An Overview of Australian Maritime Zone Boundary Definition

Bill Hirst
Manager, Maritime Boundaries Program
Australian Surveying and Land Information Group
Canberra, ACT, Australia
BillHirst@auslig.gov.au

Brian Murphy
GeoFix Pty Ltd
Canberra, ACT, Australia
bmurphy@spirit.com.au

Philip Collier
Senior Research Fellow
Department of Geomatics
The University of Melbourne
Parkville, VIC, Australia
p.collier@eng.unimelb.edu.au

Abstract

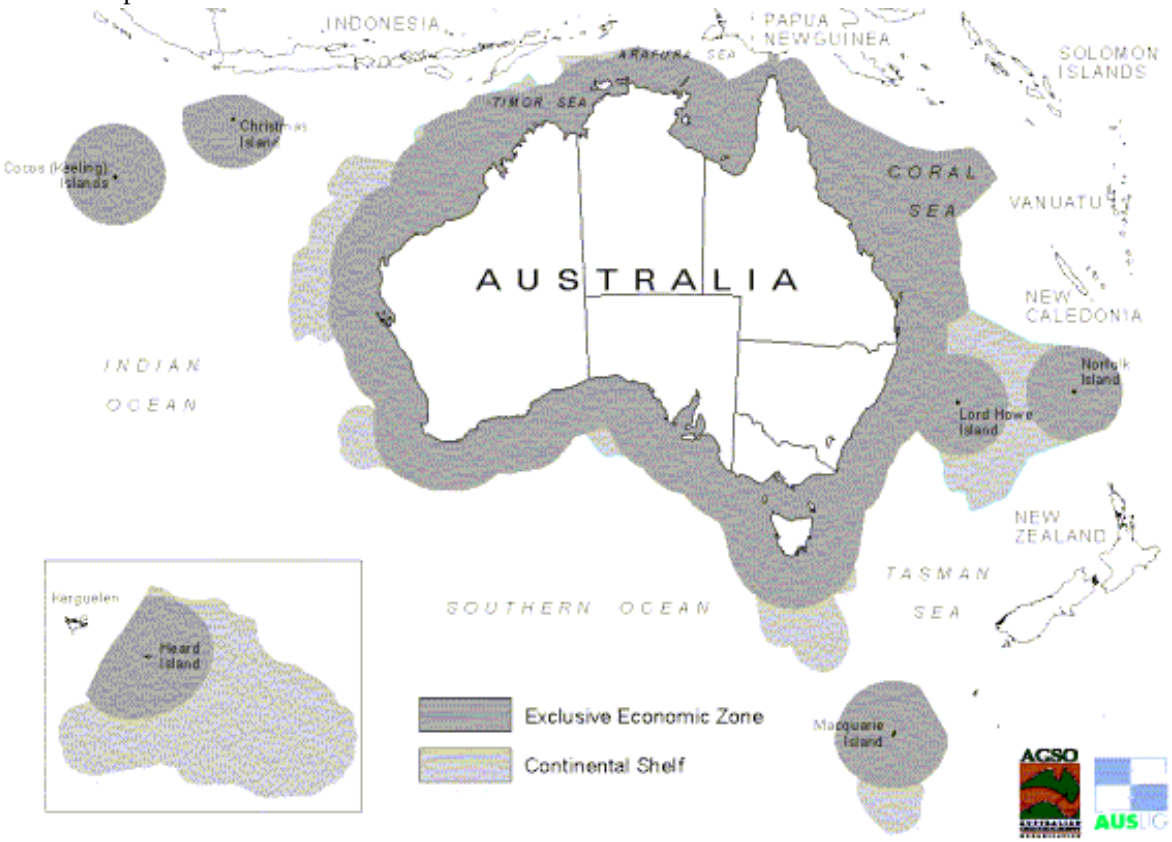
Australia became legally bound by the provisions of the United Nations Convention on the Law of the Sea (UNCLOS) when that convention formally entered into force on 16 November 1994. Because of Australia's extensive and sometimes complex coastline, defining the Territorial Sea Baseline (TSB), computing the various maritime zone boundaries, and defining areas of extended continental shelf under the provisions of the relevant UNCLOS Articles, has presented many technical challenges.

This paper briefly outlines progress in defining maritime zone boundaries in Australia and the national administrative structure that exists in support of this important work. Details on some of the more complex technical issues are presented including; the need for a comprehensive GIS to manage and manipulate maritime boundary data, problems arising in the accurate definition of the Territorial Sea Baseline where detailed charting data is not available, the need for rigorous geodetic computations, and some of the challenges presented by compliance with UNCLOS Article 76.

Introduction

Australia has a coastline length of approximately 59,700 km, which includes numerous islands and a number of external territories. In this environment, defining the Territorial Sea Baseline (TSB), rigorously computing the various jurisdictional boundaries, and defining areas of extended continental shelf are all challenging tasks.
At the time of writing (July, 1999), Australia has almost completed the validation of its TSB and is progressing with development of software to rigorously compute the geodetic position of all zone boundaries. The majority of survey work required to define the limit of the legal continental shelf has been completed and computations, in accordance with UNCLOS Article 76, have commenced in order to define the final boundary location.
Negotiations with most neighbouring countries on delimitation boundaries have been successfully carried

out and discussions aimed at resolving issues relating to overlapping marine areas have recently commenced.
Although based on provisional information only, the map shown below indicates the extent of Australia's maritime responsibilities under UNCLOS.



Administration of Australia's Maritime Boundaries

In Australia, defining national maritime boundaries is beyond the responsibilities and capabilities of any one particular government agency. The following table provides a summary of the main agencies involved in maritime boundary determination and the role played by each.

Agency	Role
Australian Surveying and Land Information Group (AUSLIG)	• Defining the TSB • Computation of zone boundaries • Provision of advice on boundary delimitation • Computations to define the limit of the legal continental shelf
Australian Geological Survey Organisation (AGSO)	• Ocean survey work • Analysis to determine limits of the continental shelf
Royal Australian Navy (RAN) Hydrographic Service	• Provision of charting and bathymetric data • Expert advice on tidal datum and symbology
Attorney General's Department	• Legal advice on international law • Treaty negotiations • Interpretation of UNCLOS Articles

Department of Foreign Affairs and Trade	• Treaty negotiations • Communication with the United Nations
State and Territory Governments	• Provision of large scale coastal mapping data

Table 1
– Major Agency Responsibilities for Maritime Boundaries in Australia

To administer the relationship between these and other relevant Agencies, the Australian government has established an Interdepartmental Committee (IDC) on the Law of the Sea. This committee meets twice a year to discuss issues of major concern. The more technical aspects of maritime boundary determination are dealt with by a technical subcommittee of the IDC. This subcommittee meets quarterly and has been successful in coordinating various activities and in identifying and solving some significant technical problems.

Examples of the issues addressed by the Technical Sub-Committee include:

- consideration of areas where TSB determination is difficult or ambiguous,
- development of comments on the draft Technical and Scientific Guidelines produced by the Commission on the Limits of the Continental Shelf (CLCS), and,
- review of the location of straight baselines within the TSB.

Australian Maritime Boundary Information System (AMBIS)

Mapping and attribute data relating to Australia's maritime boundaries is stored and managed in a Geographic Information System (GIS) known as the Australian Maritime Boundaries Information System (AMBIS).

Explanation and Structure

Managing the vast quantity of digital mapping and attribute data relating to Australia's maritime boundaries is a significant task. Originally AMBIS was based on the VISION software; however, the data is now being transferred into the ARC/INFO environment. The GIS provides the ability to answer queries efficiently and to produce maps and diagrams as required.

The advantage of using a GIS for data management is that it provides the ability to maintain the linkage between the TSB vector data and attributes relating to it. The attributes stored in AMBIS include the origins of the baseline data, data acquisition methods and data quality.

Status

Currently, the AMBIS database contains almost all of Australia's TSB including comprehensive attribute data. The remaining sections of TSB will be added by December 1999.

A complete and rigorous re-computation of all zone boundaries at 3, 12, 24 and 200 nautical miles, based on the revised TSB, is scheduled for completion by June 2000.

Several areas of extended continental shelf have been defined by AGSO and are to be incorporated into AMBIS. AGSO expects to complete data collection and analysis of the remaining areas by 2002.

Maintenance Plans

Although Australia will soon have rigorously computed maritime boundary data, it will still be based on baseline information which is, in places, defined only to limited accuracy. It is therefore likely that Australia will require a small, on-going, program of revision to critical baseline areas as the need arises.

Progress Reports

The progress of Australia's TSB validation and computation of the related boundaries can be monitored through AUSLIG's home page at:
http://www.auslig.gov.au

Defining Australia's TSB

History

In the late 1960s and early 1970s, Australia defined a complete TSB based on the best available data at that time. In most cases this was 1:100,000 and 1:250,000 topographic mapping data, supported to a limited extent by tide-controlled infra-red aerial photography. The location of the drying line, where depicted on Hydrographic Office charting, was digitised and adopted. A decision was made at this time to adopt Lowest Astronomical Tide (LAT) as the baseline datum. This is consistent with the chart datum used by the RAN Hydrographic Service.

Validation

Since 1996, AUSLIG has been validating the original TSB by comparing it with more recent and accurate charting, topographic, aerial photographic and remote sensing data. An important part of this validation process has been the recording of attribute information relating to the origin and accuracy of all TSB data.

Alternative Data

Australia's TSB is being defined so that it will always be compatible with the latest available charting information. However, in many cases the charting coverage lacks detail in very shallow areas, which are of particular interest when determining the LAT line. In these cases, other information such as large-scale topographic maps, remote sensing data, aerial photography and Laser Airborne Depth Sounding (LADS) data is used to supplement the definition of the TSB. Where this additional data is in conflict with existing chart information, the Australian Hydrographic Office is notified in order to carry out verification and to amend the relevant chart(s).

Straight Baselines

The straight baseline components of Australia's TSB were determined in the early 1980s and the coordinates of the terminal points have since been proclaimed in domestic legislation. More recent charting data has revealed some anomalies in the proclaimed positions of these terminal points. In the cases so identified, an amendment to the proclaimed positions is being proposed by AUSLIG for consideration by the relevant Commonwealth and State government Departments.

Geodetic Computations

Australia has placed a considerable emphasis on ensuring that the geodetic calculations involved in maritime boundary delimitation, and in the definition of the limits of the legal continental shelf, are all carried out as rigorously as possible. The recently released *Provisional Scientific and Technical Guidelines of the Commission of the Limits of the Continental Shelf* illustrate some of the significant complexities that are involved in the geodetic aspects of the law of the sea. In Australia, work is on-going to ensure a rigorous, robust and efficient solution to these problems.

Software Development

AUSLIG has let a tender to the Department of Geomatics at the University of Melbourne, for the development of algorithms and software capable of rigorously computing critical points on the TSB, and from these, computing the various zone boundaries, and the limit of the legal continental shelf in accordance with the provisions of UNCLOS Article 76. A related paper entitled *Maritime Zone Boundary Generation from Straight Baselines Defined as Geodesics* (Murphy et al., 1999), describes a part of the work being carried out under the AUSLIG tender. In particular some of the technical complexities of dealing with geodesic straight baselines in the context of maritime boundary delimitation are presented along with a proposal for their practical solution.

Baseline Accuracy

The positional accuracy of the various maritime zone boundaries is directly related to the positional

accuracy of the TSB. The accuracy of the TSB data, however, is not always consistent or readily determined. There are essentially three components to TSB accuracy :

- data capture process
- determination of the LAT line
- stability of the baseline over time (some areas of the coastline are influenced significantly by erosion and/or accretion.)

As previously explained, the AMBIS database holds details of the data lineage and quality. This information allows users to estimate the accuracy of the data capture process, and provides some indication of the quality of the LAT determination. The date of survey of the source information is recorded to assist in later evaluation of baseline stability. Areas identified on charts as approximately located are attributed as such.
In practice, most of the critical TSB points which determine the outer boundaries in the southern areas of Australia are stable and easily determined, resulting in an overall positional accuracy in the order of ±100 m. In some areas of northern Australia however, where foreshore gradients are generally flat and often associated with large tidal ranges, the method of determination and baseline stability are less certain and positional accuracy is estimated at ± 500 m in many areas, with greater uncertainty in some isolated instances.

Horizontal Datum

Definition of much of Australia's TSB is currently referred to the Australian Geodetic Datum, 1966 or 1984 (AGD66 or AGD84). In 2000, Australia is officially converting to the Geocentric Datum of Australia (GDA94) which will use the GRS80 ellipsoid and will be based on the ITRF92 reference frame at the epoch of 1 January 1994 (ICSM, 1998).
It is AUSLIG's intention to convert all TSB data to GDA94 for national and international consistency. It should be noted that GDA94 is, for all practical purposes, identical to WGS84, the datum for GPS (absolute coordinate differences in the order of a few centimetres Malays et al., 1997)).

Straight Baselines

Straight baselines, as adopted by Australia, are legally promulgated as geodesics. It is also the case that the 'straight line' segments of a zone boundary derived from a straight baselines are also geodesics. It can be shown that the baseline and the zone boundary geodesics are not parallel. Therefore, the computation of a zone boundary from a straight baseline, ensuring the maintenance of a consistent zone width, is not trivial.
This issue is highlighted in the paper by Murphy et al., (1999) included in these Proceedings.

Areas of Extended Continental Shelf (UNCLOS Article 76)

Australia is well advanced in the preparation of its submission to the UN Commission on the Limits of the Continental Shelf (CLCS). Symonds et al., (1999) and Borissova et al., (1999) included in these proceedings, describe the processes involved in preparing this submission, in particular the location of foot of slope points. The discussion here is limited to identifying some of the computational complexities of determining the limit of the extended continental shelf in accordance with UNCLOS Article 76.

Computational Complexities

Bridging Lines
Paragraph 7 of Article 76 states that '*The coastal State shall delineate the outer limits of its continental shelf ….beyond 200 nautical miles….by straight lines not exceeding 60 nautical miles in length…*'. This requirement allows a State to smooth the outer limit boundary by inter-connecting boundary arcs with straight lines, as shown in Diagram 1. In Australia, these lines have become known as 'bridging lines'. Paragraph 7 also requires arcs to be represented as a series of straight lines. This issue is discussed under a separate heading later in this paper.

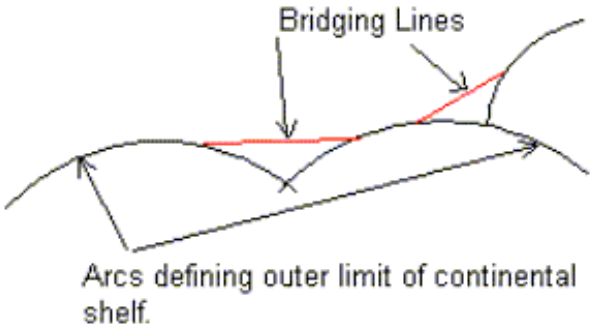


Diagram 1 - Bridging Lines

Applying the principle of bridging lines not only allows a State to simplify the delimitation of the legal continental shelf, but also to maximise the area which can be claimed, as shown in Diagram 2. Computation of the optimal location of the terminal points of these bridging lines can be complex, particularly when trying to ensure that the *total area* beneath the bridging lines is a maximum.

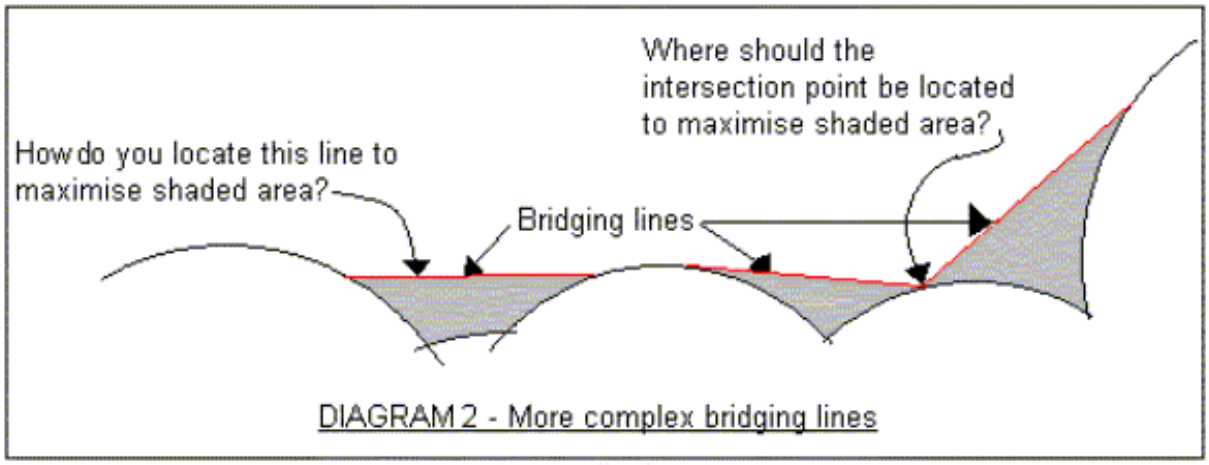


DIAGRAM 2 - More complex bridging lines

Computations are made more complicated when trying to maximise the area under a bridging line that spans arcs of different radii.

Sediment thickness

Paragraph 4 (a)(i) of Article 76 allows for determination of the outer limit of the continental shelf based on sediment thickness, which must be at least 1% of the distance from the closest point on the foot of the continental slope. This criteria is not trivial to compute as illustrated in Diagram 3.

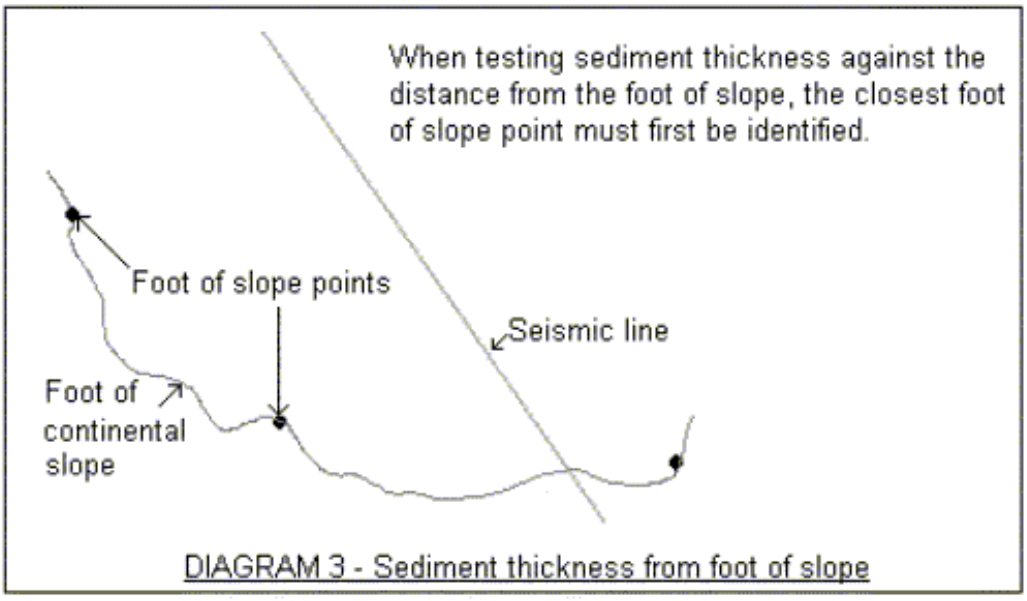


DIAGRAM 3 - Sediment thickness from foot of slope

As shown in the diagram, determination of the location of points to define the 1% sediment thickness line is complicated by the fact that the foot of the continental slope is rarely perpendicular to the seismic line

from which sediment thickness is assessed. The problem is to determine the location along the seismic line of a point where the thickness of the sediment is 1% of the distance from the *nearest* point on the foot of the continental slope.

Subdivision of Arcs

As identified in the section on 'Bridging Lines', Paragraph 7 of Article 76 requires the outer limit of the legal continental shelf to be composed of straight lines not longer than 60 nautical miles. Therefore, whenever the legal limit is composed of arcs, these arcs will need to be divided into a series of straight line segments. As such arcs are always convex to seaward, approximation by straight lines results in the loss of claimable area to the State, as shown in Diagram 4.

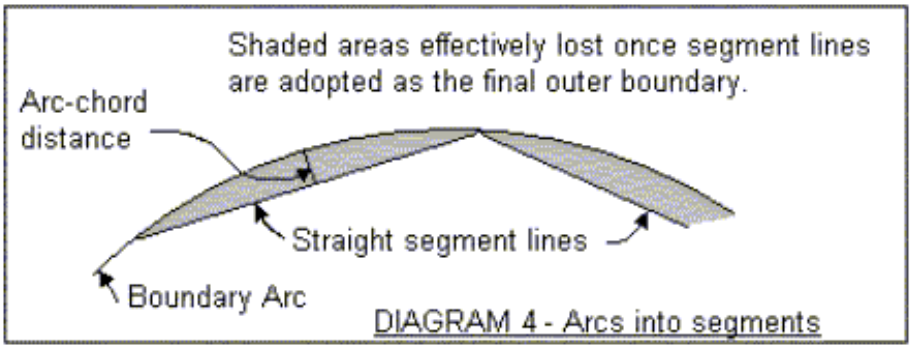


DIAGRAM 4 - Arcs into segments

The requirement to divide arcs into straight line segments results in having to strike a balance between the length of the line segments used and the consequent loss of area. The challenge is to select a segment length (or equivalently an arc to chord separation), which results in a manageable number of segments and an acceptable (minimal) loss of area.

Conclusion

Defining maritime boundaries represents a fascinating combination of technical, legal, and, in the case of overlapping areas, diplomatic challenges. Australia's experience has demonstrated the need for a broad level of commitment from all agencies involved, requiring both leadership and technical expertise. Rigorous computation of all boundaries is far from trivial and requires careful consideration and management to ensure total and credible compliance with the provisions of UNCLOS.

Australia is well advanced in defining its maritime areas; however, it is aware of some significant challenges ahead. We would welcome further international cooperation and consultation to meet these challenges and to develop a more consistent global approach to maritime boundary delimitation.

References:

Borissova, Symonds, Gallagher, Cotton and Hill
. (1999) - "A set of integrated tools based on Arcview for defining the outer limit of Australia's continental shelf" Included in the Proceedings of this conference.

Intergovernmental Committee on Surveying and Mapping
(1998) – "Geocentric Datum of Australia Technical Manual". December 1998. Available from http://www.anzlic.org.au/icsm/gdatm/gdatm.htm

Seas and Submerged Lands Act
(1973) - Australian Government Publishing Service.

United Nations
(1983) - The Law of the Sea, United Nations Convention on the Law of the Sea (UNCLOS).

Symonds, P
(1999) - "Australia's approach to defining its extended continental shelf. Included in the Proceedings of this conference.

United Nations Office for Ocean Affairs and the Law of the Sea
(1989) - Law of the Sea – Baselines – An examination of the Relevant Provisions of UNCLOS.

AMBIS Technical Specifications
(1997) - AUSLIG, Quality Controlled Document

Malays S., Slater J., Smith R.W., Kunz L.E., Kenyon S.C
. (1997) - "Refinements to the World Geodetic System 1984", Proceedings of the 10th International Technical meeting of the Satellite Division of the Institute of Navigation, September 16-19, 1997, Kansas City, Missouri, USA.

Murphy B., Collier P., Mitchell D. and Hirst W.
(1999) – "Maritime Boundary Generation from Straight Baselines Defined as Geodesics". Proceedings of the International Conference on Technical Aspects of Maritime Boundary Delineation and Delimitation. Monaco, 9-10 September, 1999.

Symonds P
…… (1999) – "Title". Proceedings of the International Conference on Technical Aspects of Maritime Boundary Delineation and Delimitation. Monaco, 9-10 September, 1999.

http://www.auslig.gov.au/techpap/hirst-lawofthesea.htm

TOP ▲

AUSTRALIAN SURVEYING & LAND INFORMATION GROUP Department of Industry, Science and Resources
Scrivener Building, Dunlop Court, Fern Hill Park, Bruce ACT 2617
PO Box 2 Belconnen ACT 2616 Freecall (Within Australia): 1800 800 173
International Phone: +61 2 6201 4201 Fax: +61 2 6201 4266