass/fail results on crustaceans and fish.

In the absence of detailed field data, the available laboratory toxicity data for five current (and one other) National Plan dispersants[iv] were assessed. A SSD and a Predicted No-Effect Concentration (PNEC) extrapolated at the 95% species protection value (i.e. PC95) was produced for each. Where fewer than five species were tested, the PNEC was extrapolated using a predefined factor to the most sensitive toxicity value. This gives a much more conservative result than under the SSD approach.

PNEC values for the six dispersants ranged from 0.013 to 1.3 mg/L. The toxicity threshold for *Dasic Slickgone NS* and *LT13002* are similar, so they pose a similar risk to marine life. *Dasic Slickgone EW* produced a higher threshold, as per expectations. Across the species, crustaceans showed greatest sensitivity, followed by fish and microalgae. Sea urchins, oysters and macroalgae were among the least sensitive. The results showed that toxicity tests can be sensitive and reliable tests with species endemic to a range of marine environments. It also showed that multi-taxa toxicity assessments, such as SSDs, hold promise as a risk assessment tool for marine life.

The report concluded that the robustness of toxicity data and its interpretation for use in dispersant decision-making in Australian could be further improved by:

- Seeking to establish the relative toxicity of oil, dispersant and dispersed oil to marine biota in order to undertake better informed risk assessment of dispersant use during a response;
- Extending the bench-top screening toxicity tests to concentrations greater than 20mg/L to obtain more reliable toxicity values to incorporate into SSDs; and
- Extending each bench-top test to measure individual contaminant groups (e.g. PAHs) in the test solutions to obtain toxicity values for concentrations of these groups.

The Hook and Lee (2014) review found that most of the reported research is conducted on commercially available dispersant formulations used in North America and Europe. The report highlighted the paucity of data available for decision making in Australia due to regional differences in the available dispersant products, the species under risk and types oil likely to be spilled. The review provides an easily understood overview of dispersant action and oil toxicity, and how to do a NEBA to inform response decision-making. It uses the *Deepwater Horizon* incident as a case study to illustrate each of these. It describes the effects of dispersant and dispersed oil on each major species group, and where relevant, their different life stages. A summary and critique of the field environmental studies (dominated by studies on *Corexit 9500A*) concludes:

- Chemical dispersion with *Corexit 9500A* demonstrably accelerates the process of biodegradation, decreasing the residence time of oil in the marine environment and its overall impact potential;
- Similar studies with other dispersants have not been done – which includes almost all on the Australian OSCA Register – as degradation rates appear to differ across products;
- Dispersing oil increases solubility and hence toxicity. Field studies during the *Deepwater Horizon* response showed dissolved oil concentrations above those shown to affect fish embryonic development in laboratory studies. But what was not shown, was whether these concentrations were sufficiently frequent or sustained to cause widespread effects at a community structure or population level; and
- Laboratory tests have showed that dispersants may be toxic to invertebrate embryos and corals (significant in Australia). However, observed effects may differ in the field, due to recruitment of organisms from surrounding regions and rapid dilution of dispersants associated with natural oceanographic processes (e.g., advection/diffusion and current transport).

The overall conclusion is that a controversy remains for dispersant use despite the amount of detailed research on the efficacy and effects of *Corexit 9500A.* Risk assessments for dispersant use are a major challenge for Australia as reliable data for Australian-held products and their interaction with regional species are even more limited.

Hook and Lee (2014) conclude that current Australian testing processes do little to address the assumption that the oil is the most toxic part of any chemically dispersed oil mixture. The majority of toxicity tests have not been conducted with exposure scenarios typical of an actual oil spill (Lee et al., 2013), nor have those species or life stages most likely to be exposed to oil during a spill been included. Research has not looked at potential changes in trophic level dynamics or the significance of bacterial action on residual oil environmental persistence. All these information gaps make it difficult to conduct a robust NEBA. These information gaps persist because:

- Little is known generally about how dispersants influence the biodegradability of oil;
- Little is known about the significance of episodic dispersant exposure on trophic level/ecosystem dynamics;
- Few studies adequately characterize the exposure to oil in their test systems;
- Few studies have looked at impacts on corals and deposit feeding organisms; and
- Few studies have been conducted with dispersant products accepted for Australian use.

Australia would benefit from local research into the effects of:

- Short-term (hours) exposure to oil, dispersed oil, and dispersant to trophic level dynamics
- Chronic (days to weeks) exposure to oil, dispersed oil and dispersant to benthic organisms, including corals; and
- Dispersant on the biodegradation rates of oil.

Hook and Lee (2014) recommended the creation of a local database. This would record the potential toxic effects of dispersant products against local high risk residual and refined oils.

This review's conclusions have significant implications for AMSA and for the Australian offshore petroleum sector. That sector has a larger strategic dispersant capability (inventory) than the National Plan, as their contingency plans include subsurface blow-out scenarios such as the *Deepwater Horizon* or *Montara* spills that may have a significant release over extended time frames. This could require the use of dispersant for a much longer time than a large spill in the maritime sector which tends to be relatively quick (e.g. a full tanker spill). Also, oil weathering processes (and application logistics) generally conspire to limit the duration or extent of effective dispersant operations.

2.5. Effectiveness of Response and Dispersant Monitoring

Effective monitoring of dispersant use for effectiveness, plume movement, or operational decision-making, has always been problematic (Fingas, 2014). Current rapidly deployable monitoring approaches are rudimentary. They are primarily qualitative and do not fully provide the level of real-time and geo-referenced data desired for modern response operations and subsequent scientific monitoring. The SMART kit, as previously deployed by CSIRO during the *Montara* and *Deep Water Horizon* incidents, relied on the increase of one fluorometer channel to give a qualitative indication of oil dispersion.

AMSA, in its **responder** role, and CSIRO have collaborated in a joint research and development project to develop a world-first, in-situ, real-time oil and dispersant monitoring apparatus and capability (Qi, 2015).Two prototypes for monitoring surface water have been developed that can collect semi-quantitative data to inform field dispersant operations and provide data for subsequent impact assessments. The original specification required a small, compact, lightweight, towable, flow-through sensor array (fluorometer and laser microscope particle size analyser) that could be quickly set up on a small vessel of opportunity. The array had to be available to begin operation to match the fixed wing aerial dispersant capability. In addition, it needed to be small enough to be transported by car, aircraft or small vessel, and come with trained and competent operators.

The new monitoring kit comprises a multichannel fluorometer and a laser microscope particle analyser. Laboratory meso-scale assessments validated the sensor selection. The two sensors can capture the changes in hydrocarbon concentration and the characteristic property changes of chemically dispersed oil in water. Oil can be differentiated at different dispersion states and oil dispersant efficacy can be measured and ranked. The fluorometer measures the oil concentration and the microscope measures the oil and oil/dispersant droplet sizes and distribution. Droplet size is a major determinant of whether the oil remains neutrally buoyant or resurfaces.

The towed sensor platform has the flexibility to be deployed in two different modes: for fixed depth subsurface water monitoring; and for variable depth water column profiling. Sea trials demonstrated that the monitoring kit could be readily deployed from a vessel with minimum infrastructure, and stable operation occurred at up to five knots of tow speed.

Monitoring results are analysed on-site, in real-time, in a geographic database. The incident management team can quickly receive advice about where oil is (surface and water column) and where dispersant has been used. This can quickly inform decisions about when and where to start, move and cease dispersant operations.

Development is nearing completion. The literature review, sensor design and manufacture, towed platform development, laboratory meso-scale assessment of sensors and field trials of the prototype are all completed. Test results show that AMSA's original technical specifications have been exceeded. CSIRO will retain the prototypes to add to their capability (the monitoring kit and technical expertise to run it) to deploy under the response deployment contract with AMSA.

2.6. Information and Knowledge Transfer

Australia has a very capable spill response science community. Among other notable agencies, both the CSIRO and the Australian Institute of Marine Science (AIMS) are recognised internationally for their spill science expertise. AMSA entered into a Scientific Support Agreement (SSA) with CSIRO in 2011 (AMSA, 2011). This provides the framework for a range of services to be provided by CSIRO to the National Plan. These include ad hoc technical advice, joint research investments, and a response support contract. CSIRO's expertise is added to AMSA's to improve planning, situational awareness and decision-making.

A less widely recognised part of the SSA is the direct technical support and advice provided by CSIRO to the National Plan Environment, Science and Technical (ES&T) Network[v]. Each year CSIRO contributes significant staff time to teach and mentor ES&T members to help them improve their scientific, policy and technical disciplines. This is critical to AMSA (and the wider National Plan partners) in both **responder** and **advisor** roles.

For example, in November 2013, after the intense public scrutiny catalysed by the *Crude Solution* programme (60 Minutes, 2013) CSIRO and AMSA collaborated to produce a Dispersant Masterclass. This one-day technical event was trialled at the 2013 ES&T Network development workshop in Darwin and was repeated in May 2015. The Masterclass aim is to collate, present and discuss the science and technology behind all aspects of dispersant response. Presentations include:

- dispersant and surfactant chemistry;
- fate and behaviour of oils and dispersants;
- eco-toxicology;
- jurisdiction and policy;
- application technologies, methods and occupational safety;
- monitoring;
- research and testing;
- NEBA; and
- media and community relations.

During the sessions, and in a closing panel discussion, participants are encouraged to "leave no question un-asked" (AMSA, 2014).

CSIRO's contribution has included planning, development and delivery. Contributors have included experienced responders and internationally recognised experts on all aspects the use of chemical oil dispersants. Dr Kenneth Lee from CSIRO and Francois Merlin (ex-Cedre in France) were both involved in the recent revision of the International Maritime Organization's (IMO) guideline document on dispersant use. A significant measure of success is the growing demand for more sessions for a broader range of participants. A more enduring measure of success will be the increased level of community understanding of dispersants as a sound response option. This will inevitably be measured in both the court of public opinion and the court of inquiry.

Following on from the success of the CSIRO relationship, AMSA is encouraging other science, research and operational agencies, to discuss similar arrangements, in support of both the National Plan and other AMSA functions, such as maritime search and rescue. These could eventually become similar technology partnerships, where shared knowledge and expertise can grow and be shared.

3. Conclusion

As a country with less experience than many other countries in the use of dispersants, Australia has relied heavily on international experience. However, this has not insulated Australia from the very hard lessons other countries have received having used chemicals to disperse oil. To turn recent events and their challenges into opportunities, AMSA has set out to ensure it has the much more technically independent and robust understanding of dispersant use in Australia. Significantly supported by CSIRO, NICNAS and other expert advisers, AMSA's objective is to become more confident that the National Plan dispersant response strategy will be one of the best supported and most integrated anywhere. The credentials of the scientific agencies providing advice should increase the confidence of holders, users, decision-makers, stakeholders and the general public that the National Plan dispersant response strategy is soundly based, and when used, will result in a net environmental and/or community benefit.

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Endnotes

[i] Australian Oceanic Climate Zones, Seas and Currents

Noting also that Australia (as an island continent is bounded by the Pacific Ocean to the east, the Indian Ocean to the west and the Southern Ocean to the south, and is influenced by major currents as shown below.

Australian Marine Climate zones

Equatorial	*Torres Strait, and the Coral, Timor and Arafura Seas, and the Pacific and Indian Ocean areas.*
Tropical	*Northern Australia, north of Cairns in Queensland and Geraldton in Western Australia (WA).*
Sub-tropical	*Cairns to the New South wales (NSW) border, and Geraldton to Perth in WA.*
Temperate	*South of Perth in WA, and across the southern coast to NSW, including Tasmania.*
Sub-Antarctic	*Southern ocean and around the Australian sub-Antarctic islands.*
Antarctic	*Around the margins of Antarctica.*

Major Currents and Circulation Patterns Around the Australian Continent. *Figure courtesy of S. Condie (CSIRO).*

ii <u>Oil Dispersant Chemicals Assessed by NICNAS</u>

CAS Number	**Chemical name**
<u>Surfactants</u>	
577-11-7	Dioctyl sodium sulfosuccinate
1338-43-8	Sorbitan, mono-(9Z)-9-octadecenoate
9005-65-6	Polyoxy-1,2-ethanediyl derivatives of sorbitan, mono-(9Z)-9-octadecenoate
9005-70-3	Polyoxy-1,2-ethanediyl derivatives of sorbitan, tri-(9Z)-9- octadecenoate
103991-30-6	Ethoxylated fish oil
8002-26-4	Tall oil
<u>Solvents</u>	
112-34-5	Butyldiglycol; Diethylene glycol monobutyl ether
64742-47-8	Petroleum distillates, hydrotreated light fraction
29911-28-2	Dipropylene glycol monobutyl ether
111-76-2	2-Butoxyethanol
57-55-6	Propylene glycol

iii <u>Dispersant Products Containing the Chemicals Listed Above.</u>

Nalco Corexit EC9527A
Nalco Corexit EC9500A
Dasic Slickgone LTSW
Dasic Slickgone NS
Dasic Slickgone EW

Chemetal Ardrox 6120
Total Fluide Finasol 51

iv <u>Dispersants assessed under SSD protocol</u>
Dasic Slickgone NS
Dasic Slickgone EW
Dasic Slickgone LTSW
Ardrox 6120
Finasol OSR 51
Chemetal LT13002

v <u>ES&T Network</u>
This was previously known as the ESC Network (Environment and Science Coordinators), but subsequently widened to take account of the wider range of technical knowledge and disciplines required to support spill planning and response.