

# A Model of Boundary Delimitation in a Peace Agreement

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**Key words:** boundary demarcation, boundary documentation, boundary maintenance, boundary delimitation, international boundary agreement, boundary arbitration, ICJ, GPS, coordinates.

## SUMMARY

The purpose of this article is to present a model of boundary delimitation in a peace agreement that will enable a successful process driven boundary making, thus reducing many problems during the demarcation stage, preventing future disputes and supporting reliable future boundary restoration if required.

The boundary delimitation in a peace agreement is the most critical stage in the process since all the following stages of implementation and documentation depend on that initial stage. Any ambiguity at this stage will result in a dispute between the demarcators.

Since a peace agreement is usually concluded under a tense and suspicious atmosphere the chance of ambiguity in the boundary delimitation as a result of compromises is high.

In addition, the common professional means at that stage are also limited, including the lack of common geodetic reference and coordinate system, the lack of common maps and sometimes even common language, names and terminology.

This article elaborates on the problem and introduces a comprehensive model to overcome the problem.

The model makes use of orthophoto or ortho-images, of GPS measurements, of an establishment of a joint boundary datum, a joint production of coordinates as well as other means.

The suggested model is unique and was first successfully implemented in the October 26, 1994 peace agreement between Israel and the Hashemite Kingdom of Jordan. The fact that the implementation of the process was carried on smoothly and that during the last twelve years, since the signing of the treaty, no serious problem arose reflects the reliability of the model.

The implementation of the recommended model has a potential of stabilizing the boundary making process and saving unnecessary friction and disputes between the parties. This is beneficial and especially important at the critical stage of the boundary definition when the suspicion between the parties is at its highest level. Thus, improving the chance to a successful process and sustainable peace.

## THE BASIC STAGES OF THE BOUNDARY MAKING PROCESS

The basic stages of boundary making process begin with the preparation of documents and supporting materials for the negotiations between the politicians to achieve a peace agreement and finish with the maintenance of the boundary. They include:

1. The preparation stage before the peace agreement.
2. The delimitation of the boundary in a peace agreement - This stage refers to the earlier processes for determining a boundary, including its embodiment in a Treaty.
3. The demarcation of the boundary – This stage refers to marking the delimited boundary on the ground.
4. Documentation of the boundary – This stage refers to the field survey of the boundary markers, the recording of boundary coordinates and documentation of all these materials and additional ones like maps, drawings and photographs to support future boundary restoration if required.
5. Boundary maintenance – This stage refers to the on-going process of taking care of the boundary condition usually as part of the boundary administration.

The recommended model of boundary delimitation in a peace agreement:

1. A small scale map index.
2. Large scale orthophoto sheets or orthoimages showing the boundary delineation.
3. Instructions for boundary demarcation.
4. Instructions for surveying, recording of coordinates and boundary documentation.
5. Instructions for a procedure of authorization of the coordinates and definition of order of precedence with reference to binding materials.
6. Instructions for boundary maintenance and boundary restoration.
7. Definition of a time schedule.
8. Construction of a joint professional organ to be responsible for the implementation.

### Elaboration:

1. **Map Index:** A general small scale map index, covering the boundary sections, showing the index of the map sheets showing the boundary line delimitation in an annex to the peace agreement.

At the early stage of the delimitation usually there is no common agreement about the use of a common map. Every party has its own maps, sometimes in different cartographic projections, different scales, different levels of accuracy, different cartography and symbols, different location of the boundary line and even different names.

The boundary and the names are sometimes a major reason for disputes.

In the case there is no agreement about a common small scale map to be used as reference for a map index, the parties may prepare especially a blank chart, draw only a small scale skeleton of natural features like rivers, adding possibly a few

main roads and show the index of the boundary map sheets on top of it. This index could be used with no names on it.

2. Large Scale orthophotos: A series of orthophoto maps attached as an annex to the peace agreement showing the delimitation of the boundary line.

The advantages of the orthophotos for this purpose are:

**Fast production:** Orthophotos or ortho-images are produced much faster than maps, with no need for interpretation of natural or artificial features, no need for cartography and names. The production of common maps for the common use of the negotiating parties may be a non achievable mission due to time constrains of the political process.

**Easy availability:** Aerial photographs are today much more available than in the past when they used to be restricted military materials. In any case, even where aerial photographs are not available or releasable, there is an alternative to use high resolution satellite images. They are available commercially all over the world at relatively low cost, and many companies worldwide are ready to rectify the images to ready to use ortho-images. The open source non dependent solution eases the two parties to adopt that alternative.

**Up-to-date-ness:** The up-to-date-ness of the material, the short time required to obtain and to rectify aerial photographs or the high frequency of commercial high resolution satellite imaging all over the world enables up-to-date acquisition of images of the boundary zone.

**Support of demarcation:** Since the orthophotos or ortho-images, used for the delimitation represent the real physical situation on the ground, it is relatively easy to use it in the field during the initial marking of the delimited line during the demarcation. At that stage the boundary has not yet been surveyed and not defined by precise coordinates.

**The Scale of the orthophoto:** Having in mind the expected use of the delimited orthophotos during the demarcation, the professional joint team has to take care of a proper delimitation. In order to ease the interpretation in the field a proper scale should be chosen.

Our experience was to use 1:10,000 scale orthophotos unless smaller scale of 1:20,000 should be adopted because the boundary is very long and too many orthophoto sheets are required. In special important areas a larger scale 1:2,000 – 1:5,000 should be adopted. In strategic points only a larger scale as large as 1:1,000 may be sufficient.

3. Instructions for the boundary demarcation: The instructions refer to the implementation of a joint process, the reference materials for the demarcation (referring to the delimited orthophoto maps and additional materials) and the way of use including order of precedence in case of a few sources of delimitation.

The instructions should refer to the process of locating and constructing and placing of boundary pillars and to additional requirements with reference to line of sight or distances between boundary pillars.

4. Surveying, recording of coordinates and boundary documentation: It is recommended that the wording of the boundary annex in the treaty defines the

task of surveying the boundary pillars, production of their coordinates, recording them and preparing a comprehensive documentation of the boundary.

It is recommended that the coordinate system and the reference datum of the coordinates be specified and sometimes the methodology and technology if there is a preference.

5. Authorization of the list of coordinates: A far ahead step would be a specification of a procedure of approving and adopting the coordinates.

There should be specified an order of precedence of the various definitions of the boundary. Our recommendation is that the joint coordinates will be binding and taking precedence over the maps and any other source as to the location of the boundary line.

A major strength would be given to the coordinates if when produced they will become retroactively part of the treaty itself, thus gaining the highest political authorization. This can be implemented if specified in the original peace agreement itself.

6. Maintenance: Instruction should be given with reference to the procedures of joint maintenance of the boundary pillars, including their reconstruction in case of damage, destruction or displacement.
7. A schedule should be given to the process.
8. It is recommended to specify the organ which will be responsible to take care of the implementation of the boundary making process. Our recommendation is that this should be the responsibility of a joint team of experts headed by experienced boundary engineers under the Joint Boundary Commission.

## **THE JTE**

The importance of a precise definition and appropriate implementation is so great, and the necessary professional skills to cover all the up-to-date technologies are so many, that we designate in our model a special joint team of experts (JTE). This must be set up as early as possible in the boundary making process, to be responsible for all the technical issues and to advise the political leaders in this respect. The JTE is part of the Joint Boundary Commission (JBC) and is its main operational organ during most of that body's work.

The advantage of establishing this team as early as possible is that being professional the members of the JTE have a common technical language, and are used to teamwork. Thus, once their task is clear, the level of suspicion between them is much lower than between the politicians. As the cooperative work proceeds, the level of confidence grows, which contributes significantly to the implementation of the task.

According to our model, the JTE should begin to prepare the required professional tools for the whole process, as early as possible, even before the delimitation is ready.

The main tasks of the JTE until the Treaty of Peace:

1. To assist Boundary Commission in the preparation of the wording of the Article of the International Boundary in the Treaty of Peace.

2. To assist the Boundary Commission in the preparation of the wording of the Annex to Treaty of Peace, specifying the delimitation and demarcation of the International Boundary.
3. To prepare all the required data and materials for the technical Appendix to the Annex of the Treaty of Peace referring to the International Boundary.
4. To delineate the boundary line on the proper technical aids in accordance with the decision makers.
5. To define and prepare the technical Appendix of the delimitation for the signatures on the Treaty of Peace.
6. To define a common geodetic framework to serve as geodetic control and reference for the definition of the boundary coordinates.

The main tasks of the JTE after the Peace Treaty:

1. To demarcate the land boundary, including the construction of boundary pillars.
2. To conduct a field survey of the boundary pillars and to define the boundary coordinates of the pillars.
3. To document the International Boundary demarcation, including the coordinates of the boundary pillars.
4. To be responsible for the maintenance of the boundary line after the Peace Treaty, including technical support to resolve any technical issues which arise with regard to the location of the boundary.

It is recommended that the JTE will be headed by boundary engineers who have experience in the implementation of a boundary making process.

The Implementation of the model in the 1994 Peace Treaty between Israel and Jordan with regard to the land boundary:

## **THE JOINT BOUNDARY DATUM**

### **Determination of a reference frame**

The basic practical step of the JTE work from the geodetic aspect is the determination of reference frame (system). Determination of a reference frame is an essential step to enable the professionals To "speak the same language". After this stage, The JTE can keep on going in its professional activities which are controlled by the existence of a common reference frame.

The reference frame determination is involved with a definition of a 3D system (the geodetic datum) and a 2D system (the grid). The JTE may decide to determine a unique and local geodetic datum based on the WGS'84 ellipsoid, and to use a well known UTM convention as the grid system.

Technically, a series of control points (datum points) are recommended to be established on each side along the boundary line, and measured jointly by both parties.

It is recommended that prior to the official GPS survey of the joint datum points, both parties conduct a "pilot Project" to check the joint survey work and exchange GPS data which was collected in Jordan and Israel. The purpose was to examine the possibility of GPS data processing by both sides with different types of software. The "pilot-project" coordinated and the ability to adjust different software ended successfully.

### **Definition of a joint boundary datum**

An optional way of creating the reference of the geodetic datum is to determine it by fixing the coordinates of one of the datum points, adopting the WGS'84 ellipsoid, and fixing the reference ellipsoid in the geocenter according to the precise GPS vectors which were measured between the datum points.

Concerning the vertical datum, the JTE can agree to adopt the ellipsoidal heights (for all the boundary coordinates) with reference to the joint boundary datum and to the WGS'84 reference ellipsoid. Such a decision simplifies and facilitates the computation since only one 3 dimensional datum has to be determined. Though not mandatory required, there is a possibility to make an attempt to determine the geoid, or the sea level surface, as the datum of the vertical component of the coordinates.

The coordinates of a common reference point may be computed by an average between the results of the absolute positioning which may be calculated by each side, using broadcast ephemeris.

### **THE CASE STUDY: THE IMPLEMENTATION OF THE MODEL IN THE 1994 PEACE TREATY BETWEEN ISRAEL AND JORDAN**

The relevant wording of the peace agreement:

#### ANNEX I (a) - ISRAEL-JORDAN INTERNATIONAL BOUNDARY DELIMITATION AND DEMARCATION:

##### "2.C. Emek Ha'arava/Wadi Araba

1. The boundary line is shown on 1:20,000 orthophoto maps (10 sheets, Appendix I attached to this Annex)
2. The land boundary shall be demarcated, under a joint boundary demarcation procedure, by boundary pillars which will be jointly located, erected, measured and documented on the basis of the boundary shown in the 1:20,000 orthophoto maps referred in Article 2-C-(1) above. Between

each two adjacent boundary pillars the boundary line shall follow a straight line.

3. The boundary pillars shall be defined in a list of geographic and UTM coordinates based on a joint boundary datum (IJDB 94) to be agreed by the Joint Team of Experts appointed by the two parties (hereinafter the JTE) using joint Global Positioning System (GPS) Measurements. The list of coordinates shall be prepared, signed and approved by both Parties as soon as possible and not later than 9 month after this Treaty enters into force and shall become part of this Annex. This list of geographic and UTM coordinates when completed and agreed upon by both Parties shall be binding and shall take precedence over the maps as to the location of the boundary line of this sector.
4. The boundary pillars shall be maintained by both Parties in accordance with a procedure to be agreed upon. The coordinates in Article 2-C-(3) above shall be used to reconstruct boundary pillars in case they are damaged, destroyed or displaced."

"3. Joint Boundary Commission

- A. For the purpose of the implementation of this Annex, the Parties will establish a Joint Boundary Commission comprised of three members from each country.
- B. The Commission will, with the approval of the respective governments, specify its work procedures, the frequency of its meeting, and the details of its scope of work. The Commission may invite experts and/or advisors as may be required.
- C. The Commission may form, as it deems necessary, specialized team or committees and assign to them technical tasks."

## **DISCUSSION**

The Israel-Jordan Peace Treaty is a good example of implementation of the recommended model. The following is a discussion of the implementation of the model in this treaty and recommendations which are an outcome of the lessons learned. The numbers are in respect with the numbers of the activities specified in the recommended model.

1. A small scale map index was included in Annex I to the treaty. It is shown in the following figure 1. It also indicates the various sectors of the boundary, the maps of which are included as appendices in Annex I.
2. Image maps in various scales which show the boundary line in the different sectors of the boundary are included as appendices in Annex I to the Peace Treaty.

The land boundary along the Aravah Valley (Emek Ha'Aravah/ Wadi Araba) is shown on 1:20,000 orthophoto sheets. The boundary in the rivers (Jordan River and Yarmouk River) is shown on 1:10,000 orthophoto sheets. The

boundary in the Dead Sea is shown on 1:50,000 ortho-images and the relevant part of the Gulf of Eilat (Gulf of Aqaba) is shown on a 1:50,000 ortho-image.

The 1:20,000 orthophoto for the land boundary was used successfully in the field during the demarcation, augmented by photo enlargement of a scale of 1:10,000 and in certain cases even higher enlargements of regular air photos.

In spite of the significant length the land boundary, and the additional preparation work, a 1:10,000 scale orthophoto is recommended. This recommendation is more important if all the copies used by the parties are reproduced from one source. If the copies used by the parties for demarcation are not produced from one source there will always be slight differences which may be potential sources of disputes.

The 1:10,000 orthophoto for the river sectors was used successfully but in order to see better small islands in the river of a magnitude of several meters a color orthophoto of larger scale orthophoto would be recommended.

The 1:50,000 orth-images were used successfully in the Dead Sea and the Gulf of Eilat. The use of this scale was the only choice to see both sides of the coastline because of the widths of the sea and the gulf.

In addition to the 1:50,000 ortho-image coverage a larger scale imagery of each of the coasts is recommended to improve the interpretation of the coastlines.

An example of an orthophoto of the land boundary in a reduced scale is shown in figure 2.

3. The instructions in the treaty with regard to the boundary demarcation are included in paragraph 2 of ANNEX I (a) defining that there will be a demarcation by boundary pillars, that it will be based on the boundary line shown on orthophoto maps (as part of the delimitation in the treaty), that it will be a joint procedure, that the pillars will be jointly located, erected, measured and documented and that the boundary between adjacent boundary pillars will follow straight lines.
4. Instructions for surveying, recording of coordinates and boundary documentation are included in paragraphs 2 and 3 of ANNEX I (a) defining that the measurement of the boundary pillars and documentation will be a joint procedure.

It specifies that the result will be a jointly agreed list of geographic and UTM coordinates based on a joint boundary datum.

It specifies the technology of measurements (GPS) and that the measurements will be jointly performed.

It specifies that the list of coordinates shall be prepared, signed and approved by both sides.

An example of the first page of the Israeli Jordanian boundary documentation is attached as figure 3.

5. Instructions for authorization of coordinates and for defining their order of precedence is specified in paragraph 3 of ANNEX I (a). It is specified that the

coordinates when completed and agreed upon by both parties shall be binding and shall take precedence over maps as to the location of the boundary line.

More than that, it says that the list of coordinates will become part of the Annex of the Treaty of Peace (receiving the direct powerful original authorization of the treaty itself).

An example of the form of approval, adoption and authorization of the coordinates of the international boundary line is given in figure 4.

6. Instructions for boundary maintenance and reconstruction are defined in paragraph 4 of ANNEX I (a) specifying that it will be a joint maintenance. The specific procedure is left for the future but there is a specific guidance to use the agreed coordinates for reconstruction of boundary pillars in case they are damaged destroyed or displaced.
7. A time reference of up to 9 months is specified in paragraph 3 of ANNEX I (a) for the approval of the list of coordinates.
8. With reference to construction of a dedicated professional organ the Israel-Jordan Peace Treaty takes into account that the joint professional team was already working for the purpose of the preparation of the treaty itself. It specifies especially in article 3 of ANNEX I (a) the establishment of Joint Boundary Commission comprised of three members from each side. This commission may form, as it's deems necessary, specialized a team and assign it technical tasks.  
It specifies in paragraph 3 of ANNEX I (a) that the Joint Team of Experts appointed by the two parties should agree on the coordinates.

## **SUMMARY AND CONCLUSION**

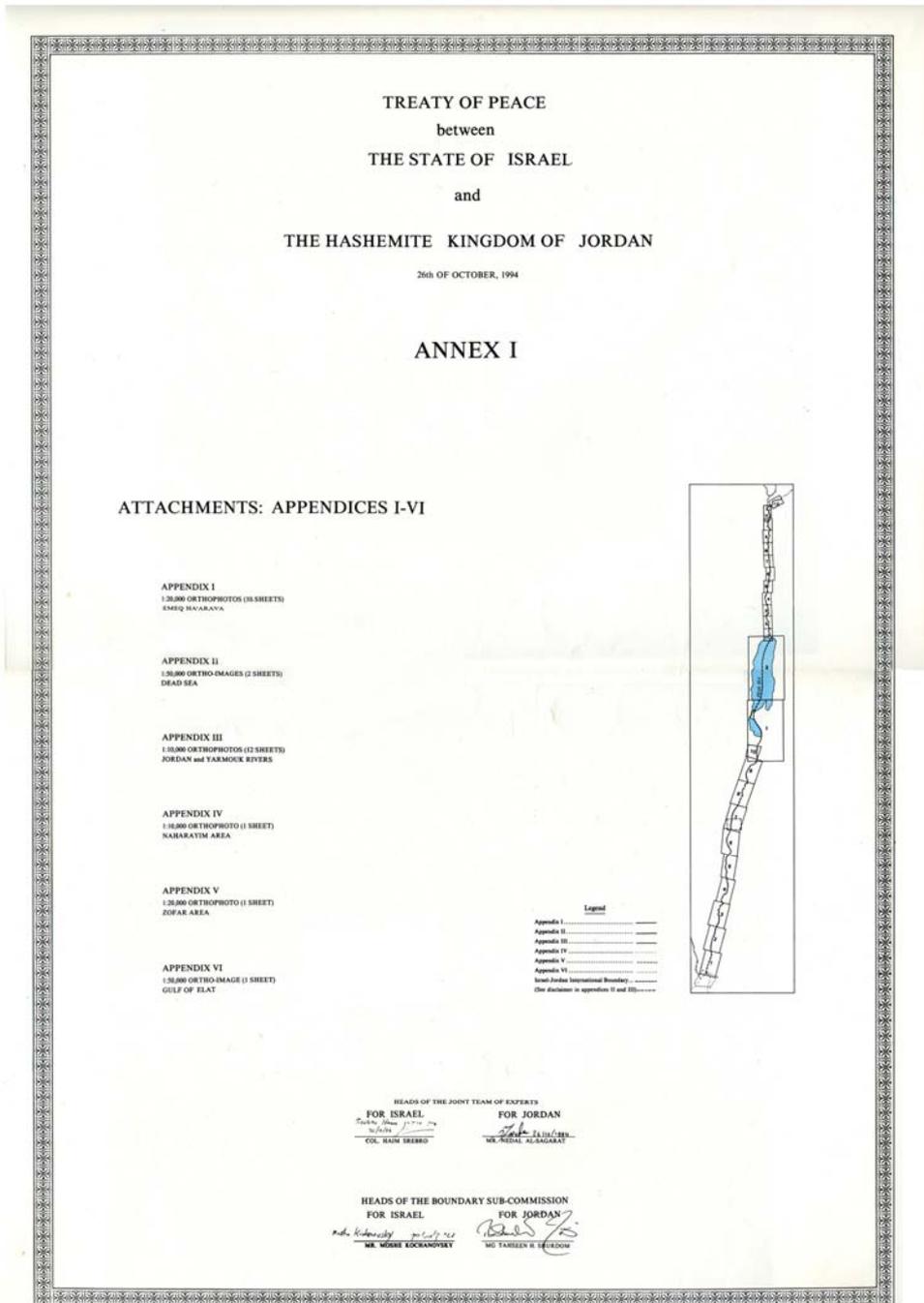
This article presents a model of reference for the responsibilities and assignments to tasks and be taken care of in a treaty delimitation.

In addition, the article also refers to specific instructions which refer to technical activities along the boundary making process.

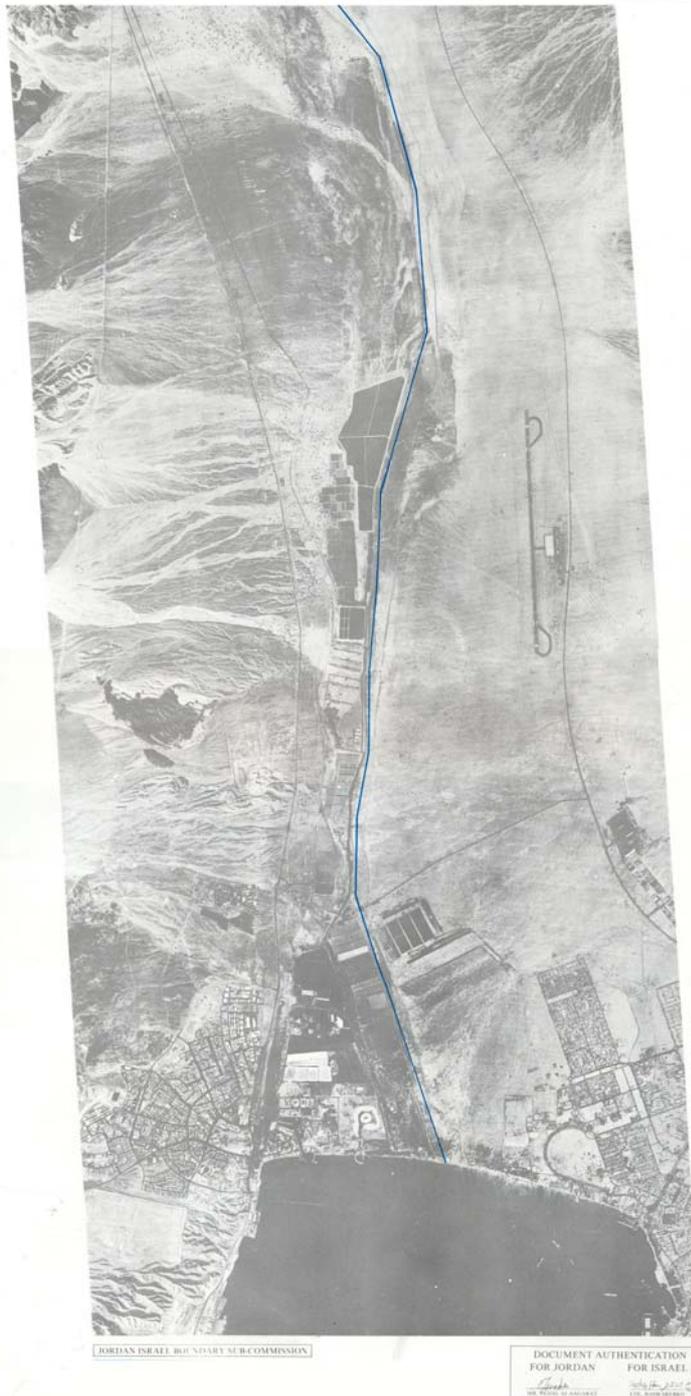
It recommends a model of incorporating these tasks and instructions in the treaty delimitation.

The article shows the implementation of the recommended model in the case of the 1994 Israel-Jordan Peace Treaty. It analyses the implementation of the model in this special case and discusses technical lessons learned from the special case.

The joint smooth implementation of the model during the Israeli Jordanian boundary making process, and the fact that all the practical problems with regard to the boundary line for the last 12 years since the treaty were successfully solved using the model show the importance of such a model for boundary management, for prevention or solution of boundary disputes.



**Figure 1:** The Israel-Jordan Peace Treaty: The map index.



**Figure 2:** The Israel-Jordan Peace Treaty: The 1<sup>st</sup> orthophoto sheet.

# JORDAN - ISRAEL

## BOUNDARY LINE

### DOCUMENTATION

#### Wadi Araba /Emeq Ha'arava sector

*This document is a geodetic appendix following the demarcation of the boundary pillars in Wadi Araba / Emeq Ha'arava and fulfilling the task of Annex I(a) para. 2.C.3 of the Treaty of Peace between Israel and Jordan of October 26<sup>th</sup> 1994. The documentation was achieved by the JTE as part of the tasks of the Joint Boundary Commission.*

The State of Israel

The Hashemite Kingdom of Jordan

*Signatures*

*For Israel*

*For Jordan*

*Technical Experts*

*Head of JTE*

*Date*

**Figure 3:** The Israel-Jordan Peace Treaty: The boundary documentation.

JORDAN ISRAEL BOUNDARY COMMISSION  
FORMAL APPROVAL AND ADOPTION OF THE COORDINATES  
OF THE INTERNATIONAL BOUNDARY LINE

The Government of the Hashemite Kingdom of Jordan and the Government of the State of Israel hereby agree:

1. In conformity with Article 3 and in accordance with Article 2.C.3 and Article 2.B respectively of Annex I(a) of the Treaty of Peace between Israel and Jordan of 26 October 1994, the Jordan Israel Joint Boundary Commission hereby approves and adopts the Jordan Israel International Boundary Line Documentation including:
  - a. the list of coordinates of the boundary pillars of the Wadi Araba/Emek Ha'arava sector, agreed to by the Joint Team of Experts on 19 September 1996, a copy of which is appended hereto; and
  - b. the list of coordinates of the Southern part of the Dead Sea and Salt Pans sector, agreed to by the Joint Team of Experts on 10 March 1998, a copy of which is appended hereto.
2. By this act the coordinates of these parts of the international boundary are formally approved by the Parties as required by the Peace Treaty and become part of Annex I(a) of the Peace Treaty.
3. The approved coordinates are henceforth binding and take precedence over the maps, orthophotos and orthoimages as to the location of the boundary line of these parts of the international boundary, as envisaged and specified in Article 2.C.3 and Article 2.B respectively.

Done at Bet She'an on this twenty-ninth day of December, 1998, which corresponds to the eleventh day of Ramadan, 1419 and to the tenth day of Tevet, 5759.

Signed by:

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For the Government of the  
Hashemite Kingdom of Jordan

\_\_\_\_\_  
For the Government of the  
State of Israel

**Figure 4:** The Israel-Jordan Peace Treaty: The approval of boundary coordinates.

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## **BIOGRAPHICAL NOTES**

Dr. Haim Srebro is the Director General of the Survey of Israel, a co-chairman of the Israeli-Jordanian Joint Team of Experts, responsible for the delimitation, demarcation and maintenance of the International Boundary. He has been involved as a leading figure in all the boundary negotiations and demarcations between Israel and its neighbors since 1974.

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