

Report of External Review of the Australian Ocean Data Network

Author: Dr Neville R Smith, Consultant, Melbourne, Australia
March 2021

Executive Summary

The external review of the Australian Ocean Data Network (AODN; hereafter the Review) was charged with providing a forward-looking assessment and evaluation of the Integrated Marine Observing System (IMOS) AODN program and processes to ensure the AODN facilitates efficient and optimised data access and delivery of derived products to Australia's marine science community now and into the future. The Review was asked to consider the current and future capability (i.e., skills, infrastructure, partnerships) of the AODN program and to provide findings and recommendations to guide changes in the AODN.

The Review made 52 Findings and provided 13 Recommendations for the consideration of Review sponsors.

The Review conducted surveys and interviews of AODN stakeholders and peers and interviewed key personnel from the IMOS Office and the AODN. The AODN provided input against the terms of reference through a series of detailed presentations and meetings as well as self-assessment (benchmark rating) in selected areas of their activities. The Review found the input of AODN to be informative and constructive and wishes to acknowledge the significant contributions of the AODN Management Team and other AODN staff to the conduct of the Review.

The Review broke its charge into eight areas:

- (a) Remit, scope and structure
- (b) strategy and planning
- (c) business processes
- (d) human resources (capability, capacity)
- (e) IT infrastructure, including architecture
- (f) data ingestion
- (g) data and product services
- (h) benchmarking

The Report and synthesis and recommendations were organised accordingly (the findings in this Summary are hyperlinked to the main body of the Report).

Remit, scope and structure. The Review concluded IMOS, and its national partners needed to clarify and distinguish between governance and activities of the national ocean data network and those of the IMOS group and program known as AODN ([Finding 1](#)). There should be a shared understanding of the organisational arrangements involving AODN, the IMOS Office, the AODN Technical Advisory Group (TAG), the National Marine Science Committee (NMSC) and the IMOS Science and Technology

Advisory Committee (STAC (Finding 2, Finding 6) and of the status of intergovernmental representation (Finding 3). The remit of the AODN should be adjusted accordingly (Finding 5). The organisational arrangements should clearly distinguish the roles of different IMOS entities (Finding 4, Finding 7).

Recommendation 1 *IMOS should provide added clarity around national provisions for ocean data management, in consultation with the NMSC, and adjust terms of reference, organisational arrangements and scope accordingly. A clear statement on the remit of AODN should be agreed.*

Strategy and planning. The Review found AODN had weak strategic planning and that this weakness impacted most areas of its work. The Review further found that the expected flow-down from national and IMOS planning, and upward influence from AODN was fractured and inconsistent (Finding 8). Stakeholders advised that IMOS and AODN needed to have a user-driven approach and that strategy and policy needed to be reset to reflect that (Finding 9). The planning cycle for AODN should be revised, with strategy guiding prioritisation, and with far greater transparency and engagement with stakeholders early in the planning cycle, prior to the annual planning meeting. Plans should include indicative schedules for the out-years (Finding 10).

Recommendation 2 *The AODN should develop a strategic plan, reflecting the high-level strategy of the IMOS Plan, but also identifying aims and priorities to guide AODN plans. Stakeholders should be engaged in this process. The Annual Business Planning cycle should be restructured to allow greater external engagement and increased transparency around priorities.*

AODN business processes. The Review found that the project management methodologies adopted by the AODN represent best practice and should be retained and strengthened (Finding 11, Finding 12). However, implementation of project planning in isolation has caused significant issues during roll out including (a) disconnect with Governing Board decisions, (b) poor recognition and buy-in from clients (mostly Facilities), (c) an over-crowded pipeline of work, and (d) excessive time and documentation devoted to the planning process. The AODN Project Management methodology (PRINCE2) was in wide use in Australia and IMOS should support IMOS-wide buy-in, but in a so-called Lite form that was more appropriate for small-to-medium projects (less than \$1M; Finding 11).

An analysis of recent projects revealed multiple failings in the process; the coincident roll-out of Project Management was one contributing factor. The review concluded that IMOS should rethink its decision-making process for projects heavy in IT and involving AODN. The business case presented to the Governing Board should align with the expectations of Project Management, with clarity on the products/functionality required, and with a level of specificity that allows sound cost estimation (Finding 13). IMOS should also examine co-investment and costing arrangement for IT infrastructure projects (Finding 14).

Recommendation 3 *IMOS should adopt Project Management methodologies to support project planning and execution of IT projects, harmonised with governing body decision making processes as appropriate. Project Management implementation should be right-sized for the size and complexity of projects and AODN should reset its processes accordingly.*

Human resources (capability, capacity). The Review could not find any persuasive evidence that AODN was either over- or under-resourced relative to objectives of IMOS but does conclude it was under-resourced for the grander national objectives. AODN base funding included both core funding for operations and maintenance, and funding for project builds (refurbishment of assets and new builds). This was not unusual for organisations with significant assets and relatively short life cycles (5-10 years). Base funding was supplemented with finite term funding for specific projects. The base project funding was largely at the discretion of the AODN Director, while additional funding was determined by the Governing Board and the IMOS Office. Added clarity was needed to ensure IMOS and AODN had clear line of sight on investment returns (bang-for-buck; [Finding 15](#), [Finding 16](#)). Weaknesses in planning and priority setting contributed to a perception in AODN and IMOS generally that AODN was under resource pressure. The expansion in IMOS facilities from 2018 undoubtedly added pressure and indirectly impacted core activities (delays, technical debt).

Recommendation 4 *The review does not provide any recommendation for a change in base funding but does recommend adjustments to process so there is a clear line of sight for (a) base funded operations and maintenance (core), (b) base project funding, and (c) fixed-term project funding.*

The Review found AODN staff enjoyed good levels of respect professionally and a rewarding work environment. Pressures from both the core and project pipelines manifested as increased stress on capability and capacity and a tendency for AODN to push back when faced with new demands ([Finding 17](#)). Several capability gaps were identified and AODN needs improved capability planning to better manage skill demands ([Finding 18](#)).

The Review also concluded that the short-term contracting arrangements for AODN staff contributed to high staff turn-over and disruption to both the core and project tasks. These arrangements were also a mis-match with the long-term strategy for IMOS and national data activities ([Finding 19](#)). Greater use of outsourcing could alleviate AODN specialist skill needs ([Finding 20](#)).

Recommendation 5 *AODN should put in place capability planning processes, including options for out-sourcing when special needs arise. IMOS should explore options for more secure staffing arrangements consistent with the IMOS long-term strategy for AODN, to improve position competitiveness and to mitigate high staff turn-over rates.*

Architecture. The Review recognized AODN successfully delivered a diversity of data in self-documenting architecture-independent open formats with widely used metadata standards and that this represented a significant achievement ([Finding 21](#)).

The Review clarified data flows into AODN (AODN data) and found several potential avenues to improve the architecture of the ingestion system, including consideration of recent changes in standards and the potential of systems available through the cloud. The Review also concluded IMOS, in consultation with IMOS partners, should improve guidance for data providers concerning (i) standards adopted for provider-AODN interface; (ii) general policy for quality control responsibilities which should reside with the data providers; (iii) conditions to be satisfied for data providers to be IMOS-approved and supported data flows; and (iv) the evolution toward a broader national data curation and publication role ([Finding 22](#), [Finding 23](#), [Finding 24](#)).

The Review concluded the pipeline architecture did promote scalability and efficiency but AODN identified several potential barriers, including the harvesting of data and metadata and technical debt (Finding 24). The Review found bespoke ingestion, processing, loading and publication/web services solutions proscribed against scalability, efficiency and agility in the architecture. If such solutions were deemed necessary by IMOS, cloud solutions should be preferred with sunset agreements to reduce legacy risks and costs (Finding 25).

Recommendation 6 *IMOS and AODN should reset policy and guidance for existing and potential data providers so that (a) required data and metadata standards were clear, (b) differentiated responsibilities and accountabilities were clear, and (c) integration into the AODN architecture was strongly preferred.*

The Review found that the publishing and web services architecture was offering the user community diverse opportunities to discover, access and download data. The Reviewed noted greater exposure and understanding of the different AODN catalogues would enhance this impact (Finding 26). Some aspects of the web services architecture were dated and the Review encouraged AODN to evaluate options, including those offered by the cloud cf. AODN-built solutions (Finding 27, Finding 28) to better inform users of the breadth and depth of data accessible and downloadable (perhaps indirectly) from the main Portal.

The Review found there was an urgent need for review and resetting of AODN architecture, and that major infrastructure decisions and builds should be delayed until this was done (Finding 29).

Recommendation 7 *AODN should undertake a review and reset of its architecture as a matter of urgency, with scalability and efficiency included in the criteria, and an overall aim of greater flexibility to introduce new technologies. The resetting should include greater consideration of cloud solutions where appropriate.*

IT infrastructure. The Review supported the AODN use of commercially provided web services and noted they provided important additional security and reliability for the AODN production systems. The Review noted several potential avenues for more effective exploitation of cloud offerings and greater use of proprietary systems (cf. self-builds) in the future (Finding 31). The Review noted an urgent need to improve handling of large (mostly gridded) NetCDF datasets and a need to find a more effective solution for querying and subsetting such datasets. The Review supported AODN plans to investigate cloud optimised gridded data services but also encouraged IMOS/AODN to seek improved forms to improve usability of data (analysis-ready), either through a tender or a partnership (e.g., under the NTP program) (Finding 31, Finding 32).

Recommendation 8 *AODN should assign high-priority to the need to find efficient and effective IT solutions for handling large datasets including querying and subsetting capabilities.*

Data ingestion. The Review found that the ingestion and curation of IMOS observation facility data was generally effective and most stakeholders rated it as strong or better. The Review found AODN Workflows for data ingestion were well-documented and provided surety around responsibilities through the lifetime of data from instruments into the AODN. The attention to detail was

appropriate and admirable and should make the process stable and capable of managing disruptions such as changes in technology or personnel (Finding 34).

The Review identified an expectation of continuous incremental improvement and enhancement of the ingestion infrastructure (dataset-specific pipeline handlers, Toolbox, etc.). The Review found this to be unrealistic and likely a contributing factor to AODN over-commitment. AODN should reduce ad hoc incremental change and improvements in favour of a planned and orderly review and update cycle (Finding 35).

The success of AODN has led to demand to access its ingestion and curation system. IMOS has supported selected external data holdings to be managed as AODN data, but the Review found unmet demand, particularly around academic and other public data. Moreover, it appeared that some of the new facilities were unprepared for the rigours and demands of AODN data management. The Review found it would be helpful for AODN/IMOS to develop guidelines and policy for the IMOS data ingestion process (Finding 36). This guideline should also consider a position on legacy datasets, specifically observations related to Facilities but collected before IMOS came into existence. Users clearly expected such data to be presented in a unified way through the Portal, even if the form of the data proscribed against it being made discoverable, accessible and downloadable through AODN (Finding 37).

The Review found ambiguity in the accountability and responsibility for publication. For IMOS generated data the situation was clear, but for third party AODN data and republishing of national AODN partner data, the situation needed added clarity (Finding 38).

The Review found that the policy and practices around handling multiple versions of the same data stream and publication (including formal publication through the use of digital object identifiers) should be reviewed. This review should also consider scientific and technical guidance materials around the quality of the data and how to use available data (Finding 39).

Recommendation 9 *Policy and guidance should be developed for the observation-AODN interface to make clear the differentiated responsibilities for quality assurance and quality control, the high standards on metadata and data, and the enduring responsibilities of data curation and publication that were borne by AODN.*

Data and product delivery services. The Review devoted considerable time to assessment of AODN data and product services, principally because of the extensive feedback received on the topic. There were differences of view, with some respondents focusing on the huge advances made by IMOS AODN, which the Review recognized, while others focused on what should or could be done to improve data services. Opinions on the impact of AODN data delivery services also varied; the Review considered them to be favourable (good, but not strong).

The Review found that despite recent attention being given to the demand for value added products, the present IMOS and AODN strategy was not sufficiently user-driven and user-focused and must be updated (Finding 40).

Recommendation 10 *IMOS, with input from AODN, should review and update strategy to ensure greater focus on users and usability with identified actions to achieve such change.*

The Review also considered the way AODN managed the relationship with users and identified a number of shortcomings, some of which derive from the lack of user registration, a process that might allow IMOS and AODN to gather intelligence on users and usage to inform future IMOS/AODN strategy. Such a process need not and should not hinder the commitment to open data (Finding 41). The Review found IMOS/AODN needed a dedicated channel (a User Desk) for soliciting user and client feedback and gathering intelligence on user demographics and IMOS data and product usage and future needs. It should be separate from AODN (Finding 42).

The Review found AODN needed to enhance its skills and competencies in user/client relationship management to ensure a culture that was user focused and that all elements of their work benefited from user feedback (Finding 43). As part of this process of change, AODN/IMOS should consider an annual or biennial user forum or similar mechanism to garner advice and input from Nodes, Facilities and other user groups. This should be convened mid-way through the planning cycle to properly inform planning and should be user-oriented (use cases, user needs, etc.), not a technical display (Finding 44).

The Review found that the lack of an active user uptake program meant that AODN and IMOS were being forced to push data and data products rather than having the pathway to impact facilitated by a community of value-adders. IMOS should consider creating a modest user uptake program to foster the development of innovation and user applications (Finding 45).

Recommendation 11 *AODN and IMOS should enhance capabilities and functionality for users including consideration of i) user registration, (ii) the creation of a User Desk, (iii) enhanced capability and capacity for user relationship management, (iv) a dedicated user forum, and (v) a system of user uptake grants.*

The Review found that a national strategy for agreeing standards for managing marine biological data, and for providing an effective (biological) data service was needed. The AODN/AODN TAG were well placed to lead such work from a technical perspective, but it was deemed essential to engage the marine biological community more broadly, including data providers and data users. The NMSC Monitoring and Baseline Working Group could facilitate such involvement (Finding 46).

The demand for changes and improvements in the AODN Portal was constant and enduring, and far outweighed the ability of AODN to service those requirements. Changes to the Portal should be strategic and systematic; user community driven; feasible and viable within the limitations of architecture and IT infrastructure; and demonstrably impactful (Finding 47).

The present AODN Portal does not have the capability to manipulate or visualise data to meet a major demand from users for value-added products and visual/graphic material. IMOS needed to develop a specific strategy to meet this demand. AODN can contribute through co-design and co-development, as appropriate, but should make its focus the provision of effective data services to underpin this development. It was the opinion of this Review that the strategy should focus on facilitation rather than a new set of facilities within IMOS (Finding 50).

Recommendation 12 *IMOS and AODN, with its partners, should develop and agree a strategy specifically for (a) management and servicing of biological and ecosystem data, and (b) for developing value-added data and data products.*

The Review concluded the AODN Portal was at, or close to its end of life, with growing technical debt and a growing gap between where AODN should be and where it was now. Such a finding should not be a surprise in a world of rapidly changing standards and technology. A major refurbishment without substantial change in the architecture would likely not be cost effective or a viable longer-term solution (Finding 48). The current Portal should be frozen during the 2021-22 fiscal year and a plan for its replacement developed. The Review concluded there should be less self-build and more off-the-shelf/cloud services incorporated into its replacement. Its design should be user driven (Finding 49).

With respect to national AODN data services the Review concluded that AODN should continue to promote and contribute to a national interoperable network of marine and coastal data services with the AODN Portal providing a window to national data holdings. The AODN should also seek further opportunities to ingest, curate and publish national publicly funded ocean and coastal observations more generally (Finding 51).

Recommendation 13 *The AODN Portal, in both its national and IMOS manifestations should be replaced, to take advantage of new technology and to better position it to respond to future user needs.*

Benchmark advice was provided through surveys and interview and by AODN through self-assessment. AODN was rated favourable (but trending to strong) across its planning and business processes; as experience was gained and improvements were made with both strategic planning and Project Management it should move toward strong. The AODN Team was strong in some parts but had gaps and weaknesses in others, particularly when referenced against future AODN requirements. It was well-respected by its peers. Position security and staff turn-over weighed heavily on the assessment. AODN architecture was not well positioned and does require urgent technical review and resetting. IT infrastructure was generally well-positioned. Data ingestion processes were rated as strong, with several attracting benchmark rating from peers. Data services, however, were viewed less favourably, weighed down by expectation (perhaps unreasonably so) and limitations of the architecture. AODN leadership on national approaches to services was welcomed but many challenges remained (Finding 52).