GIS, Charts and UNCLOS – Can they live together?

Bill Hirst[1] and David Robertson[2]

Address

[1]Geoscience Australia
GPO Box 378
Canberra, ACT 2601
Phone: 02 6249 9741 Fax: 02 6249 9939
Email: Bill.Hirst@ga.gov.au

[2] Geoscience Australia
GPO Box 378
Canberra, ACT 2601
Phone: 02 6249 9541 Fax: 02 6249 9541
Email: David.Robertson@ga.gov.au

Published with the permission of the Chief Executive Officer, Geoscience Australia.
The opinions expressed in this document are those of the authors alone and do not necessarily represent the views of the Australian Government.

ABSTRACT

Geographical information, particularly as presented on charts, has always been central to the process of delimiting and managing maritime boundaries. More recently modern Geographic Information Systems (GIS) have been widely employed for boundary creation, management and dispute resolution. However, the use of GIS raises a number of questions in itself. For instance paper charts can be accessed and interpreted by anyone, whereas information stored in a GIS requires specialised software and skills to view and interpret the data.

Other questions that arise include: Who really uses maritime boundaries information and what is the most suitable format for them to access this information? How important are charts as a source of baseline data? How accurately should a Coastal State determine their maritime boundaries? Can a Geographic Information System (GIS) be used to maintain maritime boundaries data? Does this conflict with the United Nations Convention on the Law of the Sea?

Australia has been considering these and related issues in depth for a number of years. This paper attempts to describe our current thinking on these issues and encourage debate.

Introduction

In the more than twenty years since 1982 when the current United Nations Convention on the Law of the Sea was finalised there have been significant changes to the technology available to map and chart the world as well as store this information in complex mapping databases generally known as Geographical Information Systems (GIS). As well, the technology to position a vessel or platform at sea has dramatically increased precision from several hundred metres at best to sub 10 metres accuracy using the Global Positioning System (GPS).

These advances in technology have generally been of great benefit to the technical expert responsible for the definition and maintenance of a nation's maritime boundary information. In particular, a GIS can store and depict the location of the maritime

limits, as well as, store detailed textual information about the limits or baseline from which they are derived. Since the early 1990's Australia has maintained a GIS known as the Australian Maritime Boundary Information System (AMBIS) to store its maritime boundary information.

In general, this has proved to be an efficient and valuable way to manage the data, however, it has also raised several issues. These issues can be generalised into two categories, these being (1) aspects to do with the mapping of the baseline and maintenance of the computed boundaries; and (2) the practical use of the data to enforce maritime jurisdiction and fulfil the requirement to deposit maritime boundary information with the United Nations.

Issues Arising from the Development and Maintenance of a Maritime Boundaries GIS

Australia has spent a considerable amount of effort and time on developing an accurate and up to date depiction of its maritime limits. Given the vast coastline, it has been an enormous task to map the low water line around the coastline and given some of the natural features such as the vast mud flats of the North West coast of the country and the complexity of the Great Barrier Reef, it is difficult to keep up with the changes which seem to appear with each mapping of such features. At the same time, the policy makers and managers of the marine jurisdiction are looking for more stability (less changes) in the location of the various maritime limits. As well, those that are tasked with enforcing these limits require certainty in the location of the boundary lines. Thus, there is potentially a tension between the perceived need to accurately map and maintain the 'true' position of the baseline against the practical need to have stability and certainty in the location of the limits.

Source of data - charts versus alternate

At the time that Australia's original baseline was developed in the late 1970s, the best available mapping for much of the coastline was the 100K series of topographic maps and this formed the basis of the first version of AMBIS. Since this time we have worked hard with the Australian Hydrographic Office to converge the normal baseline in AMBIS with current charts. However, this is not a straightforward process and will take time to achieve. In the meantime, AMBIS will continue to be based upon source material other than charts where such material is clearly the best available depiction of the low water line. This includes the use of aerial photography, satellite imagery, occasional field checks, and topographic mapping.

Most readers would be aware of Article 5 of UNCLOS which gives guidance to the depiction of the normal baseline as:

> *"Except where otherwise provided in this Convention, the normal baseline for measuring the breadth of the territorial sea is the low-water line along the coast as marked on large-scale charts officially recognized by the coastal State."*

However, it is the view of the authors that to limit source of information about the coastline to charts for the purpose of locating the normal baseline is too literal an interpretation of this article. Authors such as Beazley (1994:p4) suggest that the low-water line should be depicted as accurately as possible. In recognition of this aim, AMBIS incorporates a low water line derived from 1:25,000 topographic mapping data for parts of the Australian coastline around the island of Tasmania. The charts for this area are 1:150,000 and 1:300,000 scale and are older than the topographic mapping data. If the aim is to achieve the most accurate and up to date depiction of the coastline then it makes sense to use the topographic mapping data. This is consistent with the widely held view that scales smaller than 100,000 are not large scale and if at all possible should not be relied upon for baseline determination (Carleton and Schofield, 2001:p18).

Furthermore, charts are primarily produced for safety of navigation which means that the main focus of surveys is justifiably where the major shipping traffic is and not in shallow waters. Hence the shallow waters that are of concern to maritime boundary practitioners are often unsurveyed or have poor positional accuracy. Also, chart revision priorities are logically determined on the basis of safety of navigation rather than changes to the baseline definition.

However, this also raises the question of how accurately a coastal State needs to map its coastline for the purpose of maritime boundary calculations.

The ambulatory nature of coastline has been recognised as an issue for the determination of maritime boundaries (Reed, 2000:p185). It is generally recognised that the coastline changes over time in a cyclical motion (moving both landward and seaward and back again). Hence it could be argued that a particular depiction of a long length of coastline is in fact an average position of the total coastline and hence is as valid as any future or past depiction. It may therefore be sufficient that a chart provides a representation of the coastline which may not accurately reflect the real world feature, but nevertheless, provides a stable and publicly available line from which to calculate the various maritime limits.

As mentioned above, a coastal State may develop a low-water line based upon a variety of sources in addition to charts. Ideally, where alternative sources are used, this new data should be incorporated on relevant charts in the course of normal revision. In this way the GIS data will converge with charting over time.

Maintenance and frequency of updates

UNCLOS provides a guide as to how maritime boundaries should be determined but is generally silent on how often the boundaries should be revised. The exception to this is Article 76 paragraph 9 which describes the requirement of a coastal State to deposit with the United Nations relevant information *"permanently describing the outer limits of its continental shelf."* There is no other reference to the word "permanently" in the other Articles requiring States to deposit relevant information (Articles 16, 47 & 75). Presumably, and justifiably, a coastal State has the right to update the location of its maritime boundaries when it so desires.

GIS, and web mapping technology, has the capacity to enable an online database containing the most up to date information on maritime boundaries to be available at any time. So, if 'better' source material showing a change in the baseline becomes available this could be included in the database, together with the derived new limits, and made available to users almost straight away. Under this model, the maritime limits could conceivably change on a daily, weekly or monthly basis.

Whilst it may appear to be a noble cause to maintain an accurate and up to date database of the coastline, there are more pragmatic issues to be considered. In particular, changes to the boundaries may cause unnecessary complexity to the work of those responsible for managing the marine jurisdiction. Constant changes to boundaries has the potential to cause confusion and possibly reduce confidence in the location of maritime limits.

Thus, as maritime boundary practitioners, we are left to deal with the tension between the need to have the location of the boundaries consistent with the coastline (or chart) and the practicalities of making changes to the boundaries. With this in mind, the authors do not favour the vision described above of a constantly maintained online database where users could download up-to-date information. Instead, we favour a more pragmatic view of determining maritime boundaries as accurately as possible and leaving them in place for some time or until there is a major reason to make a change.

Whilst this sounds straight forward enough, it then opens the question of what criteria to use to instigate a change to the baseline and hence the maritime limit. There appears to be two main ways of approaching this problem based on an arbitrary time period or some 'error' tolerance. So, for instance, something like a 5 year program could be instigated for the update of the maritime limits. Over that time, changes to the coastline could be documented and updates progressively made to the database in preparation for a recomputation of the boundaries towards the end of the 5 year cycle. This, would provide some certainty in the location of the boundaries and potential updates to their position, however, does not address the issue of the 'validity' of a limit which no longer reflects the current position of the normal baseline.

Thus, the second approach would be to decide on a reasonable tolerance for the limit to be in 'error' with respect to the normal baseline without requiring an update. So, only changes that exceed this tolerance would require an update to the baseline and recomputation of the boundary. There is no clear criteria from which to select this tolerance and a pragmatic decision would need to be made. So, for instance, information can be recorded on the accuracy of the baseline during the capture process. For example, an overall statement of the accuracy of the baseline in AMBIS is:

> *The positional accuracy varies according to the scale and origin of the source data, the data digitising process and the stability of the coastline. Experience and emperical evaluations suggest that the data is generally better than +/- 150 metres.*

This provides a possible tolerance for the scenario above whereby changes to the baseline are incorporated into the data only where they are more than 150 metres from

the current position. Alternatively, a simple rule of thumb, such as 1% of the width of the territorial sea (approx 220m for a 12 M width) could be used.

This approach has the advantage of keeping the data 'not inconsistent' with UNCLOS but again has the potential to result in numerous updates to the maritime boundary information in areas where the coastline is unstable. In practice, other considerations such as economic, political and/or environmental sensitivities may influence a coastal State to review baselines.

Issues Arising from the Practical use of a Maritime Boundaries GIS

Practicalities of enforcement of maritime jurisdiction

A States' ability to manage its marine jurisdiction is dependent on an unambiguous demarcation of its maritime boundaries. So, are maritime boundaries as currently depicted unambiguous? And, if not, is there a better way to define them to bring greater certainty to their location. Some issues that we have considered on the matter include:

Does the mapping accuracy of the normal baseline propagate to the boundary? So, for instance, if a coastline is mapped to say +/- 150m is there a similar level of uncertainty in the maritime boundary derived from this baseline? It could be argued that this is an unsustainable proposition and that a boundary must be considered fixed once the location is computed. The difficulty is that every mapping of the coastline is likely to be different and therefore produce a slightly different resulting boundary.

Charts have a legal status and as such are often used as prima facie evidence in cases dealing with maritime boundaries. Further, if the maritime boundaries themselves are printed on charts this is likely to give more weight to the location of the boundary. However, charts are of a certain scale and so for instance, 1mm on a 150K chart is equivalent to 150 metres on the sea and on a 300K chart is equivalent to 300 metres. So, there will always be some uncertainty to the exact location of the boundary when reading it from a chart simply because it is a representation of the boundary rather than the actual coordinate.

This raises the issue of the legal status of maritime boundaries data held in a GIS. If for some reason the exact location of a boundary is contested, does the position of the baseline and/or limit shown on a chart take precedence over the GIS position which may be more current and of higher precision? Does the actual location of the coastline at that time become relevant and take precedence over both? Does lodgement of data (coordinate lists or charts) with the United Nations, as required by UNCLOS (Articles 16, 47, 75 and 84) influence the status of any of these options?

Deposit of maritime boundary information with the United Nations

Whilst seemingly a relatively simple task, the requirement to deposit maritime boundaries information with the United Nations raises some interesting questions. Firstly then, what is the purpose of this requirement in UNCLOS. The purpose has

been described by the Division of Ocean Affairs and Law of the Sea (DOALOS) as (DOALOS 2003):

> *The purpose of the provision of the Convention related to the deposit of charts or lists of geographical coordinates of points is to ensure that the international community is adequately informed of the boundaries of the territorial sea and other maritime zones of a coastal State.*

Thus, the act of deposit provides certainty to the limits of sovereign interests of the coastal State as well as providing necessary information to mariners so that they don't unwittingly infringe on the rights of a coastal State.

So, what then is it that is required to be deposited with the UN and in what format can it be supplied? In general, UNCLOS specifies that the baselines, or the limits derived therefrom, as well as, the lines of delimitation between States, shall be shown on charts of a scale adequate for establishing their position (Articles 16, 47, 75, 84). Alternatively, a list of geographical coordinates specifying the geodetic datum may be substituted. Furthermore, DOALOS examines all such deposits only from the point of view of these requirements set out in the Convention.

So what does this mean to a coastal State wishing to make a deposit? First, there is a choice between whether to use charts or a list of geographic coordinates. As well, there is the decision about whether to deposit information on the baseline or the limits.

At this point, it should also be highlighted that Article 5 on the normal baseline (ie the low water line) is not referred to in Article 16. This is presumably because it is assumed that the coastline as depicted on a chart is a fair representation (if not the actual source) of the normal baseline. This, however, is not always the case particularly where a State has used other source information to determine the normal baseline (as discussed earlier in this paper). So, fulfilling the requirements of the Convention may not in fact provide a clear and unambiguous picture of the location of a State's baseline.

The use of charts to publicise the location of the baseline and/or the limits whilst useful to the mariner has some constraints. Most obviously being a hardcopy chart it is useful to the mariner or as a desktop view of a State's maritime limits but the actual data is not portable to another map or GIS for a particular purpose. As well, the accuracy of the information is a function of the scale of the chart, so for example, 1mm on a 150K chart is equivalent to 150 metres on the sea which may not be rigorous enough for all purposes, such as the demarcation of hydrocarbon exploration leases. Finally, changes to the baseline and or limits would have to be accommodated within the publishing cycle of charts.

The option to deposit a list of geographical coordinates would seem to have been included for the purpose of accurately locating the end points of straight lines (whether they be bay or river closing lines, straight baselines or archipelagic baselines). Having said this, a GIS stores all it's spatial information as a list of geographical coordinates and there does not seem to be any reason that the location of an outer limit line could not be defined by a list of geographical coordinates. An

example of this approach has been implemented by Nauru in defining its maritime limits by a list of coordinates of basepoints, arc intersection points and intermediate points on the outer limit line. This approach would seem to have much to recommend it in that it provides an accurate depiction of the complete maritime boundary information. It does not provide an immediate picture of the limits as would be shown on a chart but could easily be added to a chart or any other map if desired. The main drawback for nations with long coastlines and vast maritime areas is that it may require a very long list of coordinates to depict the limit accurately. The number of points required will depend on the length of chord chosen to represent each segment of an arc. So, for instance, a reasonable approximation of the 200 M exclusive economic zone limit might be a 1 metre arc to chord separation or chords of approximately 1 nautical mile. Whilst on the face of it, a long list of coordinates may look cumbersome, if provided in a standard format the coordinates can more than easily be loaded into a GIS for display purposes.

To take a step further then, given the prevalence of GIS to be used for maintaining spatial information such as maritime boundaries and given that a GIS is really only a list of geographical coordinates, would this format be a more suitable and acceptable method of depositing maritime information with the UN? The major advantage of this is that a GIS is the most efficient and concise way of storing spatial information. It also provides a format which accurately depicts the maritime limits, can be easily transferred to other users and possibly most advantageously can contain textual information about the boundaries. The major drawbacks would appear to be the fact that a GIS does require some expertise to operate and the format of the data may be particular to a specific brand of GIS software or may become totally redundant in the future. A simple list of coordinates on the other hand will always be accessible to all. The other issue of course is whether a GIS fits within the current requirements of UNCLOS for the deposit of charts or a list of geographic coordinates.

Conclusions

There is often a general assumption that the main requirement for maritime boundary information is for the mariner. Charts are referenced in UNCLOS and there is the option to deposit charts with the UN to fulfil a State's obligation to make maritime boundary information widely available.

However, there are users other than mariners who have an equal need for maritime boundary information. These users are often policy makers or legal people working at their desk rather than the bridge of a ship. For example, the administration of petroleum leases and management of fisheries both requires a knowledge of the relevant boundaries. More commonly today this information is accessed via a GIS rather than a paper chart. The advantages of a GIS are that it contains information about the boundaries rather than simply the boundary line itself (as would be marked on a chart). As well, a GIS allows for specific purpose maps to be easily produced which can help the policy maker.

The wide use of GIS for the maintenance of maritime boundary information also raises a number of questions about the capture of information about the line of low water, the maintenance program to effect changes to the baseline and the limits

derived therefrom, the practical use of the data for ocean management and enforcement of laws, as well as the requirement to deposit this information with the UN.

A GIS allows for the easy integration of data other than from charts into the database and a record kept of where that data comes from. The ease with which this can be done lends itself to the continual update of the baseline to reflect the latest and best available mapping of the coastline. However, it has also been recognised that certainty and stability of the limits is an important factor to consider and that in fact less change to the limits is actually better in a pragmatic sense. Thus, a tension exists between the desire to have an accurate representation of the baseline and maintain certainty in the location of the boundaries so that they can effectively be enforced.

In consideration of the above, the authors are of the view that it is important and reasonable to map the baseline as accurately as possible and that a GIS provides a valuable tool to record this data along with its source. It is recognised that this may require use of information other than charts however that ideally such information should be incorporated on charts as part of the revision cycle. Further, the authors favour the increased certainty resulting from less frequent updating of maritime boundaries locations.

Finally, the question is raised as to the best format for the deposit of maritime boundaries information with DOALOS. Arguments for and against some options have been outlined and it is hoped that further discussion on the issue may ensue.

Acknowledgements
The views expressed in this document are those of the authors alone and do not necessarily represent the opinion of the Australian Government.

References

Beazley, P. B. (1994). 'Technical Aspects of Maritime Boundary Delimitation' *Maritime Briefing, Vol 1, No. 2* Durham: International Boundaries Research Unit.

Carleton, C and Schofield, C (2001). 'Developments in the Technical Determination of Maritime Space: Charts, Datum, Baselines, Maritime Zones and Limits.' *Maritime Briefing, Vol 3, No.3* Durham: International Boundaries Research Unit.

DOALOS (2003). Presentation on the Deposit and Charts and Lists of Coordinates of Points – Briefing. *13th meeting of States Parties to the United Nations Convention on the Law of the Sea*, New York 9-13 June 2003.

Reed, M (2000). *Shore and Sea Boundaries Volume Three* Washington: US Government Printing Office.

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