GIS APPLICATIONS TO MARITIME BOUNDARY DEFINITIONS: DIPLOMACY ON AND UNDER THE SEA

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ABSTRACT: Under evolving criteria established under the **United Nations Convention on the Law of the Sea (UNCLOS)**, coastal states continue to re-define their sovereign claims to ocean space. Construction of a global database founded on a geographic information system (GIS) incorporates both adjudicated and claimed maritime boundaries providing the basis for determining what marine activities are permissible under the UNCLOS Articles. Graphic presentation of the location of such boundaries, coupled with attribute tables containing pertinent parameters, qualifications and references to these limits, permits offshore operators to plan and conduct activities which will not be in violation of UNCLOS Articles or the coastal nation's claims.

MRJ Technology Solutions maintains a global database of maritime boundaries incorporating not only limits established through legal channels such as the **International Court of Justice** and the coastal state's tribunals, but also those claimed but not legally resolved. In the case of the latter, disputed or unresolved boundary claims are especially significant to mariners who may be uncertain as to whose waters they may occupy or transit. The database clearly displays areas of overlapping claims and questionable limits, and provides accompanying attribute tables providing pertinent information on the nature and status of the claims.

With the increasing capability to exploit natural resources on and under the deep seabed, at least 33 coastal nations can or have redrawn limits to their continental shelf claims which extend beyond their respective Exclusive Economic Zone - traditionally 200 nautical miles from the actual coast or baselines. As these cases are resolved through the **UN's Commission on the Limits of the Continental Shelf,** they will be incorporated in the global database as revisions to the outer bounds of national claims to the seabed.

Introduction

The establishment of a boundary on land is quite straightforward -- build a fence, a wall, a road, or a ditch and declare that access to or occupation of the terrain on "your" side is subject to your discretion. This works well when distinct points on the ground may serve as markers from which your boundary lines originate. A "property owner" with the means to control access may thus regulate activities within that region. This owner hopes that another state acknowledges such claims and any question about their location and associated or implied rights can be settled amicably. There are other means of adjudication open to states who may dispute boundaries -- one such body is the International Court of Justice which renders decisions affecting boundary delimitation.

The "straightforwardness" of delimitation based upon terrestrial features begins to fail when a body of water becomes part or all of the boundary. A river, lake, estuary , shoreline or other fluid body complicates delimitation. Such features are dynamic and may change within short periods of time, leading to revised interpretations of geographic location upon which boundaries are based. Beyond the sight of land, reasonably accurate positioning is achieved through satellite positioning systems such as the Global Positioning System (GPS) or similar geodetic locational methods. In the sea the delimitation of maritime jurisdiction is further compounded by the selection of the datum from which boundaries are derived. There are at least six different vertical references (hydrographic datums) employed to define the basis for drawing maritime boundaries. While such issues are beyond the scope of this paper, we will examine the traditional maritime boundaries invoked by coastal states and the application of Geographic Information Systems (GIS) to facilitate display and interpretation of coastal state claims.

Maritime Boundaries

Coastal states draw maritime boundaries to delimit areas for juridical purposes. The declaration of a baseline is the basis for establishing the geographic reference from which other maritime limits are drawn. Specific protocols under the Articles of the United Nations Convention on the Law of the Sea (UNCLOS) describe the conditions under which a state may establish such baselines, using the shoreline (mean low water), a straight baseline established under UNCLOS Articles, or a combination of both. The traditional zones of a Territorial Sea (usually 12 nautical miles), the insertion of a Contiguous Zone (additional 12 nautical miles) and the claim of an Exclusive Economic Zone (EEZ, usually 200 nautical miles) are shown in Figure 1. Since the fundamental reference to such boundaries is the baseline, the UNCLOS has declared formulae to determine the length and direction of lines other than the curvilinear "shoreline" which is based upon various vertical datums.

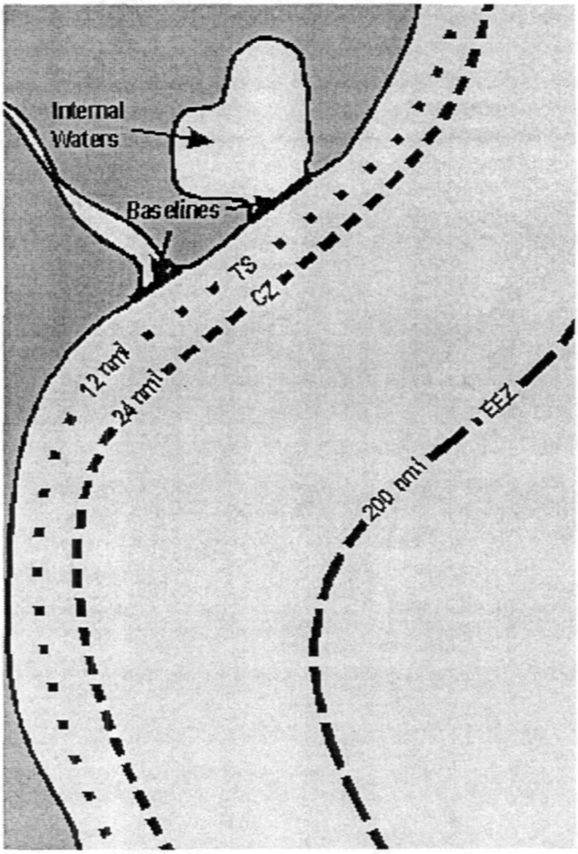

Figure 1: Primary maritime boundaries drawn from baselines. TS=Territorial Sea, CZ=Contiguous Zone, EEZ=Exclusive Economic Zone. Continental Shelf boundaries may extend seaward of the EEZ limit.

These constructs, termed "straight baselines," enclose river mouths, irregular embayments of a specific size, and other features where "internal waters" may be claimed. Under Article 7 of the UNCLOS, straight baselines may be constructed only in a) localities where the coastline is deeply indented and cut into or, b) where a fringe of islands lies in the immediate vicinity of the coast. Two conditions regarding the width of embayments and permissible baselines appear in Figure 2.

Another maritime boundary of growing significance is derived from geographic references other than the baseline. Delimitation of the Continental Shelf Regime employs bathymetric, geomorphic and geologic datums which also require geospatial documentation. Whereas the EEZ is established to allow of control of activities on the sea's surface and in the water column, the Continental Shelf claims are directed toward resources, mineral and living, which lie on and under the seafloor. These shelf claims can extend for significant distances beyond the 200 nautical mile EEZ and encompass enormous tracts of the seafloor. Finally, there are claims on the seafloor under high seas regions which lie beyond any coastal state's claims. These are included under the United Nations "Sea Bed Authority" and convey rights to deep-sea mining in international waters.

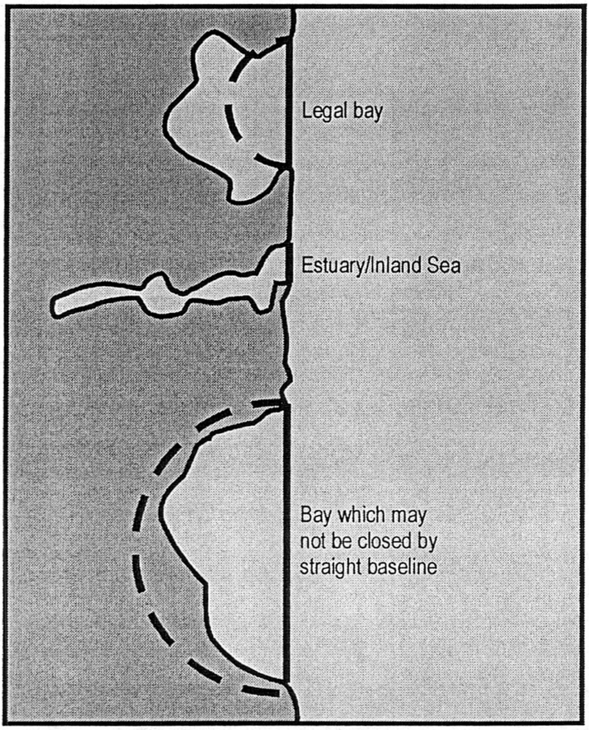

Figure 2: Straight baseline construction according to Article 10 of the UNCLOS. The depth of indentation of an embayment must be greater than one-half the length of the baseline closing the bay.

Maritime Boundaries as Spatial Data

Maritime boundaries established under either the UNCLOS protocols or unilateral coastal state claims are dependent upon some geospatial reference which (initially) provides a point on the earth's surface as the fixed basis for a claim. In the case of the low water datum or straightlines for baseline construction, such locations depend upon a variety of hydrographic determinations referenced to their vertical datum. For Continental Shelf boundary constructions (and for other boundaries far from shore), oceanographic and geophysical surveys and their attendant positioning capabilities under such systems as the GPS determine the accuracy of geospatial coordinates employed in establishing boundary claims.

The Management of Maritime Boundary Data in a GIS Approach

A Geographic Information System (GIS) is a computerized data management system for the capture, storage, retrieval, analysis and display of spatial data. The basic elements of a GIS are <u>points, lines, and polygons.</u> They permit the display of two-dimensional presentations of "attributes" - descriptions of features and data which characterize a particular data set.

To manipulate spatial data in a GIS mode, the computer needs three things:

.. Where each feature is in some referenced geographic space (position)
.. What each feature is (attribute information)
.. The spatial relationship of each feature with respect to others ("neighborhood")

For maritime boundaries, these conditions are met by the declarations of the coastal state in applying for recognition of its jurisdiction. The basic features are the points: these may be shoreline low water (or other datum) points, geographic features serving as points (headlands, islands, etc.), "turning points" for straight baseline constructions, end-points for a line, or corners for a polygon. After these elements are entered in the GIS database, attributes are applied which "label" the feature and provide background information on the nature of that feature. Finally, the GIS relates the feature (point, line or polygon) to neighboring features (coastline, similar features, different features, etc.).

Applications of a Maritime Boundary Database

Maritime boundary information is available from a variety of sources, including the United Nations, various State Departments or their equivalents in coastal states, academic institutions and private databases. Yet nowhere are all the data, and especially their attributes providing essential background information, available in a GIS database. Marine enterprises benefit from, and depend upon, information regarding the juridical claims presented by coastal states. Under such claims, stipulations addressing constraints to various activities under UNCLOS protocols or coastal state declarations become integral elements in planning offshore developments which will both justify investor's support and assure unimpeded execution of proposed offshore endeavors.

MRJ Technology Solutions has developed, and will shortly offer, a Global Maritime Boundary Database (GMBD) which will contain information on current maritime delimitation and offer periodic updates to changes in coastal state's claims to jurisdiction over offshore regions. An example of such a database entry is provided in Figure 3. Here the claims of Pakistan have been displayed and the variety and nature of UNCLOS claims as well as indigenous claims and the location of a disputed area are presented in a database format.

At present the GMBD boundary data are derived from numerous sources. We have employed World Vector Shoreline (WVS) at the scale of 1:250,000 as the reference for boundaries. Due to the small scale of the WVS as compared to the larger scale of approach and harbor charts (1:100,000 to 1:25,000) from which listed boundary coordinates are derived, a review has been made of nautical charts and supplementary sources of hydrographic data to ensure islands, reefs, rocks and shoals were represented in WVS. Buffers constructed from such data provide the basis for graphic presentation of boundaries in the GMBD.

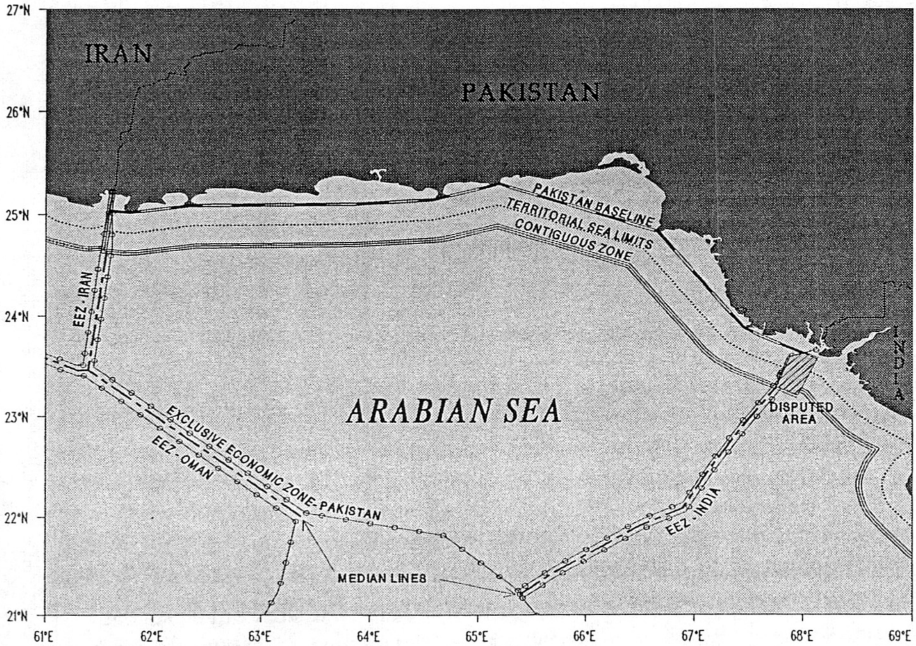

Figure 3: Example of GMBD entry. Attribute data describe construction of maritime limits and sources of information.

Maritime boundaries: India, Oman, Iran (median lines, not arbitrated).

Baseline published in Gazette of Pakistan via Ministry of Foreign Affairs, 29 August 1996. (DOALOS, Law of the Sea Bulletin #34, p. 45, 1997). Straight baseline turning points:

Signed UNCLOS 12-10-82
Ratified UNCLOS 02-26-97

Baselines	08-29-96	
TSL Claimed	1996	12 nmi
CZ claimed	1996	24 nmi
Fisheries Zone(1)	1973	35 nmi
EEZ	1976	200 nmi
Continental Shelf 1976	200 nmi (plus continental margin definition)	
MSR Jurisdiction	Yes	
MSR Regulations	Yes	

(a)	25°02.20'N	61°35.50'E
(b)	25°00.95'N	61°46.80'E
(c)	25°05.30'N	62°21.00'E
(d)	25°06.30'N	63°51.01'E
(e)	25°09.00'N	64°35.20'E
(f)	25°18.20'N	65°11.60'E
(g)	24°49.45'N	66°40.00'E
(h)	23°52.80'N	67°26.80'E
(i)	23°47.30'N	67°35.90'E
(k)	23°33.90'N**	68°07.80'E**

**disputed by India

Comments:

Straight baselines from which TSL, CZ, EEZ and Continental Shelf shall be measured. From Pakistan's Territorial Waters and Maritime Zones Act of 1976 (sec. 2, par. 3). Internal Waters lie landward of these baselines.

(1) Current deep sea fishing policy reserves exploitation rights in Zone I, between 12 and 35 nmi from shore, for artisinal fishermen. Zone II, 36-200 nmi, open to larger trawlers and longliners, requires a license from Ministry of Food, Agriculture and Livestock. (World Fishing, January 1998, p. 2)

**Disputed zone with India results from overlap of TSL/CZ boundaries. (DOALOS, Law of the Sea Bulletin #35. p. 41, 1997)

Sources of Error

Questions of scale and projection enter into an assessment of accuracy in any GIS. In the case of maritime boundaries, this is especially true since data derived from nautical charts suffer from factors such as line width on the chart and variations in chart datum between countries (hence a discrepancy in buffering). Mercator projection is the common basis for mariners, and errors in line length and in true distances increase cumulatively as distance from the equator increases. The basis and assumptions for all data in the GMBD are carefully enumerated for the user and sources of error are identified as appropriate to each entry.

Users

Maritime boundaries affect all those engaged in offshore activities, from extractive industries such as fisheries and petroleum to the conduct of marine research. The latter is of special concern to the academic community since formal permissions for obtaining samples from the water column or the seafloor may require not only consent from the coastal state but participation on-board ship by coastal state scientists. The GMBD is designed to provide those engaged in maritime activities with a planning tool which presents the geographic extent of real or perceived jurisdictions of coastal states. It further identifies those regions in which boundaries are in dispute, overlap or are otherwise unresolved. For example, numerous boundary issues have been raised as a result of fisheries disputes, and in many cases the fisheries agreements and their limits and conditions (usually quotas, restrictions in gear and vessel size or seasonal constraints) are incorporated in the GMBD.

Conclusions

No maritime activity should be anticipated or undertaken without cognizance of boundaries claimed by coastal states. Coastal states are entitled to control and participate in marine activity occurring in waters which they may rightly claim under ratification of the UNCLOS. As the legal framework of maritime boundaries evolves, the GMDB will provide current status and locational information in a GIS context useful to a variety of users.

Authors

Mr. Christensen is a member of the technical staff with MRJ Technology Solutions, Farifax, VA, USA. He has been with that firm for over five years, and leads efforts in electro-optical systems, natural language understanding, geospatial database processing and scientific visualization. He has 15 years experience in artificial intelligence, computer systems development and consulting, and holds B.S. degrees in physics and mathematics, M.S. in electrical engineering and expects to receive an M.S. in engineering management in January 2000.

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Lorin Pruett is the architect of the GMBD. He has been involved in all aspects of its development for over 10 years. Lorin has a B.S. in Geology and an M.A. in Geographic Information Systems. He has been designing, developing and maintaining large geographic database systems since the mid-1980s. Lorin has been editor for, contributed to, or authored numerous contract related documents.