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COMPREHENSIVE PROCESS-DRIVEN BOUNDARY MAKING MODEL: A CASE STUDY OF THE JORDAN-ISRAEL BOUNDARY

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ABSTRACT

Surveyors had a central role in boundary-making processes from at least the 19th century. The latest technological developments in this field have further widened their involvement in the process and changed the concepts and practices implemented. The Process Model presented here incorporates the new technical means available for modern surveyors in accomplishing a more stable and sustainable boundary through a structured procedure. The roots of the traditional theory of boundary making were put down a century ago by Curzon[6], Holdich[9] and others referring mainly to the three-stage process of allocation, delimitation and demarcation. This article renews the existing model of boundary making process adding to it two additional stages: boundary documentation and boundary maintenance to build up a comprehensive approach. The direct involvement of the authors in boundary making processes between Israel and its neighboring countries facilitated assessment of the model elements and their full implementation in the Israel-Jordan Boundary making from negotiations, through demarcation in the field up to continuing bi-lateral maintenance operations.

KEYWORDS: Jordan. Israel. Boundary. Curzon. Holdich.

INTRODUCTION

Borders not only define the sovereignty of states but also their natural and economic resources as well as their long-term capacity for maintaining their cultural and societal identity. Unclear definition of boundaries is among the primary reasons for territorial conflicts that frequently lead to armed confrontations between nations.

The overall responsibility for defining boundaries and resolving border disputes naturally belongs to the political leadership. However, most of the work is done behind the scenes by professionals, border experts from a range of disciplines – including international law, surveying and mapping. Surveying engineers play a principal role throughout the boundary-making process. Their professional responsibility extends beyond the technical support of boundary negotiations and also includes involvement in delimiting boundaries in peace treaties, and responsibility for boundary demarcation, documentation, and maintenance. Their failure in performance may lead to boundary conflicts.

The modern theory of boundary making developed at the end of the 19th century and the beginning of the 20th century. Until that period, the terminology was not clear, and even basic terms such as delimitation and demarcation were often confused.

Lord Curzon [6], Sir Henry McMahon [13], Col. Sir Thomas Holdich [9], and C.B. Fawcett [8] defined the basics of the modern theory of boundary making. Other prominent figures in this area outside Great Britain were mainly Haushofer from Germany, and Lapradelle from France. The advantages of their practical involvement in boundary making, encompassing continents, and their timeliness gave their publications special impact. The publications of Lapradelle [12] and Jones [10] reflect an important major step in separating the practical stages of boundary making. In their publications, they divided the process into three or four basic stages: Allocation, Delimitation, Demarcation, and in addition, overall Boundary Administration (Figure

1). Although Jones also refers to additional activities that he considers of great importance, such as a detailed description of the demarcation, the basic theoretical stages still remain the above-mentioned stages.

In spite of the fact that international boundaries are an important element in stabilizing the relations between nations, an up-to-date, internationally agreed model of the boundary-making process does not exist. Moreover, there has been no comprehensive attempt to extend the description of the early three or four phases. The lack of such a model leads to insufficient technical support for statesmen with regard to delimiting the boundary and the practical arrangements associated with it.

The objective of this article is to describe a comprehensive boundary-making model that may assist the different negotiating parties in reaching an agreement and then lead them through the differing professional ways of demarcating the boundary in the field and making it sustainable.

A new extended boundary-making model is proposed and its relationships with the existing four-stage model are graphically presented in figure 1. This model was developed based mainly on the experience gathered during the boundary making between Israel and Egypt and between Israel and Jordan. The different stages of the model are described with reference to these case studies emphasizing our conclusions regarding technical recommendations which are of general relevance.

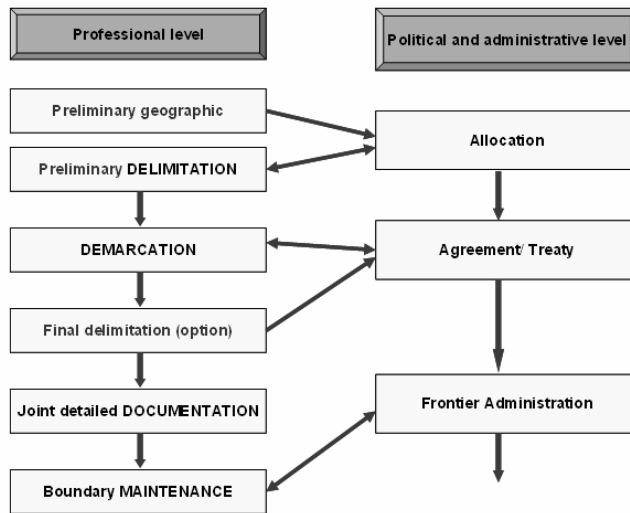


Fig. 1. The structure of the proposed Process Driven Model

PRELIMINARY NEGOTIATIONS AND FORMALIZATION OF A "COMMON AGENDA"

Any professional involved in boundary making needs to understand the wide context of the political negotiations. At the initial or preliminary stages of peace negotiations between states, a common agenda is prepared. This document includes a definition of the main subjects to be discussed and included in the final peace agreement, and the agreed terms of reference of the negotiations, with regard to the main subjects, including the allocation of the boundary. Preliminary negotiations leading toward a common agenda are characterized by heavy political pressures. During these negotiations, there are designated professional committees, one of which is a

committee on boundaries and other territorial issues. The objective of the committees is to lead toward achieving a treaty: a formal document that legally defines all relevant issues between the states and legitimates their relationship. An essential part of the treaty between the states is concerned with territory, including the international boundary between them. In complicated cases the treaty may define a delayed process of negotiation to be performed for a certain part of the boundary after the treaty is signed.

Regarding the Israel–Jordan Boundary case study, on the 25th of July 1994, there was the Washington Declaration signed by the late king Hussein of Jordan, the late Prime Minister Rabin, and President Clinton, the host of the meeting, who served as a witness. This declaration reaffirmed the five underlying principles of understanding with regard to the common agenda including the sub-agenda for borders and territorial matters. The outcome of the declaration was also an understanding to accelerate the bilateral peace negotiations and to carry them out in the region at sites along the border between the states.

The negotiations resumed in a tent in Wadi Araba in July 1994 and continued in different places along the border, either on the Jordanian side or on the Israeli side until the 26th of October 1994, when the final delimitation of the international boundary and the other components of the Peace Agreement were concluded and signed. Following the Peace Agreement, the stages of boundary demarcation, boundary documentation, and boundary maintenance were accomplished. It is important to note that within this agreement the settlement of the Maritime Boundary in the Gulf of Aqaba/Elat was defined for further settlement by the two parties (agreement on the maritime boundary was reached a year later).

During the negotiations between Israel and Jordan, principal elements of the new boundary-making process were implemented. In this article this model is further formalized and documented.

THE NEW MODEL – MEANS TO ACHIEVE THE PURPOSE

The proposed model covers all the stages in the process of boundary making, the components and activities to be included in the process, and the recommended technologies and technical means. The latter should be revised from time to time due to technological advances.

The various stages throughout the process are interrelated: considerations relating to later stages are integrated during the implementation of earlier stages. In order to optimize the process, one should analyze from the last stage backwards, and then integrate the relevant considerations. Following several iterations of assessments of implications from later stages to the earlier ones and vice versa, we have formulated the following model.

The Components of the Process-Driven Boundary-Making Model include boundary allocation, initial delimitation, demarcation, final delimitation, documentation and maintenance.

BOUNDARY ALLOCATION

Definitions and Practice

“Allocation means the initial political division of territory between two states” [10].

In modern times, the allocation usually results from a compromise between the two parties representing the two bordering countries. In colonial times, it used to be a general agreement between two colonial powers. The Allocation used to be defined in several ways:

- With reference to previously known administrative or international boundaries. An example of a reference to existing districts can be found in the definition of the separation line between Lebanon and Syria in the Order of Governor Gureau on August 31, 1920, or the reference to the boundary under the Mandate as specified in the 1979 Peace Treaty between Israel and Egypt.
- With reference to natural, prominent geographical features. This method was used all over the British Empire and was described frequently in publications [6], [9],[8] etc. Such a referential definition enabled one to describe very quickly the boundary, without knowing well the area itself or visiting it. Despite its simplicity, a significant number of conflicts arose during the implementation process owing to the implicit nature of many of the geographical definitions and difficulties in implementing them on the ground. The usual geographical features used for that method are chains of mountains, rivers, lakes, and valleys.
- The geometrical method [6] which was used during the colonial period was based on defining long straight lines along Longitudes or Parallels. It was used mainly in deserts or less populated areas. This method actually refers to astronomical lines and is referred to by others as the astronomical method. Another version of the geometrical method concerns straight lines stretched between two natural or man-made objects. This was also the general directive of the 1906 administrative line between the Egyptian Chadivate and the Ottoman Empire, which later became the international boundary between Egypt and Mandatory Palestine. The intention of the allocation was roughly a straight line between Raffa in the north and a point on the Gulf of Aqaba (not very far from Aqaba, later to be chosen at Taba) in the south (this line fully annexed practically the whole of Sinai to Egypt for the first time, because of British interests).

The allocation expresses the intention of the statesmen. The professional supporting staff would be required to inform the statesmen regarding relevant important knowledge such as security considerations, economic interests, legal considerations, topography, population distributions, natural resources, and additional geographic as well as historic, ethnographic, anthropologic, and cultural information. For a proper implementation of the above-mentioned information-based process, a team of experts should be designated at an early stage of preparing for the boundary allocation. Since the allocation has a major influence on the delimitation, being its directive, and further on, on the demarcation, it is beneficial that a technical expert, preferably a boundary engineer, who already has had experience in boundary making, participates in the early stage. His participation can prevent unexpected complications during the implementation of the boundary process.

Implementation in the Israel-Jordan Case Study

As discussed earlier, a Common Agenda, including a sub-agenda referring to borders and territorial matters, was reached in July 1994 following a few rounds of meetings between Israel, Jordan, and USA officials. The sub-agenda on borders and territorial matters stated the following:

"The international boundary between Israel and Jordan will be delimited with reference to the boundary definition under the Mandate."

This was actually an agreed guideline, which for the first time, defined mutually and formally the mandatory boundary line as a reference for the parties determining

the delimitation of the International Boundary, which was later agreed upon by both states. The original formal boundary definition of the boundary between Trans-Jordan and Palestine was published with regard to the 1922 formal British Mandate over Palestine (and Trans-Jordan) for the declaration of non-applicability of provisions of the Mandate of Palestine to the territory of Trans-Jordan. In practice, the meaning of this allocation regarding the common agenda was to refer to the specified delimitation and demarcation under the Mandate. However, the Mandatory delimitation suffered from serious deficiencies because of various contradictory interpretations.

In the case of Israel-Jordan, boundary surveyors and legal experts were consulted and their professional advice was to write in the common agenda

...*"with reference to the boundary under the mandate"*.

In this way, there was a degree of flexibility for boundary interpretations left for the precise boundary delimitation and an early dispute was avoided.

THE DELIMITATION

Definitions and Practical Implications

We follow the earliest definitions of the term coined by McMahon. See in [22]:

"the definition on paper either in words or on a map of the limits of a country"

And Curzon [6]:

"Delimitation signifies all the earlier processes for determining a boundary down to and including its embodiment in a Treaty or Convention".

Thus, the delimitation is signified by work with documents, including maps.

The delimitation stage is the most complicated stage as conflicts of interpretation inherited from the allocation stage must be resolved. At this stage, experts on both sides translate the general definitions included in the allocation to practical, precise definitions, taking into account local considerations. Sometimes the experts deviate from the original definition in order to adapt it to local conditions. Since the delimitation is usually incorporated into the treaty itself, the statesmen are still involved either directly or indirectly. Expert advice concerning potential problems during demarcation are mandatory at this stage. In our model there is also an option for initial or preliminary delimitation prior to the demarcation and final delimitation following the demarcation. This used to be the case a century ago when a lack of geographic knowledge about the area created a need for an iterative process. The implementation of final delimitation is recommended by us as will be shown later for the augmentation of the core of boundary documentation.

McEwen [14], Kadmon [11], Adler [1], and Srebro [20] recommend that practical experts should participate in the wording of the treaty or agreement at the delimitation stage. Rushworth [17] recommends the participation of experts, at least as consultants to tribunals when deciding on delimitation. The importance of such an involvement was discussed by Cukwurah [5, p. 34].

According to our model, the two parties to the negotiation should establish an organ called the Joint Team of Experts, as early as possible, in order to accomplish jointly all the professional tasks of the boundary process. This team should include geodesists, cartographers, and other mapping experts. The team should be a part of a Joint Boundary Commission, together with lawyers, liaison persons, consultants when needed, and a commissioner who has the confidence of the statesman who is leading the negotiation between the states.

The JTE tasks would typically be:

- Preparation of background information for the delimitation, including field reconnaissance, defining the parameters of the geodetic support and implementing the relevant activities with regard to it, defining the mutual set of graphic aids, including maps, which is required as a background for depicting the layout of the boundary line in the treaty.
- Involvement in preparing the delimitation of the boundary line itself, both its wording and the set of mutual maps of the treaty, in coordination with the statesmen. If the delimitation covers sections other than the land boundary, such as a boundary line in a river, in a lake or a maritime boundary, it is the task of the joint team of experts to define the technical parameters and methods for this delimitation and to implement them.
- Determine delimitation implementation procedures: specify the method of defining boundary coordinates, and determine the order of precedence of the various boundary definitions in the future (for example, between boundary coordinates, delimitation on maps, the wording of the treaty, and the physical signals).

Initial Delimitation within the Framework of the Israel-Jordan Boundary



Fig. 2. A portion of the map album of the Israel-Jordan boundary delimitation.

WADY ARABA/ EMEK HA'ARAVA Orthophoto

A major conflict arose during that stage almost at the beginning of the work of the Joint Boundary Commission owing to difficulties in interpreting the term "Centre of Wady Araba" which is a central element in the British Mandate definition. According to Shoshany et al. [19], there were historically two main interpretations given for this

definition: line of lowest points and a line following the centre line of the valley, as perceived in its generalized wide extent. During the British Mandate over Palestine and Trans-Jordan, a line was drawn on small-scale maps; this line was supposed to represent the lowest points of interpretation. Following heavy political and professional negotiations during the 1994 peace negotiations an agreement was reached. The conflict resolution was reached by a territorial division fulfilling the Jordanian expectations to gain sovereignty over a certain amount of land occupied by Israel, and the Israeli expectations to avoid evacuation of agricultural settlements, their fields and orchards. The Joint Boundary Commission, and practically the Joint Team of Experts, was granted a level of flexibility during the precise delimitation, with reference to the precise definition of an agreed line. This flexibility allowed the teams to come to a logical and fair solution with regard to the practical situation on ground and to local interests on both sides. The actual delimitation was implemented on orthophoto sheets by senior boundary engineers, the heads of the JTE.

Figure 2 presents a portion of the maps representing the boundary delimitation, which were then signed by the Late Israeli Prime Minister Rabin, by the Jordanian Prime Minister Al Majally, and by the American President Clinton during the Peace Agreement Ceremony at the Araba border crossing (nowadays Rabin Border Crossing) on October 26, 1994.

Technical Recommendations for the Delimitation Stage

Following the experience gathered during demarcation of the boundary line between Israel and Egypt, there were implemented in the Jordanian – Israeli boundary delimitation the following conclusions:

Selection of Maps: delimitation lines, which are marked on 1:250,000 or 1:500,000 maps (such as the map attached to the Treaty of Peace between Israel and Egypt 1979) or on poor 1:100,000 maps (like the separation line between Israel and Syria in 1974 and the withdrawal lines, associated with the Treaty of Peace between Israel and Egypt in 1979), are not adequate for field demarcations and thus cause very serious problems of interpretation due to the following reasons:

- Poor resolution: since one millimetre on the map means 250m (on the 1:250,000) or 100m (on the 1:100,000) in the field.
- Features on the maps are too generalized and do not meet the real features on the ground.
- Their positional inaccuracies are often at a magnitude of hundreds of metres.
- The width of the delimited lines on such maps cover up to hundreds of metres on the ground (up to 700m in the Israeli-Syrian separation line). The solution that was found in the case of the withdrawal lines between Israel and Egypt in 1979 was that the joint team of experts prepared a full coverage of strips of controlled photomosaics (ungrided orthophoto) along 1100 km at a scale of 1:100,000. The delimited lines were jointly transferred from the poor 1:100,000 treaty maps to the photomosaics and signed by experts from both sides. Enlarged 1:25,000 photomosaic strips (enlarged from the mutually signed 1:100,000 photomosaics) were used as the field material for the demarcation, which was jointly, fully and successfully performed along 1100 km of lines. This solution depended on mutual good will. On the other hand, in the absence of common good will, even precise geodetic equipment could not help to fully overcome the contradictory interpretation of the separation line in the Golan Heights, owing to poor delimitation.

- When a boundary is marked on maps of various scales, a contradiction may exist between the depictions. This was experienced in 1979 in the case of the Peace Treaty between Israel and Egypt with reference to the depiction of the withdrawal lines on the 1:250,000 and the 1:100,000 maps. It is recommended that the different maps be given a measure of accuracy and reliability. In addition it would be beneficial if there would be a comment referring to the originality of the maps.
- Verbal descriptions are not a sufficient tool for delimitation since such descriptions refer to features that may change or disappear, like trees, buildings, wells, etc. The description may be well interpreted just after being defined, but may be difficult to interpret years and decades afterwards. Another reason is the use of geographical names. Geographical names also change historically due to political, social and demographical changes. Sometimes, especially in areas that were not well mapped, geographical names are either replaced or used differently to mislead the demarcators. Verbal descriptions which refer to measured distances may not fit actual measures that can be taken using modern equipment. Moreover, verbal boundary definitions may contradict each other and may disagree with a geographical layout or delineation on a map.

General recommendation: to reduce the use of various descriptions and, if there are several such descriptions used, to define an order of precedence among them [21].

BOUNDARY DEMARCATION

Definition and Practice

McMahon, see in [22], Holdich [9], and Curzon [6] defined the demarcation as laying the boundary on the ground. Curzon referred to demarcation

“...as applying to the final stage and the marking out of the boundary on the spot”.

He referred to demarcation as a more technical process than delimitation, which involves setting up beacons, pillars, or posts, numbering them, and recording them on maps [18]. This stage is accepted as the third of the four stages, the last to be administered as a boundary [10],[16], [2].

According to McMahon, see in [22], the delimitation does not supply

“Stability and finality which should be the underlying object of all international boundaries”.

According to ICJ (ICJ Reports, 1962, Preah Vihear Case), one of the primary objects when establishing a frontier is to achieve stability and finality. This is impossible if the line be called in question, such as may be when relying on a treaty clause. A natural indication may be regarded insufficient to achieve certainty and finality.

There is a level of latitude that is granted to the demarcators, when implementing their task, in order to take into account local geographical, administrative, or other considerations [6], [10], [5], [3], [2], [18]. Rushworth [18] commented that although latitude was more essential when the delimitation maps were of poor quality, it is still considered necessary for modern demarcation.

According to Jones [10, p. 59], the provisions that are granted to the demarcators to deviate from the delimitation usually refer to equitable compensation. He gave a few examples for such provisions, which include the Argentina-Chile convention of May 2, 1904 and the Estonia-Latvia delimitation convention of October 19, 1920. Jones recommended not to mention territorial compensation in the treaty, thus to enable non-territorial compensatory measures. Jones [10, p. 60] also referred to restricting the deviations to slight or minor modifications and gave examples. These include cases such as the Colombia-Ecuador treaty of July 15, 1916, the Colombia-Peru treaty of March 24, 1922, and the Costa Rica-Nicaragua convention of December 24, 1886, which specify that the commissioners have a limit of one mile for a deviation from the delimited line. The Protocol of Peace, Friendship, and Boundaries between Ecuador and Peru, which was signed at Rio de Janeiro on January 29, 1942, does not put a limit to the parties, who may

"grant such reciprocal concessions as they may consider advisable in order to adjust the aforesaid line to geographical realities" [United States, Executive Agreement Series, No. 288 (Washington 1943), Article 9].

The demarcation process is sometimes delayed for very long periods of time following the delimitation. Before the 20th century, only a few boundaries were demarcated [3]. Later on, colonial powers preferred in certain cases not to demarcate boundaries because of economical reasons (cost), or because the boundary was in an uninhabited area such as Wadi Araba between Palestine and Trans Jordan [3] and Wadi Batin, between Iraq and Kuwait [4].

The trend today is to demarcate international boundaries, but there are countries that still avoid it because of economical reasons, or in order not to enter into potential conflicts.

Demarcation Issues in the Israeli Context

Experience in demarcation in the field was gained during the implementation of the Israel-Egypt and Israel-Jordan boundaries. In both cases, at least partial demarcation of an earlier boundary already existed: as was conducted in 1906, along the Rafa-Taba line for the Israel-Egypt boundary, and in 1946, along a short section near Aqaba for the Israel-Jordan boundary. Linking between new and old demarcation points, is essential although tracing remnants of old demarcations may be most difficult. This was experienced in 1981 during the demarcation of the international boundary line between Israel and Egypt, especially in the sandy regions. In the north, in certain cases, several pillars were found, close to each other, representing generations of renewed boundary pillars. In other cases, the pillars disappeared in the sand dunes, and were re-exposed following windstorms in places different from their original location. In the south, pillars disappeared or were removed sometimes due to engineering constructions, leaving contradictory boundary interpretations. This was experienced in 1995 during the demarcation of the international boundary between Israel and Jordan. The old boundary pillar, which was demarcated near the Gulf of Aqaba in 1946, was off the delimitation line of the international boundary in 1994. The solution was to move the line toward the old pillar at that location and to compensate for it, by moving the line north of this pillar in the opposite direction.

The best results of demarcation, and the easiest ones to implement, are achieved if the delimitation is made jointly, including thorough field reconnaissance, and physical marking of the delimited line. The demarcated boundary should be jointly surveyed, using the best available geodetic technology. The result of the survey should include a detailed description of the demarcated boundary, the core of which should be a joint

list of boundary coordinates in a common geodetic system. This will be the binding source for boundary restoration in the future.

As discussed earlier, the demarcators should be given latitude in adjusting for topographical and other problems and obstacles, including accessibility problems, or anticipated unstableness of the boundary pillar, which requires continuous maintenance. This sort of problems was faced during the 1982 Israel-Egypt field demarcation, either in the unstable sand dunes, or on high slopes of ridges, and in placing new pillars in turning points of the boundary line where old pillars already existed.

An important conclusion from these cases concern the design, construction and positioning of new pillars (Figure 3): they must be adequate for geodetic measurements, maintenance (including the accessibility) and future restoration (due to tilting, collapsing, or disappearance).



Fig. 3. An Israeli-Jordanian boundary pillar positioned near the Gulf of Aqaba/Eilat.

THE FINAL DELIMITATION

Jones [10] recommended that the boundary should be ascertained on the ground and then be delimited. The final delimitation includes a descriptive part and accurate data of field measurements. The most accurate definition today is an analytical list of coordinates for the entire boundary on a common geodetic system including a common accompanying data file. This was implemented in the past. Today the relevant activities are included in the comprehensive stage of documentation. There is an option to adopt and authorize the precise coordinates of documentation as the final delimitation.

But in the past the geographical data of the final delimitation of boundaries included descriptions of local features, either natural, such as ridges, rivers, thalwegs, hill peaks, and trees or man-made such as roads, wells, and buildings. In addition to the description of features, the delimitation included distances between boundary pillars and existing features.

If a precise final delimitation (including a precise list of coordinates) becomes part of the document of a treaty, it gets its direct authorization from it and no additional demarcation is legally required (But the demarcation is practically required for

boundary administration). Sometimes the treaty itself requests that the joint boundary commission accomplish certain duties to be performed after the treaty is signed. In such a case the additional document should be authorized by the two parties. An example of such a case is found in the Treaty of Peace between Israel and Jordan. The Treaty requested the Joint Team of Experts to demarcate the land boundary and to define geographic coordinates that will be agreed upon by both parties, which will be binding and take precedence over the maps annexed to the Treaty of Peace representing the preliminary delimitation.

BOUNDARY DOCUMENTATION

The importance of a certain level of documentation was recognized in the past. Jones [10, p.199] remarked that the importance of a technical report of the demarcation is to prevent loss of data, which may be valuable for future demarcations, surveying, and geodetic work. Cukwurah [5, p.79] mentioned that

“on completing demarcation work, it is the duty of demarcators to compile a detailed general description of the boundary line and the topographical coordinates of all boundary posts, marks and beacons including their types, forms, dimensions and colouring”.

Following the Court’s leading principle, that the element of stability and finality should be the underlying objective of all international boundaries (ICJ, 1962 Preah Vihear Case), we think that a joint comprehensive detailed documentation of the boundary, which is sufficient to support an accurate reconstruction of every boundary pillar, is the ultimate means of achieving it. Furthermore, in spite of the fact that physical demarcation of the boundary is recommended, especially in areas of tension, for easing boundary administration and reducing violations, theoretically and legally, a combination of a mutual delimitation and comprehensive documentation may also be sufficient.

Our recommended approach is to define the documentation of the boundary as a designated major stage in the process of boundary making, similar to land registration in the land administration process, the difference being that the final approval and authority are not given by an authority of a single state, but are given by the two neighboring states, along the relevant boundary line, by their authorized representatives. Achieving a comprehensive, mutually agreed upon detailed documentation should be the ultimate goal of boundary makers. This maintains the quality of finality and theoretical stability. In order to achieve the full range of stability, including the practical point of view, it should follow a thorough, well-maintained demarcation. Current measurements technologies can support a level of several centimetres of accuracy. This is ten times better than required for most cases of international land boundaries, and a hundred times better than the accuracy of most of the existing international boundaries in the world.

An accurate, detailed comprehensive documentation supplies the technical solution for any potential conflict between relevant countries, with regard to the accurate location of the boundary line, or any interpretation with regard to it. If it does not succeed in preventing legal action, a common, accurate, detailed documentation can, at least, shorten the work of an arbitration or conciliation tribunal or of a jury of the Court, since it contains the solution of the case. The accuracy and the comprehensiveness of the documentation define the technical solution, whereas the signatures of the authoritative representatives give it its legal decisiveness.

According to our experience, the value of the descriptive data with regard to the type and shape of the pillars is only complementary, whereas the positional and geodetic data that fully documents the location of the boundary, and which is sufficient to support any objective technician to reconstruct the boundary line, is essential.

Our experience is based on a few practical cases with regard to reconstructing old international boundaries. The first case took place in 1981, when a joint team of experts tried to trace the international Mandatory boundary line between Palestine and Egypt. It was agreed that this line was to be the new International Boundary between the State of Israel and the Republic of Egypt according to the 1979 Peace Treaty between the States. This line was delimited in 1906 and demarcated in 1907. The joint team tried to trace the old pillars on the ground (the pillars were of different types). Most of the pillars along the mountainous southern part of the boundary were found in the field, except the southern edge, including Taba, which was a populated area. All the pillars along the sandy northern part disappeared, and only part of the pillars in the hilly central part existed. If there had been proper certified, detailed technical documentation during the mandatory period, it could have been implemented in the Peace Treaty, and in any case the dispute over Taba would have been prevented [7].

The second case occurred in 1994 during the Israel-Jordan negotiations, when the Joint Team of Experts had to recover or agree on the international mandatory boundary line between Palestine and Trans-Jordan. This line was supposed to serve, according to the agreed Common Agenda, as the reference line to the international boundary between the State of Israel and the Hashemite Kingdom of Jordan, to be incorporated into the 1994 Treaty of Peace between the States.

Since the mandatory boundary had not been demarcated, and definitely not documented, the only existing materials had various interpretations, either verbal or on inaccurate maps. The parties utilized their good will and their creative professional skills to overcome the complicated problems, which could also have ended with a boundary dispute. All of this would have been prevented if proper technical documentation had existed.

Following our experience, we tried in 1992 to implement our conclusions in detailed documentation of the international boundary between Israel and Egypt. The joint technical work included GPS measurements of the boundary pillars, which resulted in technical data about the boundary line, including a list of coordinates, distances between the pillars, horizontal angles of directions of the boundary line for each boundary pillar, slope distances between boundary pillars, a 1:250,000 graphical layout of the boundary, and 1:100,000 maps showing the boundary. Technical reference data was also included, such as the datum definition and the computation of grid coordinates. The content of the documentation also included background data about concepts, chronology, and data about the boundary line route, a description of the documentation procedure, general data about the GPS survey, the equipment, the data processing, the technical problems, and the boundary line maintenance. The appendix to the documentation includes relevant clauses from the Treaty of Peace and a map album of the boundary pillars, showing for each boundary pillar three aerial photographs taken from a helicopter (one vertical and one from each side of the boundary pillar) in addition to the coordinates and a graphical scheme. The detailed album was produced jointly by the technical teams of the two states, and was fully agreed upon at the technical level in 1996.

The fact that, since the Treaty of Peace, the boundary area between Israel and Egypt has not been abandoned anymore, and two roads follow the fences on both sides, attests to the stability of the boundary line. The existing agreed-upon documentation is also a supportive factor, but the absence of continuous joint maintenance, combined with the absence of mutual signatures on the documentation, may contribute to instability of the boundary line in the future.

The lesson learned from the peace process between Israel and Egypt led to the incorporation of the agreement about the core of the documentation, which includes the initiation of boundary coordinates, as well as the creation of the joint organ to carry out the task, in the Treaty of Peace between Israel and Jordan itself, thus giving a preliminary authorization to the experts. This is a most powerful way to ascertain a stable boundary line.

The process of documentation was, in the case of Israel and Jordan, inherent in the workflow of the JTE. The preparation of documentation, which includes coordinates of the boundary line, in the accuracy framework of one decimetre, with an attached graphic scaled chart, which shows the boundary line and documentation of the geodetic reference, and a description of the process, was prepared gradually for each part of the boundary. That included the land boundary, the maritime boundary in the Gulf of Aqaba, the boundary at the Dead Sea, and the boundary line along the Yarmouk River (the documentation of which was required because of the construction of a dam on the river). The documentation for each sector was prepared separately and was signed upon finalization, by an expert of each party and by the head of the JTE of each party.

A special document was prepared to confirm the mutual boundary documentation, and to affirm that it resulted from implementing the Treaty of Peace, in order to strengthen the legal authorization of the documents. This document was signed by both chairmen of the Joint Boundary Commission. During the first twelve years, following the Treaty of Peace, the documentation has already shown its importance in maintaining the boundary. It was used to solve practical issues in each of the portions of the international boundary.

The recommended content of the documentation of the international boundary includes the following chapters:

1. The purpose of the documentation
2. Background (basic facts and concepts, chronology, verbal description of the boundary line route)
3. The documentation procedure
4. The GPS survey or other geodetic surveys (the technology used, the equipment, the geodetic network design, the survey campaign, the teamwork, logistics, and description of technical problems).
5. The data processing (the software, the method of computation, the estimation of accuracy, and an evaluation of the results)
6. Determination of the reference frame work (definition of the main point, datum definition and computation of grid coordinates)
7. Boundary line maintenance (maintenance principles and guidelines, report formats, and the technology component)
8. A scaled illustration of the boundary line route
9. A list of 3D geodetic coordinates of boundary points or boundary pillars, a list of 2D grid coordinates
10. Descriptions of boundary pillars.

BOUNDARY MAINTENANCE

Boundary pillars and other boundary features need maintenance. Demarcated posts are the leading evidence in the field, pointing out the location of the boundary. They are required for the boundary administration. Their existence helps people near the boundary to be acquainted with the boundary location, to adjust their behavior to the existence of the boundary, and to prevent intentional and unintentional violations of sovereignty. Such violations may be expressed even by violations of infrastructure, including roads and constructions, agriculture, or illegal exploitation of natural resources. Such violations may, in the long run, result in disputes between the relevant states.

Few boundary experts have given proper attention to this aspect, including, for example, Jones [10, p.214]. Cukwurah [5, p.83] emphasized its importance in the following statement:

“The delimitation and demarcation of an international boundary will be no avail if, in the long run, no provisions are made by parties for the protection, maintenance and repair of an established boundary. The inviolability of such boundaries is generally recognized in its policies and practices of states. This sanctity can advance (if continuously respected) or destroy (if violated), the good neighbourliness existing between adjoining states. And this fact is very often reaffirmed in boundary treaties”.

The reasons for the disappearance of boundary pillars can be many, either natural or caused by people. Unstable ground such as sand dunes, muddy soil, or a slope of soft soil would potentially tilt the pillar, which then may fall down, and then be moved away by water or wind erosion. If possible, the demarcators should avoid constructing boundary pillars on unstable ground, which will require continuous and costly procedures of maintenance, or if there is no choice, a proper type of pillar should be adopted (usually with a very deep construction, sometimes the pipe type). Sometimes water erosion or wind erosion may cause a pillar to come apart, especially if masonry constructions or cairns are not sufficiently fortified, or if iron parts are rusted. Examples of those types of natural causes occurred along the international boundaries between Israel and Egypt (mainly in the sand dunes), and between Israel and Jordan, either exposing the bases of pillars in sandy areas and in the waterbed of the Wadi (in both cases, fortification with stones around the bases of the pillars solved the problems) or in the muddy area south of the salt pans of the Dead Sea (where a very long pipe replaced the standard concrete pillar). There is the special case of the boundary pillar on the water line of the Gulf of Aqaba, where the salty water erosion causes the concrete pillar to disintegrate (This will be resolved by replacing the pillar by one that will be made of special concrete with anti-salt water additives).

In extreme cases, potentially even along the Wadi Araba, which is part of the Great Rift, pillars may move because of earthquakes.

Human activities could cause damage or the disappearance of boundary pillars as well. This resulted in punishing such offenders according to international law. According to Cukwurah [5, p.84], under Roman law the punishment was to be 'sacrificed to god'.

In order to achieve successful maintenance of the boundary line, in the long run, it is recommended that:

- A permanently designated joint technical team of specialists is the proper organ to take care of the boundary.
- The preplanning of the location of the boundary pillars, as well as their types and materials, should consider optional requirements of boundary maintenance.
- Detailed technical boundary documentation suitable for maintenance operations should be prepared as soon as possible and authorized by the parties of the two states.
- Periodical reconnaissance tours in the field are required, and maintenance actions, like repair, reconstruction, etc., should be pre-planned and must not be delayed for a long time in order to avoid deterioration of the boundary condition. These tours would yield joint reports.

This process should be preliminarily agreed upon, if possible during the negotiations of the peace treaty, or by the joint technical team, if such an organ is established. It is recommended that the reconnaissance tour be concluded in a report that will point out the problems and the required measures to be taken.

In places other than the land boundary, maintenance has different meanings, such as placement of buoys in the sea, or arrangements that are made along rivers in order to monitor the boundary line with reference to the river's changes. Each of these special elements needs special maintenance instructions and agreements.

BOUNDARY ADMINISTRATION

Boundary Administration is the stage that follows the treaty between the states, and includes all the activities with regard to the area close to the boundary line and sometimes even the boundary zone. It refers mainly to the administrative rules and behavior on both sides, but also to the behavior of the inhabitants. It includes interrelations such as the passage of people and of goods, including the existence of passage stations and passage control, security control, including trespassing and smuggling, roads and other means of traffic and communication, usage of water, agriculture, etc. It covers the boundary maintenance as well, and forms a well-maintained boundary line, but it is required even when the boundary is not well demarcated, or even if the boundary is disputed. In such cases its role is even more significant.

Jones [10] defined boundary administration as the 4th definite and last stage of the boundary process. Others also referred to the administration, even before Jones [12], but mainly after him [16], [3], [2]. Cukwurah [5, p.85] declared that

"In effect, the continuous functioning of the Boundary Commission in all cases is an important factor in the efficient operation of the boundary."

We do not consider the boundary administration to be a separate stage that refers to boundary making, but rather, to form an umbrella, conducting the practical, interrelated life in the boundary zone covering also boundary maintenance. We also attach great importance to the influence of the boundary administration on the boundary maintenance, the condition of the boundary pillars, and the monitoring of cross boundary intended or unintended projects and activities.

Because of the importance (sometimes crucial) of the Boundary Administration in the interrelations between the relevant states in preventing conflicts, it is strongly recommended to establish a joint committee to deal with the issues of boundary administration. Because of the positive and important impact (sometimes crucial) that the boundary administration and maintenance have on each other, it is recommended

to connect the two teams. In certain cases, such as between the US and Canada [15], the permanent Boundary Commission monitors all the components of the boundary administration, with regard to physical penetrations or violations of the international boundary line, including cooperative projects and the boundary maintenance. The boundary maintenance is covered directly by an organ of the Boundary Commission, which is the Joint Team of Experts. Sometimes various committees are devoted to special subjects (boundaries, water, customs, environmental issues, etc.) rather than one all-purpose committee, such as between Israel and Jordan. Often the boundary administration is done unilaterally by each side. This is mainly typical of states that are hostile to each other.

The status of boundary administration between Israel and its neighboring countries:

Between 1949 and 1967 there were mixed armistice committees, who dealt with all the boundary administration issues. Since 1967, the boundary administration issues between Israel and Syria have been coordinated by a UN force (UNDOF). Since 1978, the boundary administration issues between Israel and Lebanon have been coordinated by a UN force (UNIFIL). Since 1979, the boundary administration issues between Israel and Egypt have been coordinated by military liaison units (for the first years after the Treaty of Peace, it used to be the Joint Military Committee). Since 1994, the boundary between Israel and Jordan has been coordinated by a permanent Joint Boundary Commission, which was established according to the definition of the Peace Agreement.

DISCUSSION AND CONCLUSIONS

Surveyors had a central role in boundary-making processes from at least the 19th century. The latest technological developments in this field have further widened their involvement in the process and changed the concepts and practices implemented. The Process Model presented here incorporates all the new technical means available for modern surveyors in accomplishing a more stable and sustainable boundary through a structured procedure. Understanding the process means having the capability to foresee the possible alternatives of the final demarcation from the early stages of the allocation and accordingly, to assist the political leaders and their other professional advisors in achieving the best possible results. Surveyors have the tools to identify the 'weak points' and offer solutions, since they have access to most of the geodetic and geographical information relevant to boundary making in integrative information systems. National surveying institutions are responsible for the maintenance and documentation of the boundary pillars and the boundary coordinates. Failure in fulfilling these responsibilities might lead to armed conflicts. The model presented here provides guidelines for performing the process from its early beginning to the maintenance stage. Our contribution to the model is through enhancing the interrelationships between the allocation and delimitation, between the delimitation and demarcation, and in adding two designated stages to the traditional three stages. In broad terms, the whole process represents continuous convergence toward details and specifications, where certain discrepancies would require reassessment of policies and determining guidelines earlier.

The two additional **designated stages**, proposed here, include the preparation of mutually agreed-upon precise documentation, and the boundary maintenance stage.

Mutually agreed-upon precise documentation of the boundary, which is adequate for boundary maintenance and boundary restoration, is considered to be the

most important tool for preventing future conflicts regarding the location of the boundary.

Adequate ongoing **boundary maintenance** is an important contributor to continuous boundary stability. Recommendations for achieving a professional survey of boundary pillars, not as a designated stage, were included in Jones [10], Cukwnrah [5], and others. However, we see it in a more comprehensive approach, as a designated stage in the boundary-making process, taken into account even by statesmen, who are responsible for the agreement and the process of implementation, to achieve long-lasting stabilization and peace between the states.

Implementation of the proposed model is exemplified here in two ways. First, the cost of the absence of the proposed stages is shown, which in the case of the boundary between Israel and Egypt, led to a boundary dispute, which would have been prevented if the 1906 boundary between Egypt and Palestine would have been well documented and maintained [7], [20]. This is also the case with the boundary between Israel and Jordan, where the problem was fortunately resolved by creative ideas [20], [19]. In worse cases, the absence of proper boundary documentation led to wars, such as in Iraq-Iranian war, the Iraqi invasion of Kuwait, the war between Ethiopia and Eritrea, and others. It might be constructive to initiate an international effort for the promotion of peace in the world, to document accurately international boundaries, especially in areas of tension. The case study of the Israeli-Jordanian international boundary represents the first implementation of almost the whole process model and most importantly, the new added stages; it is well documented, and is at least annually maintained jointly. The result is a stable boundary for future generations.

Finally, the process model presented here places the surveyors and the geodetic engineers in a central position of both guiding and implementing the process of making boundaries between states. Proper fulfillment of this role may contribute significantly to long-lasting peace between nations.

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