MARITIME DELIMITATION IN THE CARIBBEAN SEA AND THE PACIFIC OCEAN

(COSTA RICA *V.* NICARAGUA)

EXPERT OPINION

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30 April 2017

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INTRODUCTION

1. On 25 February 2014, the Republic of Costa Rica (hereinafter "Costa Rica") filed an Application with the International Court of Justice (hereinafter "the Court") against the Republic of Nicaragua (hereinafter "Nicaragua"), requesting the Court

> *"to determine the complete course of a single maritime boundary between all the maritime areas appertaining, respectively, to Costa Rica and to Nicaragua in the Caribbean Sea and in the Pacific Ocean, on the basis of international law".*

2. Costa Rica "further request[ed] the Court to determine the precise geographical co-ordinates of the single maritime boundaries in the Caribbean Sea and in the Pacific Ocean".

3. In the Memorial, Costa Rica claims that the starting-point of the maritime delimitation between the Parties on the Caribbean side is "on the right bank of the San Juan River at its mouth" (para. 4.13). In the Counter-Memorial, Nicaragua contends that the starting-point is situated at the extremity of Punta de Castilla, near the north-eastern corner of Harbor Head Lagoon (para. 3.48), 3.59 km east of that suggested by Costa Rica.

4. The Court, considering that there were certain factual matters relating to the state of the coast between the point suggested by Costa Rica and the point suggested by Nicaragua in their pleadings as the starting-point of the maritime boundary in the Caribbean Sea, which might be relevant for the purpose of settling the dispute submitted to it, and that, with regard to such matters, it would benefit from an expert opinion, decided, in an Order dated 31 May 2016, that "[a]n expert opinion shall be obtained, which will be entrusted to two independent experts appointed by Order of the President of the Court after hearing the Parties".

5. In its Order of 31 May 2016, the Court also decided that:

> *"(2) The experts referred … above shall visit the site. They shall advise the Court regarding the state of the coast between the point suggested by Costa Rica and the point suggested by Nicaragua in their pleadings as the starting-point of the maritime boundary in the Caribbean Sea, and in particular answer the following questions:*
>
> *(a) What are the geographical co-ordinates of the point at which the right bank of the San Juan River meets the sea at the low-water line?*
>
> *(b) What are the geographical co-ordinates of the land point which most closely approximates to that identified by the first Alexander Award as the starting-point of the land boundary?*
>
> *(c) Is there a bank of sand or any maritime feature between the points referred to in subparagraphs (a) and (b) above? If so, what are their physical characteristics? In particular, are these features, or some of them, permanently above water, even at high tide? Is Los Portillos/Harbor Head Lagoon separated from the sea?*
>
> *(d) To what extent is it possible, or probable, that the area concerned will undergo major physical changes in the short and long term?"*

6. The authors of the present Report were appointed by an Order of the President of the Court dated 16 June 2016.

I. BACKGROUND INFORMATION

7. In order to answer the questions put by the Court, we conducted two site visits (explained in subsequent section (1) below) and examined a number of documents communicated by the Parties (listed below in subsequent section (2)). These elements will be summarily presented in this section of the Report.

(1) Site visits

8. Having been requested by the Court to "visit the site" (see Order of 31 May 2016, para. 10(2)), we conducted two visits to the site from 5 to 9 December 2016 (hereinafter "first site visit") and from 13 to 17 March 2017 (hereinafter "second site visit"), which allowed us to examine the area under markedly different conditions. December and March are characterised by high and low average monthly rainfall in the area, respectively.

9. The first site visit was carried out soon after Hurricane Otto had made landfall in the San Juan de Nicaragua area on 24 November 2016. Otto was an exceptional event that caused significant geomorphic and hydrological changes in the area under scrutiny (*i.e.*, coastal erosion, opening of a channel in the beach, high-water levels in lagoons, high flow in the San Juan River). This was the southernmost hurricane on record to hit Central America and the first directly impacting on Costa Rica (see more information on Hurricane Otto below, para. 96).

10. The second site visit was carried out in March, which is the month with the lowest average rainfall in the area. Moreover, March also falls within a period characterised by low average discharge values in the lower course of the San Juan River according to the supplementary data submitted by Costa Rica on 20 October 2016 (discharge data from Delta gauging station).

(a) First site visit

11. A first site visit was conducted from 5 to 9 December 2016, less than two weeks after Hurricane Otto impacted on the area. This visit allowed us to examine the geomorphic and hydrological effects caused by that high magnitude and low frequency meteorological-hydrological event along the coast. The main activities carried out during each of those days are indicated below:

Monday 5 December 2016 (Day 1):

12. The delegation left San José at 7:15 a.m., flying in a Costa Rican plane to the small airport at Barra del Colorado, where we travelled by Costa Rican boat up the Río Colorado to Delta, crossed into Nicaraguan territory, and proceeded by Nicaraguan boat down the lower San Juan River to the Río Indio Lodge (**Fig. 1**).

Figure 1. Annotated satellite image from December 2011 (U.S. Geological Survey) showing the location of San Juan del Norte village, Río Indio Lodge, the airport of San Juan del Norte built where Greytown used to be located, the San Juan River and its mouth (its position is highly variable), Isla Portillos, and the Los Portillos/Harbor Head Lagoon.

13. After a meeting to review security and medical procedures and discuss logistics, the delegation left promptly for the field. We decided to concentrate our efforts initially on taking co-ordinates of certain points of interest and assessing the general state of the coast and its surroundings.

14. Arriving at the mouth of the San Juan River (see **Figure 1** above) in two Nicaraguan military boats, GPS co-ordinates were taken at the end of the sand spit at the north-western part of Isla Portillos and at the limit of the vegetation (in all cases where co-ordinates were taken, this was done in parallel by the topographical teams of both Parties, as illustrated in several figures below).

15. We then decided to conduct a reconnaissance of the coastal stretch between the mouth of the San Juan River and the eastern edge of Los Portillos/Harbor Head Lagoon. We therefore walked from the river mouth to the lagoon. Before we arrived at the western edge of the lagoon, it was necessary to cross a channel where water was draining from the lagoon to the sea (**Fig. 2**).

Figure 2. Drainage channel encountered during the first site visit, in which water was draining from the Los Portillos/Harbor Head Lagoon to the sea.

16. We then continued walking across the sand barrier between the lagoon and the Caribbean Sea. Arriving on the other (eastern) side of Los Portillos/Harbor Head Lagoon, we took note of the marker known as "A2" protruding from the water in the eastern corner of the lagoon (**Fig. 3**).

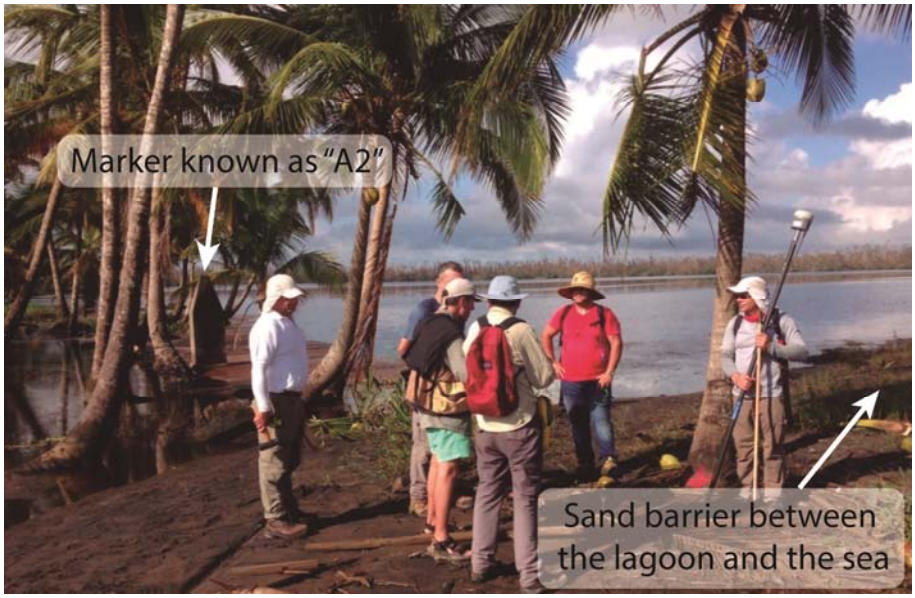

Figure 3. Image taken on the eastern corner of Los Portillos/Harbor Head Lagoon, showing the marker known as "A2".

17. We then returned to the mouth of the San Juan River by foot, where we boarded Nicaraguan military vessels for the short trip through a series of *caños* to the lodge.

18. In the evening, a brief meeting was held during which we were able to meet the pilot of the Nicaraguan drone (which would take pictures and videos of the coast the following day) and define the flight path that the drone would take.

Tuesday 6 December 2016 (Day 2):

19. Having arrived by boat at the mouth of the San Juan River, the delegation went on foot to Los Portillos/Harbor Head Lagoon. On the way there, both topographical teams took GPS co-ordinates at the channel through which the water from the lagoon was draining to the sea, close to the western edge of the lagoon.

20. The delegation then returned by foot to the mouth of the San Juan to take GPS co-ordinates, at the end of the sand spit at the north-western part of Isla Portillos. The co-ordinates were taken at the low tide occurring at 11:26 a.m.

21. Meanwhile, the Nicaraguan drone operator conducted an overflight of the area to take pictures and videos of the coast.

22. We returned to the lodge for lunch, after which we travelled by boat to the site of old Greytown, located in the area of the landing strip of San Juan del Norte (see **Figure 1** above). We wanted to determine whether it was still possible to locate the center of a square (Plaza Victoria) that was used, in 1898, as a reference point by the Demarcation Commissions established by Costa Rica and Nicaragua[1].

23. Docking at a Nicaraguan military camp, we crossed the landing strip, on the other side of which (southern side) were situated several cemeteries (*e.g.*, British, Catholic, Masonic) in a line (see **Figure 9** below).

24. We continued in an easterly direction along a path parallel to the landing strip on its southern side. To the east of the cemeteries and south of the path, towards the eastern end of the landing strip, we reached a site where Nicaragua claimed it was possible to view the remains of steps which it considered were once part of the church overlooking Plaza Victoria. However, the steps in question ascended to the south, whereas the church in question would have faced south and its steps would have ascended to the north (**Fig. 4**). Moreover, according to old maps, as explained below, Plaza Victoria should be located north of the path.

[1] In *Proceedings X of the Costa Rica-Nicaragua Demarcation Commissions (1898)*, the co-ordinates of the *Mojón inicial* (which had been placed near Punta de Castilla) were given using as the origin a monument placed in the center of Plaza Victoria, in front of a church (see Ann. 5 of Nicaragua's Counter-Memorial).

Figure 4. Steps presented by Nicaragua as possibly being those of the church that would have been built on Plaza Victoria. Arrows indicate the orientation of the stairs, ascending to the south (co-ordinates measured with a hand-held GPS: 17P 0204495E, 1208408N).

25. Returning to the lodge, the focus shifted to a marker found by both Parties in 2003 on the beach near Los Portillos/Harbor Head Lagoon, which they saw on 21 February 2003, and for which they measured the co-ordinates on 25 November 2003, during the field work of their Sub-Commission on Limits and Cartography (see, for further details on this question, paras. 151-156 below). It was assumed that this marker could be one of the markers built in the late 1890s by the Demarcation Commissions, and more precisely either marker A_m or marker A_1 depicted on the sketch-map included in *Proceedings XX of the Costa Rica-Nicaragua Demarcation Commissions (1897-1900)* (reproduced at Ann. 9 of Nicaragua's Counter-Memorial) (see **Figure 5** below). This sketch-map will be discussed in further detail below (see paras. 135-146 below), but suffice it to say for the moment that markers A_m and A_1 were auxiliary markers placed by the Demarcation Commissions at the end of the 19th century, to ensure that the location of Punta de Castilla could be always precisely determined.

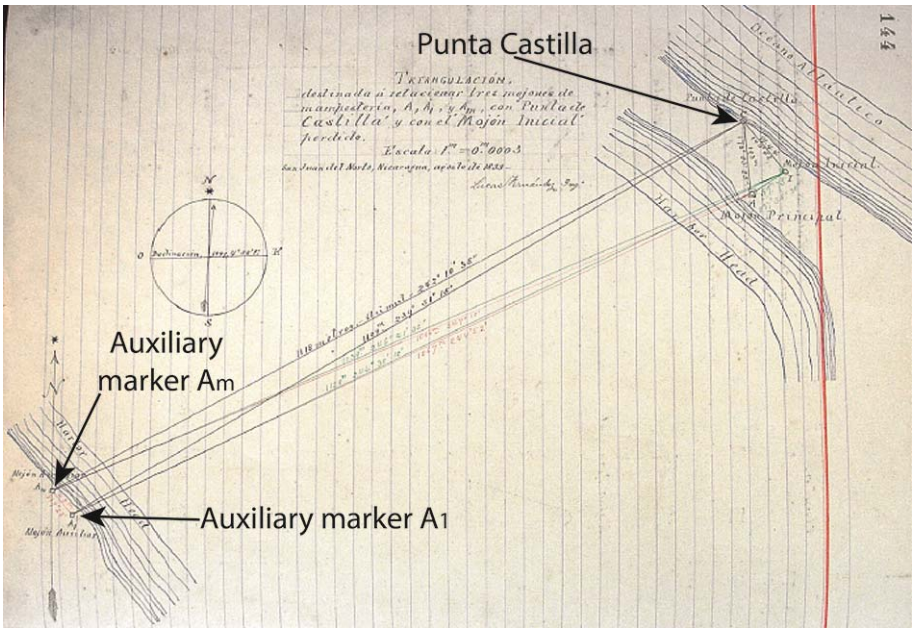

Figure 5. Sketch-map included in *Proceedings XX of the Costa Rica-Nicaragua Demarcation Commissions (1897-1900)*, showing the location of Punta de Castilla and auxiliary markers A_m and A_1, as well as their relative positions indicated by distances and azimuths.

26. We agreed to look for this marker the following day, using the average of the co-ordinates taken by the Parties in 2003 as a point of departure.

Wednesday 7 December 2016 (Day 3):

27. After being delayed by a heavy downpour, the delegation arrived at Los Portillos/Harbor Head Lagoon at 9:40 a.m. to begin searching for the marker found on 21 February 2003 and for which the Parties had measured the co-ordinates on 25 November 2003 with hand-held GPS devices.

28. Noting that the average of the co-ordinates taken in 2003 currently correspond to a point situated in the sea, we operated on the hypothesis that the marker previously found was A_m (if it were to be A_1, both points would be in the sea). We therefore used the triangulation values between markers A_m and A_1 indicated in the sketch-map included in *Proceedings XX of the Costa Rica-Nicaragua Demarcation Commissions (1897-1900)* (**Fig. 5**) to find the approximate location where A_1 could be buried on the beach. Then, we marked off a semi-circular research area of 15 m radius (estimated error margin of the hand-held GPS device) for potential exploration around this point on the beach side (**Fig. 6**). The remaining semi-circular area was located in the sea.

Figure 6. Exploration area around a point established assuming that the average of the co-ordinates measured on 25 November 2003 correspond to the location of auxiliary marker A_m and using the triangulation values indicated in the sketch-map included in *Proceedings XX of the Costa Rica-Nicaragua Demarcation Commissions (1897-1900).*

29. After discussions about the potential to bring a backhoe to the area, the delegation eventually returned to the plan of searching for the marker with iron rods to probe the sand, and manual digging when necessary.

30. Meanwhile, the Nicaraguan drone took videos and images along the coast.

31. We then returned to the site of the "A2" marker on the eastern edge of Los Portillos/Harbor Head Lagoon. The Nicaraguan delegation took the position that it had been laid by Alexander, while the Costa Rican delegation believed that it had not been constructed by Alexander but rather built some time afterwards.

32. In the afternoon, we returned to the site of old Greytown. We requested that the two topographical teams take the co-ordinates of the four corners of the landing strip to enable us to more accurately georeference maps on which it appeared.

33. We then returned to the area containing what Nicaragua contended were the possible remains of the church on Plaza Victoria. The area had been cleared of vegetation, but there was nothing to change the previous day's analysis: the stairs were facing the wrong direction for it to be the church on Plaza Victoria. Furthermore, according to old maps, Plaza Victoria was located further north.

34. Meanwhile, the Nicaraguan drone took videos at Isla Portillos, focusing on the channel in which water was draining from the lagoon to the sea.

Thursday 8 December 2016 (Day 4):

35. Our departure from the lodge was once again delayed because of rain. We therefore watched the videos taken by the drone on the previous day. We finally left at 8:30 a.m.

36. Having disembarked at the mouth of the San Juan River, we walked to the lagoon.

37. On the eastern side of Los Portillos/Harbor Head Lagoon, we asked the topographers to take the co-ordinates of the marker known as “A2”.

38. We then went towards the western end of the lagoon, near the search area defined on the previous day.

39. Having asked the topographers to calculate more precisely the supposed position of the marker A_1 on the basis of the assumptions indicated above (this having been done the previous day without all the proper equipment), we redefined the research area marking its center with a stick and defining the perimeter of a semi-circular area 15 m radius on the beach. The other half of the new research area was in the sea.

40. Together with members of each delegation, we formed a line and started probing the sand with iron rods (**Fig. 7**). Unfortunately, the equipment was rather inadequate. The corrugated rods not being easy to handle or sharp enough, they did not penetrate the ground more than 50 cm. Some workers helped the search with shovels.

Figure 7. Row of delegates probing the sand with iron rods.

41. We found nothing and decided to go back to the lodge.

42. After a short break, we went by boat to the new town of San Juan del Norte in order to visit the museum, which might have contained maps of old Greytown (**Fig. 8**).

Figure 8. Museum of San Juan del Norte.

43. We would have liked to find maps enabling us to precisely locate Plaza Victoria. For that purpose, a map showing both the cemeteries and Plaza Victoria would have been very useful. There was, however, no such map in the museum.

44. In the evening, we held a final meeting with the representatives of the Parties, during which the delegations agreed to transmit to the Court, by Wednesday 21 December 2016, at the latest, the final co-ordinates (in WGS-84) taken by their respective topographical teams for the points listed in **Table 1** below (p. 40). We also asked the Parties if they could make known to the Court their position on whether the marker found in 2003 was either A_1 or A_m, as identified in *Proceedings XX of the Demarcation Commissions (19 August 1899)*, and whether we could use the average co-ordinates (namely 10° 56' 03" N, 83° 40' 22.5" W) recorded for this marker in 2003. Finally, we asked the Parties if they could provide the co-ordinates of another marker (which Nicaragua had stated it had seen on 26 November 2003 and which it said was currently submerged near the north-western corner of the lagoon), and make known what they thought this other marker stood for. This marker was presented as having been found "inclined and submerged" in the lagoon "by approximately 98 mts to the south of the first marker found on the coast on Tuesday 24 [*sic*, should be 25] November [2003]" (*Minute of the Fourth Technical Meeting of the Sub-Commission on Limits and Cartography*, 24-27 November 2003, Counter-Memorial of Nicaragua, Ann. 15).

Friday 9 December 2016 (Day 5):

45. We departed by boat at 7:30 a.m. from the Río Indio Lodge and returned to the small airport at Barra del Colorado, and from there to San José.

(b) Second site visit

46. A second site visit was conducted from 13 to 17 March 2017. This visit allowed us to examine the area under much drier conditions than in the first site visit, with a much lower discharge in the San Juan River and water level in the Los Portillos/Harbor Head Lagoon. The main activities carried out during those days are indicated below:

Monday 13 March 2017 (Day 1):

47. The delegation left Managua at 8:15 a.m., flying in a Nicaraguan military helicopter to the landing strip at San Juan del Norte (also known as Greytown).

48. Immediately upon arrival, we started searching for the marker placed at the center of Plaza Victoria, which we had calculated to be under or in the immediate vicinity of the landing strip. We began by marking off the supposed center of Plaza Victoria, calculated through the geo-referencing of old maps. An initial research zone 60 m by 25 m was defined in the landing strip, about one third of the way from its eastern end.

49. The landing strip itself measured 25 m wide. Two cords were placed across it, marking off the eastern and western extremities of the initial research area, and short colored (pink) ribbons were tied on these cords every 155 cm, these representing the extremities of the Ground Penetrating Radar ("GPR") profiles (**Fig. 10**).

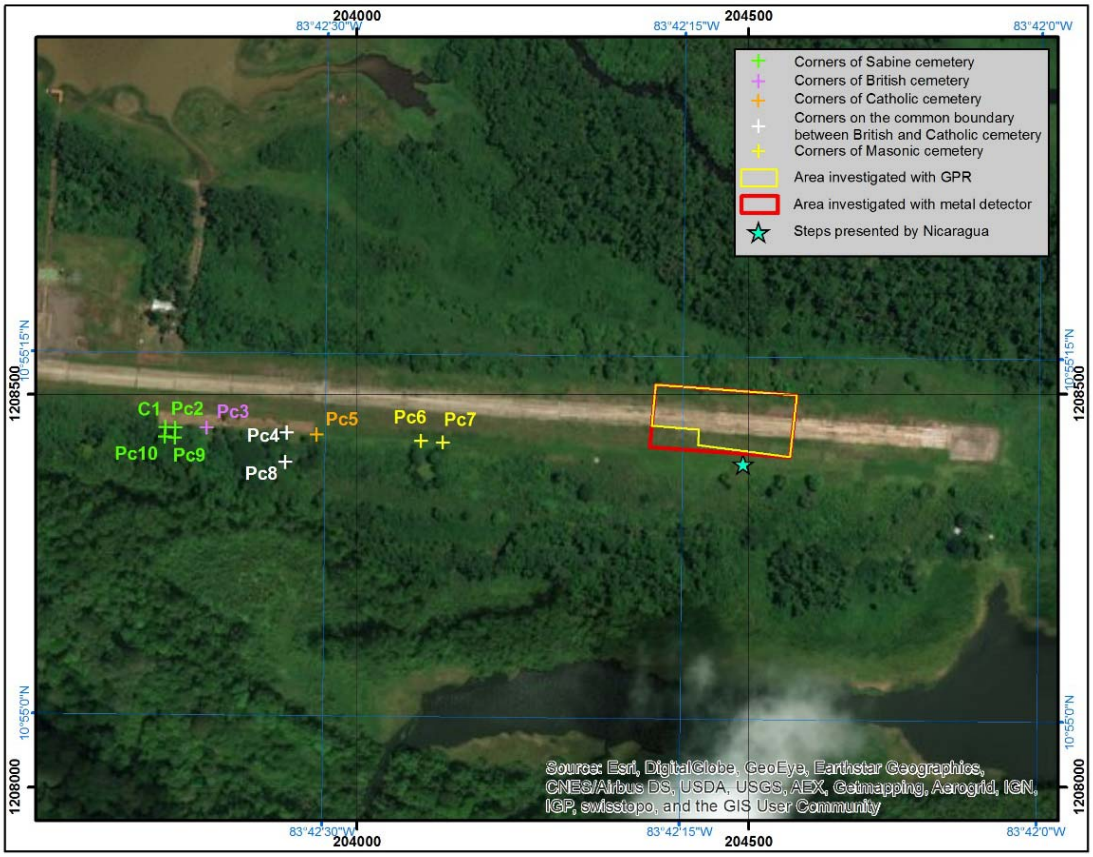

Figure 9. Area of the airport with locations of the corners of the cemeteries, the area of the airport that was investigated and the church steps presented by Nicaragua.

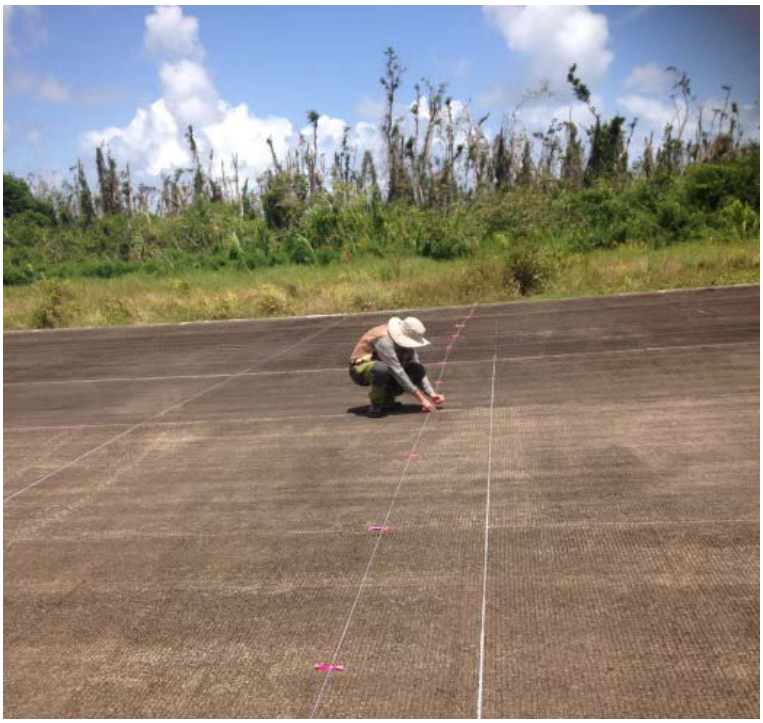

Figure 10. Placing of colored ribbons every 1.55 m on the cords marking off the eastern and western extremities of the initial research area, covering a 60 m long section of the landing strip.

50. The Nicaraguan GPR team was then dispatched to acquire 17 profiles along the 60 m long section of landing strip with a spacing of 1.55 m to indicate the presence of any anomalies in the ground below which could indicate the presence of the marker (**Fig. 11**). The metal detector furnished by the Nicaraguan delegation was also employed to survey the initial research area, but its use on the landing strip proved ineffective, detecting constant anomalies due to the presence of iron reinforcement in the concrete (**Fig. 12**).

Figure 11. Acquisition by Nicaragua of GPR profiles using a GSSI system equipped with a 200 MHz shielded antenna.

Figure 12. Surveying of the landing strip with the Nicaraguan metal detector (VALLON model VMH3CS).

51. While this work was being carried out, we determined that the research area should be expanded to encompass the adjacent zones on the northern and southern sides of the landing strip, also 60 m in length. These zones around 25 m wide extended out from the landing strip to the fence at the northern and southern perimeter of the airport (see **Figure 9** above). We requested that these areas be cleared of vegetation. Once the GPR concluded taking data of the initial research zone on the landing strip, we expanded the zone by 60 m east and west on the landing strip (for a total of 180 m) and took additional GPR data in these areas (a total of 51 profiles 60 m long each). We planned to expand the areas north and south of the landing strip in a similar manner once the vegetation was cleared.

52. The GPR team having completed its work on the landing strip, we left the research area for the Río Indio Lodge at 3 p.m.

53. That evening, a meeting was held during which the work-plan for the following day was discussed.

Tuesday 14 March 2017 (Day 2):

54. The delegation left the lodge at 7:15 a.m. to measure the GPS co-ordinates of the mouth of the San Juan River at low tide.

55. The mouth had changed since the first site visit. After calibrating the equipment and bringing it along the sand spit to the mouth, both topographical teams took the GPS co-ordinates of the mouth of the river at precisely 8:16 a.m. and 8:17 a.m., the timing of low tide according to their respective tide tables (**Fig. 13**).

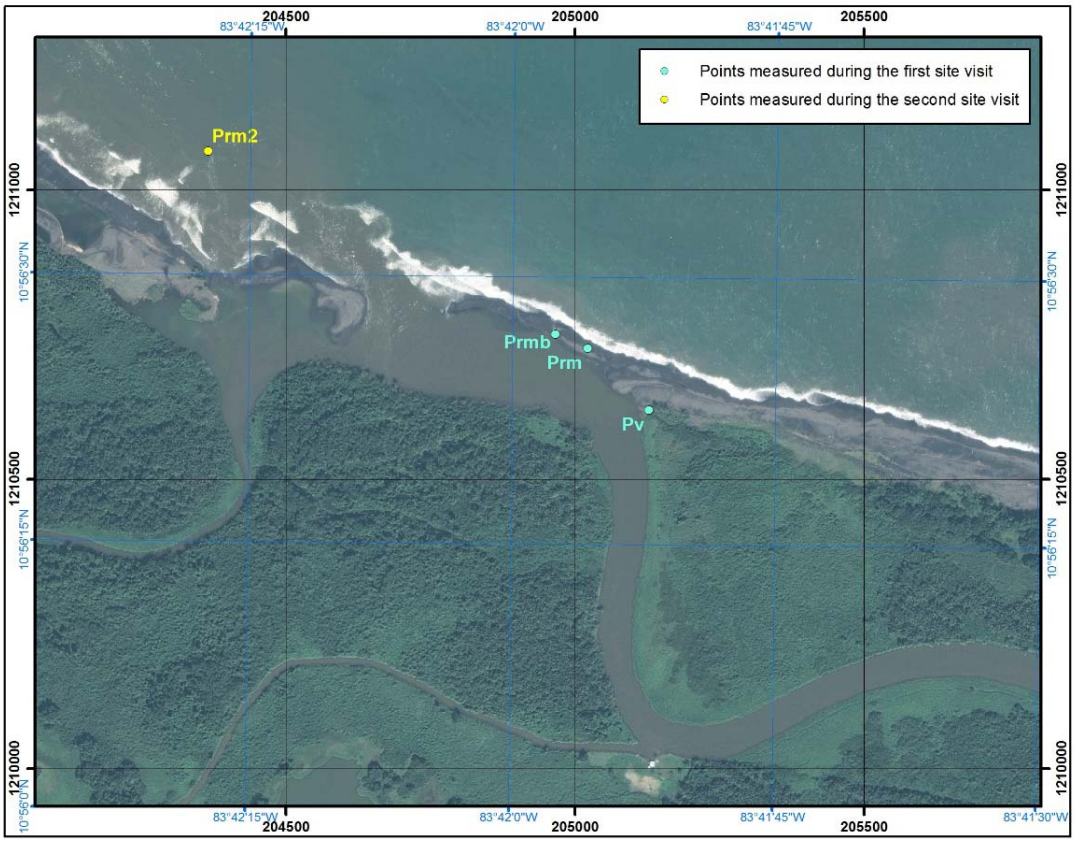

Figure 13. Area of the river mouth with the points of interest measured during the two site visits plotted on an aerial photograph dated 22 January 2016, when the sand spit was largely diminished.

56. Meanwhile, the Costa Rican drone operators arrived by quadracycle and conducted an overflight of the coast of Isla Portillos, taking pictures and videos.

57. While this was being carried out, we left on foot for Los Portillos/Harbor Head Lagoon. We conducted a reconnaissance of the coastal stretch between the mouth of the San Juan River and the eastern edge of Los Portillos/Harbor Head Lagoon.

58. Based on co-ordinates provided by Nicaragua, we established a research area measuring 22 m by 27 m on the beach, near the northwestern corner of the lagoon, in order to look for the marker found on 26 November 2003, submerged in Los Portillos/Harbor Head Lagoon, and which Nicaragua said was "in shallow water and not difficult to locate" (letter dated 21 December 2016 from the Agent of Nicaragua to the Registrar of the Court). Cords were stretched at each end and marked every 2 m with ribbon, after which the Costa Rican GPR team collected data of the entire area (a total of 12 profiles 27 m long) in the same manner as that carried out by the Nicaraguan GPR at the landing strip the previous day (**Fig. 14**).

Figure 14. Initial research area established on the western side of Los Portillos/Harbor Head Lagoon using the co-ordinates given by Nicaragua for the marker found on 26 November 2003 (10º 56' 2.3''N, 83º 40' 24.4''W). The location of that point was marked with a wooden stick (see arrow). The Nicaraguan operator of the metal detector is standing next to the stick. In the foreground, the GSSI GPR system of Costa Rica with a 400 MHz shielded antenna.

59. Meanwhile, the operator of the metal detector surveyed the area, finding several anomalies. Following excavation, however, these proved to be only small cans or other metallic debris. We requested to view the GPR profiles after a basic processing immediately in the field, locating two possible anomalies. Following excavation, these proved to be false positives most probably related to localized variations in the sandy sediments. We then began searching in the area by piercing the sand with 2 m long iron rods supplied by the Parties, which reached full penetration (**Fig. 15**). This intrusive and direct method, although tedious, was considered more reliable than the GPR, which showed poor performance in the southern sector situated at a lower elevation, with a shallower water table.

Figure 15. Piercing the sand with 2 m long iron rods.

60. It was also decided, following consultation with the Parties, to expand the research area towards the southwest, slightly into the vegetation and closer to the channel-shaped north-western edge of the lagoon. Piercing the sand with the 2 m rods proved effective albeit difficult, and it was decided to return to the same area the following day and repeat this procedure more systematically, piercing every corner of a large grid composed of 40 cm squares.

61. We left the research area at 3:30 p.m., returning on foot to the mouth of the San Juan and then going by boat back to the landing strip, where we found part of the expanded research zone cleared of vegetation, while another part still needed clearing.

62. Returning to the lodge at 5 p.m., we held a meeting with the Parties in the evening at which Nicaragua provided the GPR data from the airport, from which it was inferred that the landing strip and its foundation probably extended to a depth of 1.5 m. The representatives of Costa Rica gave us the pictures and videos taken by their drone.

Wednesday 15 March 2017 (Day 3):

63. We departed from the hotel at 7:15 a.m., in two boats, to the mouth of the San Juan River, where we immediately walked towards Los Portillos/Harbor Head Lagoon, to take the GPS co-ordinates of the eastern edge of the sand barrier of the lagoon at low tide (which was at 8:57 a.m.).

64. On the way, we stopped near the western edge of the lagoon to define a research area to be examined systematically with iron rods. One section (defined the previous day in order to locate the marker that Nicaragua had found on 26 November 2003) of approximately 27 m by 15 m was marked off to be examined with the 2 m iron rods, piercing every 40 cm. Another area, closer to the sea, in which the ground surface was higher, of approximately 27 m by 7 m, was marked off to be first cleared of 1 m of sand with shovels and then examined in the same manner as the first one, with the iron rods. The teams began this process, with almost everyone taking part and working together. Sticks were placed in the holes after the rod had pierced 2 m without encountering an obstacle (**Fig. 16**).

Figure 16. Lowering the higher portion of the beach with shovels and piercing systematically the sandy ground with 2 m long iron rods. The sticks mark the investigated points, forming a grid with a spacing of around 0.4 m.

65. While this work continued, we went with the topographers to the eastern edge of the lagoon. We first took the GPS co-ordinates of the north-eastern corner of the water body of the lagoon. At low tide time (8:57 a.m.) we took the co-ordinates of the eastern edge of the barrier that encloses the lagoon at the beach.

66. When we returned to the other side of the lagoon, we asked the topographers to take the co-ordinates of the point marking the western edge of the water body of the lagoon.

67. During all this time, the systematic piercing of the research area continued.

68. Given the work to be done at the airport, we considered it best to divide into two groups. One group, including members of both Parties' delegations and one Registry staff member, expanded the search area on Isla Portillos, while we left with other members of the Parties' delegations and another Registry staff member to pursue the work at the airport. Before leaving, we redefined an expanded research area, towards the mangrove forest in a marshy area covered by discontinuous vegetation.

69. At the airport, the area we had defined north of the landing strip (approximately 180 m x 25 m) had been completely cleared of vegetation by the Nicaraguan workers. The equivalent area south of the landing strip had only been partially cleared.

70. The Nicaraguan operator of the metal detector had identified various anomalies in the area north of the landing strip and marked them with sticks. They were checked systematically, with diggers making a hole until the metal object in question was found.

71. The Nicaraguan GPR team began surveying the area north of the landing strip. After a short time, however, they announced that the two batteries of the GPR had died. The GPR operators returned to the hotel by boat to charge them again for about 2 hours, at which point they began their examination anew. After a short while, however, the batteries died again. It was decided that the only option was to try to cover the entire area the following day, after the batteries had time to charge again through the night.

72. During this entire time, teams continued to dig for anomalies discovered by the metal detector operator, first on the northern side of the landing strip and eventually on the southern side as well. Work continued until approximately 5 p.m.

Thursday 16 March 2017 (Day 4):

73. Given the work to be done during this last day, we considered it was best to divide into two groups. We both went, with members of each delegation and a Registry Staff Member, to the airport, while another group, with members of each delegation and a Registry Staff Member, returned to the research area near Los Portillos/Harbor Head Lagoon.

74. At the airport, one of us went directly to the landing strip to continue to survey with the GPR and dig up anomalies found by the metal detector. Meanwhile, the other went into the forest abutting the airport (to the west) with a guide and the topographical teams to examine the area where the old railroad used to run. We wanted to take co-ordinates to enable us to georeference with more precision old maps showing these train tracks.

75. Unfortunately, because of the damage caused by Hurricane Otto and especially the huge number of fallen trees, it was not possible to reach the old railway. We therefore decided to take the co-ordinates of the external angles of a geographical feature which we had identified on the old maps and was still visible today. This feature is a rectangle dug on the southern bank of what seems to be an artificial channel (see Map of Greytown Harbor (1899), Documents submitted by Nicaragua on 20 October 2016 (**Fig. 17**)).

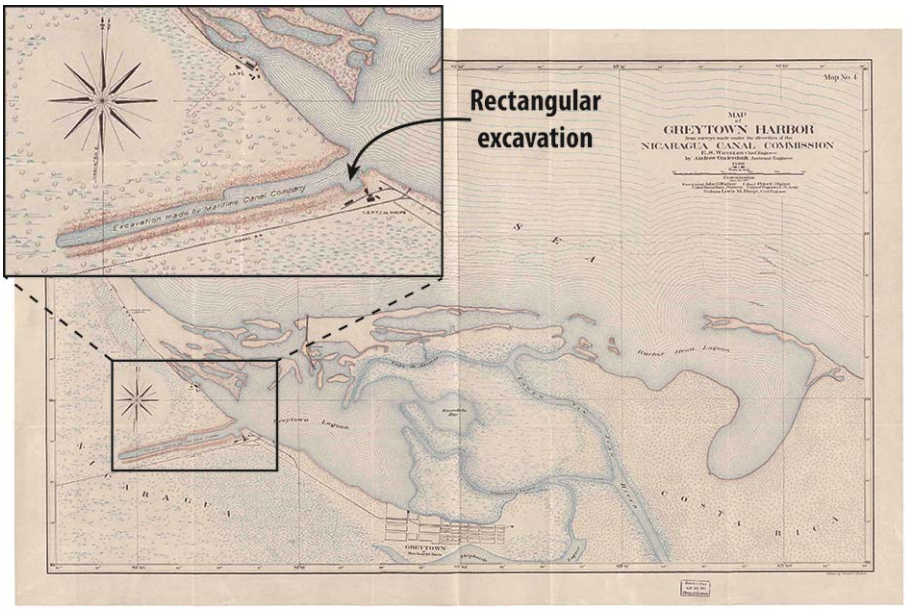

Figure 17. Map of Greytown Harbor (1899). The enlargement shows the rectangular excavation at which co-ordinates were taken. The black lines along the shore depict the path of the old railway.

76. As the batteries of the GPR died, once again, after a short while, we decided to join the second group at Isla Portillos while the operators of the device went back to the hotel to charge them.

77. When we arrived near the lagoon, the search area had almost been fully explored. We helped with the last parts and decided to end the operations. No marker was found.

78. We took a number of co-ordinates along the boundaries of the search area (**Fig. 18**).

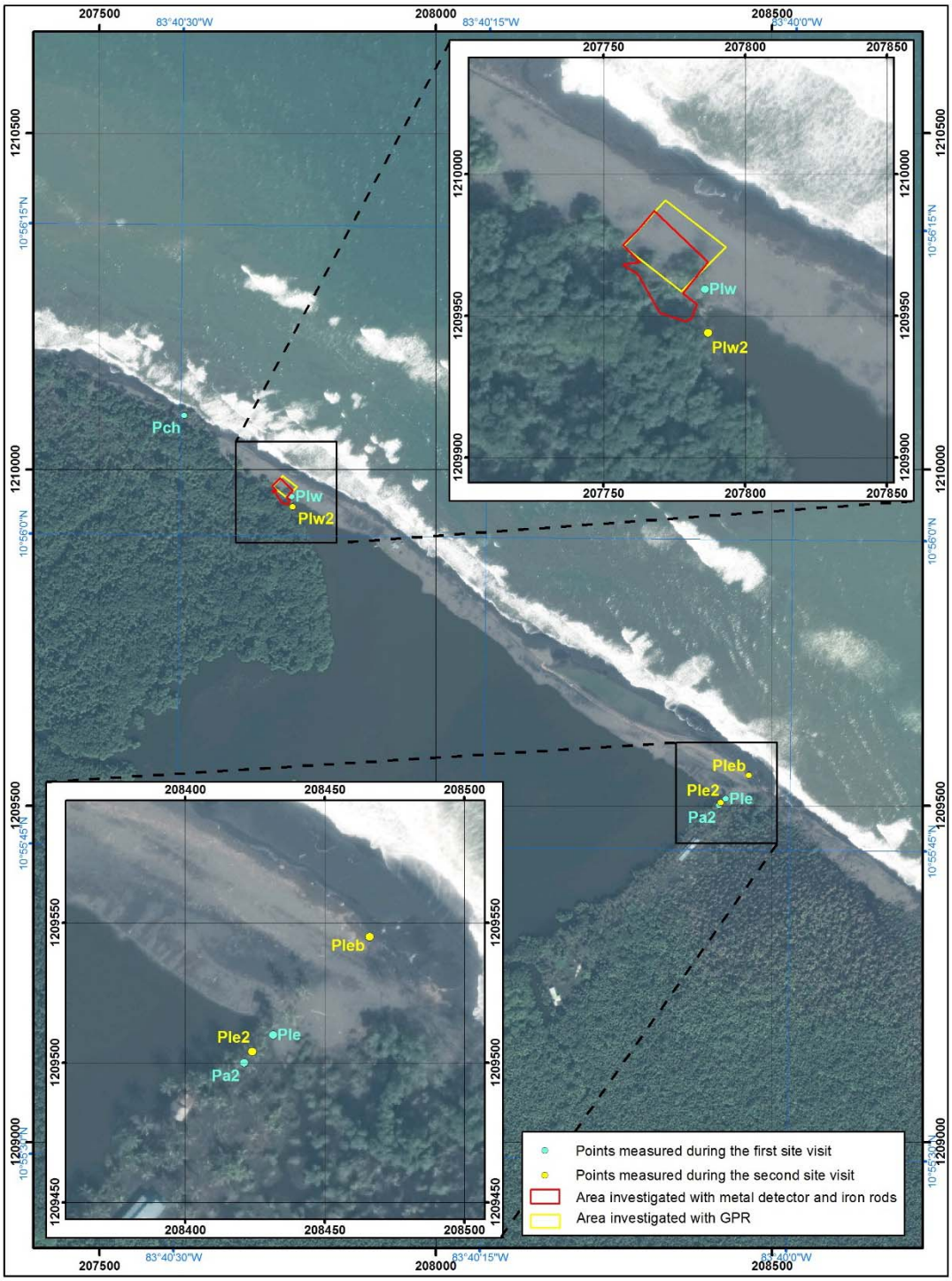

Figure 18. Area of the lagoon with the points of interest measured during the two site visits projected on a satellite image of 22 January 2016.

79. Thereafter, we went back to the hotel and checked the GPR profiles taken in the morning. We noted all the anomalies we saw, even if minor or ambiguous.

80. The GPR having been recharged, we went back to the airport at 3 p.m.. There, we continued collecting profiles in the search area, reviewed on the spot the profiles taken during the afternoon and checked all the anomalies we had noticed.

81. As nightfall was approaching, we had to stop our investigations. No marker was found.

82. We held a final meeting with the representatives of the Parties, during which the delegations agreed to transmit to the Court, by Friday 24 March 2017, at the latest, the final co-ordinates (in UTM and sexagesimal format) taken by their respective topographical teams for the points mentioned in **Table 1** below (p. 40) (see also **Figures 9, 13, 18**). The delegations also agreed to provide the processed profiles taken by the GPR devices of their respective teams, indicating the system and the software used, as well as the methodology applied.

Friday 17 March 2017 (Day 5):

83. We departed by boat at 8 a.m. from the Río Indio Lodge and returned to Managua by military helicopter.

(2) Documents communicated to the authors of the present Report

(a) Information transmitted by the Registry of the Court upon appointment

84. Upon our appointment, the Registry communicated to us the Application submitted by Costa Rica instituting proceedings against Nicaragua in the case concerning *Maritime Delimitation in the Caribbean Sea and the Pacific Ocean (Costa Rica* v. *Nicaragua)* (filed in the Registry of the Court on 25 February 2014), as well as the Memorial of Costa Rica (two volumes, dated 3 February 2015) and the Counter-Memorial of Nicaragua (one volume, dated 8 December 2015).

(b) Additional information requested from the Parties

85. Before conducting the first site visit, the Parties have been requested to communicate to us various documents (aerial photographs, maps, satellite images, geodetic data, tide records, discharge time-series). All these elements were submitted on 20 October 2016.

86. Before the second site visit, each of the Parties communicated to the Court the tide tables for the area of San Juan de Nicaragua, for the month of March 2017.

(c) Information collected during the site visits

(i) First site visit

87. During the first site visit, Nicaragua provided the authors of the present Report with videos and photographs taken by a drone on 6 and 7 December 2016.

88. Afterwards, by letters dated 21 December 2016, the Parties provided the geographical co-ordinates measured during the first site visit[2]. They also communicated additional information requested by the authors of the present Report, namely co-ordinates and images of the marker found on 21 February 2003 and of the additional marker, found on 26 November 2003, submerged in the northwestern sector of the Los Portillos/Harbor Head Lagoon. Each Party also recorded the position of its Government on whether the first of these markers was either A_m or A_1.

(ii) Second site visit

89. During the second site visit, Costa Rica provided the authors of the present Report with videos and photographs taken by a drone on 14 March 2017.

[2] By a letter dated 24 January 2017, Nicaragua provided revised co-ordinates for two points.

90. Under cover of a letter dated 24 March 2017, Costa Rica provided the final co-ordinates taken by its topographical team during the second site visit[3], as well as a report by Costa Rica's National Museum explaining the methodology and results of the survey carried out with the Costa Rican GPR. Under cover of a letter also dated 24 March 2017, Nicaragua provided the final co-ordinates taken by its topographical team during the second site visit, as well as an INETER report explaining the methodology and results of the survey carried out with the Nicaraguan GPR.

(d) Subsequent information transmitted by the Registry of the Court

91. On 18 April 2017, the Registry communicated to us copies of the Parties' written pleadings (Memorial of Costa Rica and Counter-Memorial of Nicaragua) in the case concerning *Land Boundary in the Northern Part of Isla Portillos (Costa Rica* v. *Nicaragua)*, which had been joined with the case concerning *Maritime Delimitation in the Caribbean Sea and the Pacific Ocean (Costa Rica* v. *Nicaragua)* by an Order of the Court dated 2 February 2017.

*

[3] By a letter dated 30 March 2017, Costa Rica provided revised co-ordinates.

II. GEOGRAPHICAL AND GEOMORPHOLOGICAL SETTING

(1) General geographical features of the area

92. The starting-points of the maritime boundary between Nicaragua and Costa Rica in the Caribbean coast proposed by both Parties are located in a coastal stretch associated with Los Portillos/Harbor Head Lagoon and the mouth of the San Juan River. This river, around 200 km long and with a catchment area of approximately 38,500 km^2, starts from Lake Nicaragua (or Cocibolca Lake) in Nicaragua. At around 19 km west of the Caribbean coast near Delta, the San Juan River splits into two main channels (**Fig. 19**). The southern one is called the Colorado River, which shows a major anabranch. Nowadays it carries most of the discharge of the fluvial system and has formed a wave-dominated cuspate delta in the Barra del Colorado area. Deltas in coasts with strong wave action tend to have a cuspate morphology, with a high width/length ratio, whereas deltas in which fluvial sediment supply overwhelms the erosional effect of waves tend to project into the sea showing a lower width/length ratio and a lobate or triangular geometry. The northern channel, despite its current lower flow, is designated as the San Juan River. This branch has an E-W orientation in its initial stretch and at around 9 km west of the coast turns into a general N-S direction.

Figure 19. Annotated satellite image (Landsat, December 2016) showing the main geographical-geomorphic features of the lower reaches of the San Juan fluvial system associated with the Caribbean coast.

93. Reports from 1848 indicate that around 90% of the discharge of the San Juan River used to flow into the San Juan del Norte Bay and the remaining 10% into the Colorado River (Rabella, 2004). Floods occurred in 1861 causing a significant increase in the discharge of the Colorado River at the expense of the Lower San Juan River (González, 1994). In 1865, Captain G.C. West from the Department of Coastal Studies of the USA reported that 92% of the discharge of the San Juan River flowed into the Caribbean Sea through the Colorado River (Rabella, 2004). The sharp reduction that

the Lower San Juan River experienced in 1861 is very likely the main cause for the rapid retreat that has affected the coast associated with Los Portillos/Harbor Head Lagoon in historical times. The sediment that nourishes beaches is mainly related to the sedimentary input of fluvial systems, which is redistributed along the coast by long-shore currents. It seems that since the 1861 flood, the diminished sediment flux that the Lower San Juan supplies to the coast is insufficient to counterbalance the effect of erosional coastal processes.

94. The San Juan and the Colorado in their lower reaches flow across a broad coastal plain with relatively flat topography locally interrupted by hills corresponding to inliers of Plio-Quaternary volcanic rocks (Bergoeing, 2014). The coastal fringe is characterised by the presence of numerous narrow coast-parallel beach ridges (relict beach accumulations) and lagoons related to long-term progradation in a wave-dominated coastal environment (Parkinson et al., 1998; Scheffers and Browne, 2010; Bergoeing, 2014). According to the numerical radiocarbon ages obtained by Nieuwenhuyse and Kroonenberg (1994) in the Tortuguero area, Costa Rica, the sandy beach-ridge plain has developed over the last 4-5 millennia. The San Juan and the Colorado rivers show distinct coast-parallel deflections at the mouth sector related to the growth of spits generated by strong northerly littoral drift (Parkinson et al., 1998) (**Fig. 19**). The tides, with a range of around 0.2-0.5 m (micro-tidal regime) according to the tide data (2009-2016) supplied by Costa Rica, have a limited geomorphic impact on the coast (Nieuwenhuyse and Kroonenberg, 1994; Bergoeing, 2014).

95. The climate has exceptionally wet tropical conditions, with an annual average precipitation in San Juan del Norte, Nicaragua, of 5,670 mm and a mean temperature of 26.2 ºC (data from CLIMATE-DATA.ORG).

96. The impact of hurricanes in the analysed sector is relatively small compared with other sectors of the Caribbean coast located further north. Alvarado and Alfaro (2003), in their analysis of the frequency of tropical cyclones that affected Costa Rica in the 20th century indicate the following features: (1) the country was not affected directly by any cyclone in the 20th century, and the probability of direct impact is equal or lower than 5%; (2) the five most intense hurricanes that indirectly affected Costa Rica in the 20th century were Janet (September 1955), Camille (August 1969), Allen (July-August 1980), Gilbert (September, 1988), and Mitch (October, 1998); (3) the cyclones with trajectories closest to Costa Rica (Limón taken as reference) were Irene (September 1971, 145 km), Bret (August 1993, 125 km; 40 km north of the border with Nicaragua), and Gert (September 1993, 140 km); (4) the most damaging cyclones in terms of economic losses and fatalities were Kattie (October, 1955), Joan (October, 1988), and Cesar (July 1996). Nonetheless, Hurricane Otto directly impacted Costa Rica and Nicaragua in November 2016. This hurricane made landfall about 10 nautical miles (18.5 km) northwest of the Nicaragua/Costa Rica border at around 1730 UTC on November 24 with an estimated intensity of 100 kt (185 km/h; category 3 on the Saffir-Simpson Hurricane Wind Scale), causing significant economic and societal losses (National Hurricane Center, 2017) (**Fig. 20**) and substantial geomorphic changes in the coastal fringe (*e.g.*, opening of channels, erosion in sand spits and beaches). This was an unusual hurricane due to the following features (National Hurricane Center, 2017):

(1) It is the southernmost hurricane on record to hit Central America and the first directly impacting on Costa Rica;

(2) The hurricane occurred at very late stage of the Atlantic hurricane season. Otto marked 2016 as the second longest-duration Atlantic hurricane season, with tropical storms from January to November;

(3) It traversed Central America from the Atlantic to the eastern North Pacific basin maintaining tropical cyclone status.

Figure 20. Effects of Hurricane Otto in the cemetery of Greytown. Image taken during the first site visit on 6 December 2016 (twelve days after Otto made landfall in the area).

(2) Geomorphological-geographical units

97. The area under scrutiny comprises the following geomorphological-geographical units that are relevant to the case (**Fig. 21**):

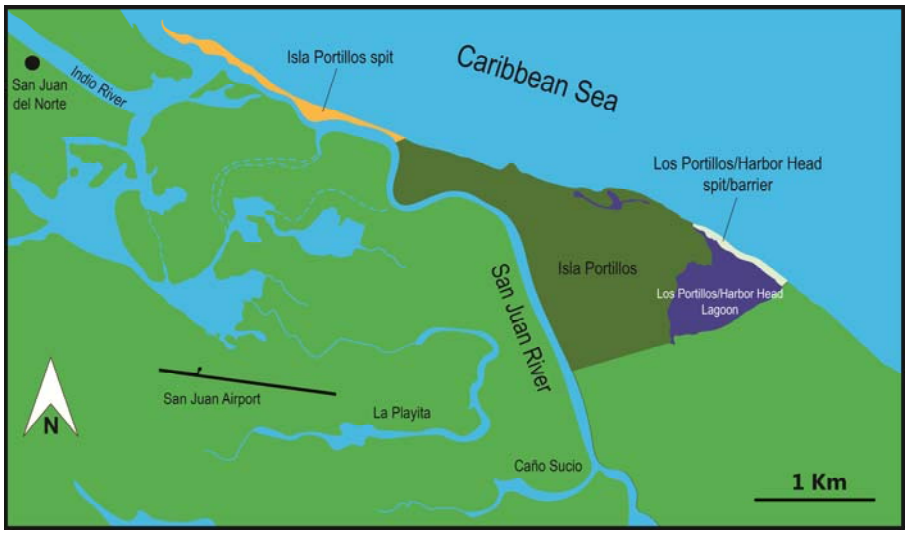

Figure 21. Sketch illustrating the geomorphological-geographical units of the analysed area relevant to the case.

(a) Los Portillos/Harbor Head Lagoon

98. This lagoon is located next to the coastline and is enclosed or semi-enclosed by a sand spit-barrier. The erosional retreat of the coast in historical times has considerably reduced the extent of this water body (**Fig. 22**). Punta de Castilla was located on the northeastern corner of this lagoon in the 1897 Award: *"the headland [in 1897], or the northwestern extremity of what seems to be the solid land, on the east side of Harbor Head Lagoon"* (**Fig. 23**).

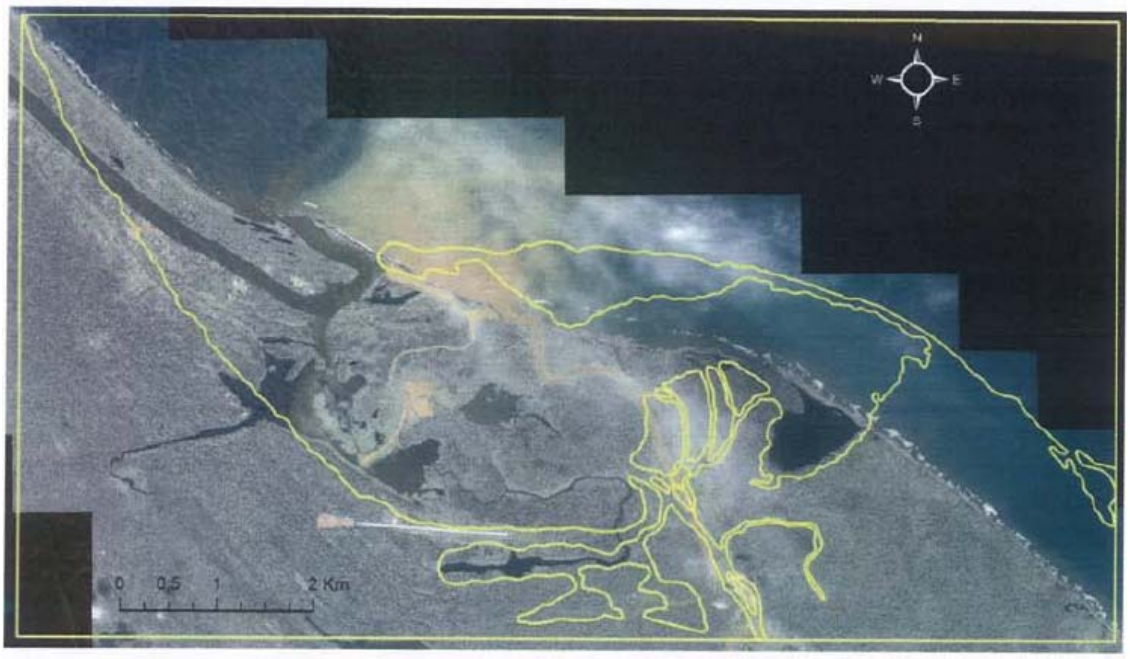

Figure 22. Cartographic overlay of the coastline as represented in a historical map produced by George Peacock in 1832 and updated in 1840, on a satellite image taken on 5 October 2013. Note the retreat of the coastline and the reduction of the extent of Los Portillos/Harbor Head Lagoon (Figure 2 of the Statement from March 2015 prepared by Prof. Colin Thorne in relation with the case concerning *Certain activities carried out by Nicaragua in the border area (Costa Rica* v. *Nicaragua)*).

Figure 23. View of the relatively firm and stable land covered by coconut trees that forms the eastern edge of Los Portillos/Harbor Head Lagoon. In the background and to the left, the spit-barrier of Los Portillos/Harbor Head Lagoon is visible. Image taken during the second site visit on 15 March 2017.

(b) Spit-barrier of Harbor Head/Los Portillos Lagoon

99. This is a ribbon-shaped and coast-parallel beach accumulation essentially devoid of vegetation that encloses or semi-encloses Harbor Head/Los Portillos Lagoon (**Fig. 21**). This barrier

mainly consists of loose sand and is attached to more solid land on the eastern corner of the lagoon (**Figs. 23, 24, 25**).

100. The 1897 Award located Punta de Castilla on solid land at the base of the spit as it existed in 1897. Topographic maps produced by Costa Rica and Nicaragua show that in the recent past there used to be a channel-like water gap between the spit and firm land, and that the Los Portillos/Harbor Head Lagoon was connected to the sea via the San Juan River (**Fig. 26**). During our first site visit carried out in December 2016, when the water level of the lagoon was exceptionally high, the sand spit-barrier extended from measured point Ple (**Fig. 27**, see co-ordinates in **Table 1**) to point Plw. Point Plw was measured on the western extremity of the lagoon as defined by a high-water mark consisting of stranded debris (highest stage reached by the lagoon water after Hurricane Otto) (**Fig. 28**).

101. During this first visit the lagoon was draining towards the sea through a channel situated next to point Pch, around 200 m to the northwest of point Plw, most probably breached by Hurricane Otto (**Figs. 29, 30, 31**). In the second site visit, the eastern and western extremities of the water body of the lagoon were measured at points Ple2 (**Fig. 32**) and Plew2 (**Figs. 33, 34**), respectively. The intersection between the shoreline and the projection of the northeastern corner of the Los Portillos/Harbor Head Lagoon perpendicular to the coast was measured in the second visit at low tide (15 March 2017; 8:57 a.m.) at point Pleb (**Fig. 35**). In this second visit, the channel that was draining the lagoon during the first visit was closed by a sandy beach deposit (**Fig. 36**).

102. The spit-barrier of the lagoon is a labile feature highly susceptible to coastal erosion and the development of inlet channels. Photographs taken in June, July and August 2012 by Costa Rica show a breach in the central sector of the spit-barrier (**Fig. 37**, provided by Costa Rica on 20 October 2016).

Figure 24. Sand spit-barrier between Los Portillos/Harbor Head Lagoon (left) and the Caribbean Sea (right). View looking to the west. Image taken during the first site visit on 6 December 2016.

Figure 25. Sand spit-barrier between the Caribbean Sea (left) and Los Portillos/Harbor Head Lagoon (right). View looking to the east. Image taken during the first site visit on 5 December 2016.

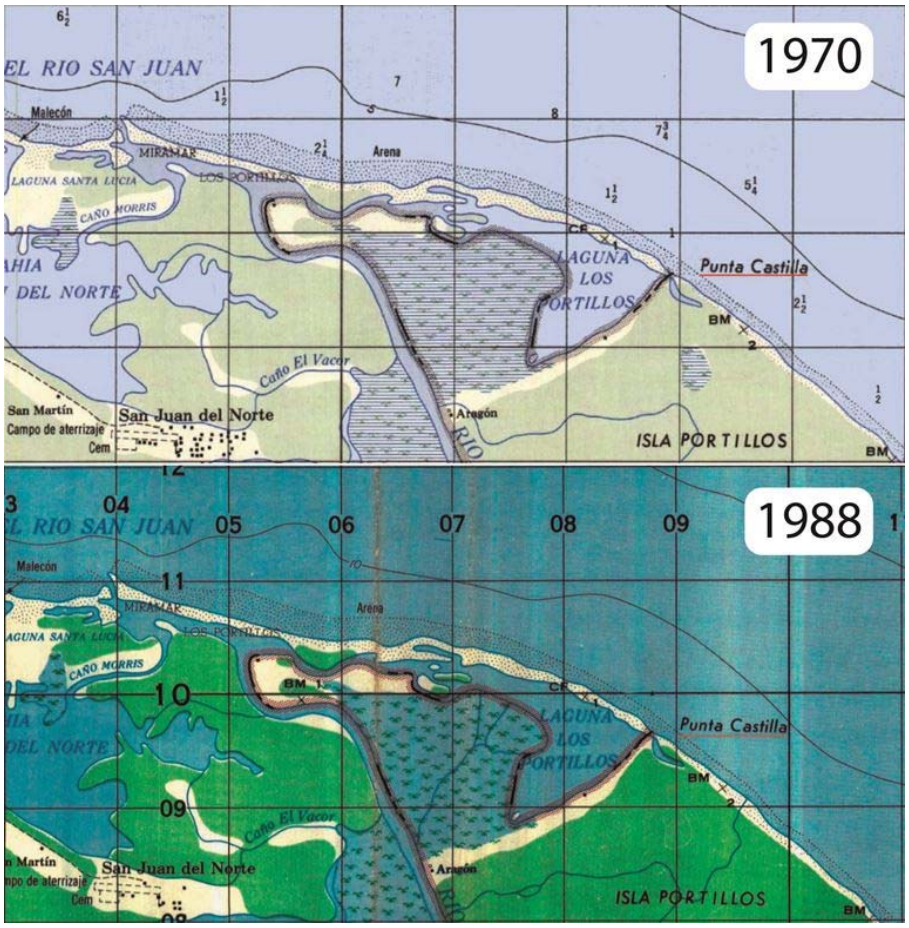

Figure 26. Portions of the 1970 and 1988 editions of the 1:50,000 scale topographic maps of Punta de Castilla (sheet 3448 I) of the Instituto Geográfico Nacional de Costa Rica. The maps reveal that there used to be in recent times a channel-like water gap connecting the Los Portillos/Harbor Head Lagoon with the San Juan River. Note that at that time the spit associated with the mouth of the San Juan River was attached to Punta de Castilla, not to the western extremity of Isla Portillos (see **Figure 3** for comparison).

Figure 27. Point Ple located at the base of the sand spit-barrier of the Los Portillos/Harbor Head Lagoon. This point is located at the contact between the relatively stable surface covered by tree vegetation on the eastern margin of the lagoon, and the accumulation of loose sand that forms the spit-barrier. The GPS receiver of Costa Rica is located at the base of a coconut tree. The flooded coconut trees in the background reveal the high water level that reached the lagoon after Hurricane Otto. Image taken during the first site visit on 6 December 2016.

Figure 28. Point Plw measured during the first site visit at the western extremity of Los Portillos/Harbor Head lagoon. The point was located at a high-water mark defined by stranded vegetation indicating the maximum level reached by the water of the lagoon after Hurricane Otto. Image taken on 6 December 2016.

Figure 29. Channel breached in the beach of Isla Portillos, west of the spit-barrier of Los Portillos/Harbor Head Lagoon. The water of the lagoon was flowing towards the sea through this channel. The star indicates the location of point Pch. Image captured from a video recorded by the Nicaraguan delegation during the first site visit in December 2016.

Figure 30. Topographer of the Costa Rican delegation measuring the eastern bank of the channel through which the lagoon was draining towards the sea (point Pch). On the other side of the channel the tree vegetation is in direct contact with the sea waves. Image taken during the first site visit on 6 December 2016.

Figure 31. Channel opened in the beach of Isla Portillos, close to the western extremity of the Los Portillos/Harbor Head Lagoon. The water of the lagoon was flowing into the sea. Flow direction is towards the camera. Image taken during the first site visit on 8 December 2016.

Figure 32. Image of Point Ple2, which represents the easternmost edge of the water body of Los Portillos/Harbor Head Lagoon on its northeast corner during the second site visit. The point was marked with a wooden stick, being measured by a topographer from Nicaragua (right). The monument to the right corresponds to a marker whose designation (Δ and a reversed s as subscript, referred to by the Parties as the "A2" Marker) has not been identified in the Proceedings of the Costa Rica-Nicaragua Demarcation Commissions of the end of the 19th century. Image taken during the second site visit on 15 March 2017.

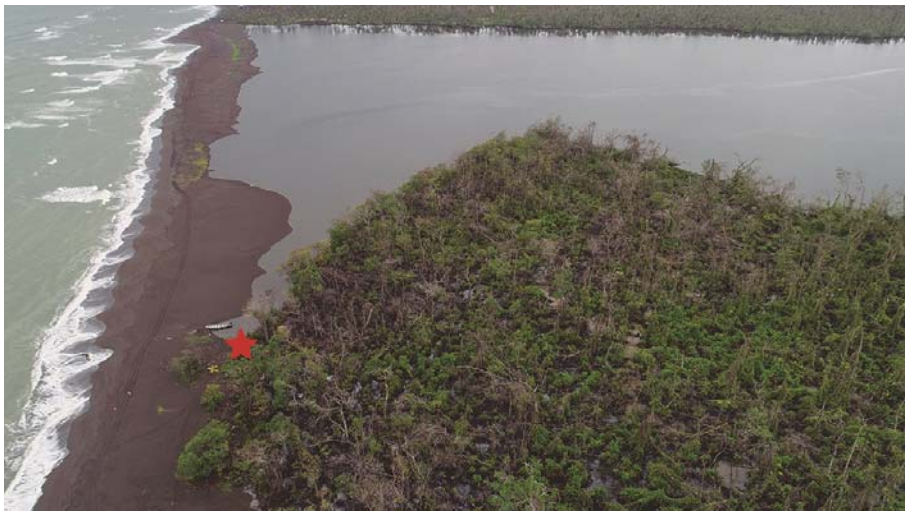

Figure 33. Point Plw2 (asterisk) measured during the second site visit at the western extremity of the water body of Los Portillos/Harbor Head Lagoon and general view of its sand barrier. Image captured by the drone of the Costa Rican delegation in March 2017.

Figure 34. Topographer of Costa Rica (left) measuring the co-ordinates of the western extremity of the water body of Los Portillos/Harbor Head Lagoon (covered by floating debris) during the second site visit. Image taken on 15 March 2017.

Figure 35. Point Pleb (wooden stick) measured during the second site visit at low tide (15 March 2017, at 8:57 a.m.). This point represents the intersection between the shoreline and the projection of the northeastern corner of the Los Portillos/Harbor Head Lagoon perpendicular to the coast.

Figure 36. Position of the channel opened by Hurricane Otto (arrow). The channel was closed during the second site visit due to the recovery of the sandy beach. Image captured by the drone of the Costa Rican delegation during the second site visit in March 2017.

Figure 37. Oblique aerial photograph of the spit-barrier of Los Portillos/Harbor Head Lagoon showing a temporary inlet channel. Image taken on 3 August 2012.

(c) San Juan River

103. This channel has a NNW-SSE straight orientation west of Los Portillos/Harbor Head and turns into a general ENE-WSW trend in the mouth area, where it shows a sinuous course (**Fig. 21**). On the right margin of the San Juan River there is a series of secondary minor channels (*caños*) directed towards the NE that may function during high flow periods.

(d) Isla Portillos

104. In this Report, Isla Portillos is defined as a portion of land, mostly covered by dense tree vegetation, framed by Los Portillos/Harbor Head Lagoon, the San Juan River and the Caribbean Sea, excluding the highly variable sand spit that grows from its northwestern extremity (**Fig. 21**). Isla Portillos is essentially an abandoned microdelta formed by the San Juan River when it used to flow into a large bay through multiple distributary channels, as shown in historical maps (see for example **Figures 22 and 38**).

105. During the first site visit, to the west of the channel opened by Hurricane Otto there was a coastal section affected by active erosional retreat. In this section, between point Pch and a point with co-ordinates 17P 0207176E 1210255N (measured with a hand-held GPS during the first site visit; error margin of 3 m), the waves were impacting directly on the tree vegetation of Isla Portillos. Some trees were located within the sea and others were being undermined by wave erosion (**Fig. 39**).

106. In the second site visit, the sandy beach had largely recovered, reaching in most of this section a width of around 50 m (**Fig. 40**). Wave action during severe storms tends to erode beach deposits and transport them offshore. Beaches recover by progressive sediment accumulation under ordinary conditions. The remaining coastal sector of Isla Portillos showed a broad and continuous sandy beach during both visits. Between the beach and the area covered by tree vegetation there is a series of discontinuous coast-parallel lagoons (**Figs. 41, 42**). The elongated lagoons are essentially remnants of the channel-like water gap that used to exist in recent times between Isla Portillos and the spit of Los Portillos/Harbor Head Lagoon (**Fig. 26**). In the western sector of Isla Portillos, the forested area is in direct contact with the sand beach and there are no lagoons with free-standing water (**Fig. 43**).

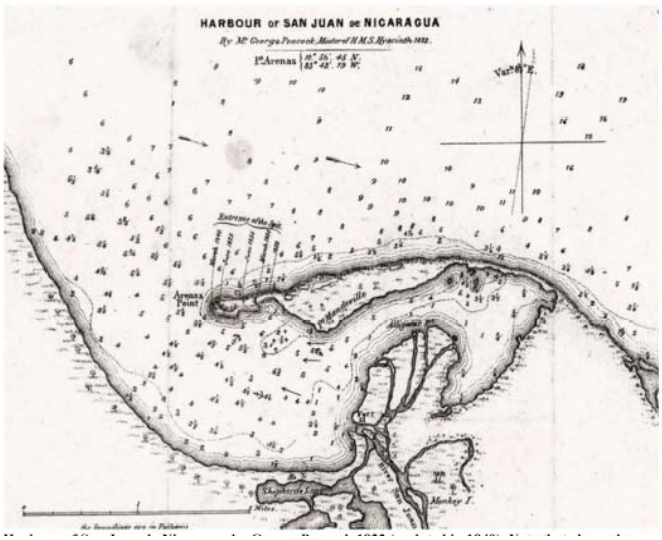

Figure 38. Map of San Juan del Norte Bay produced by George Peacock in 1832 and updated in 1840. The San Juan River used to flow into an open lagoon through multiple distributary channels forming a small delta, which nowadays roughly corresponds to Isla Portillos, as defined in this Report.

Figure 39. Image of the coastal stretch of Isla Portillos affected by severe erosional retreat. Here, the mangrove forest is in direct contact with the sea and affected by wave action. Image taken during the first site visit on 5 December 2016.

Figure 40. Coastal stretch of Isla Portillos, which was affected by severe erosional retreat during the first site visit. This image, taken during the second site visit, illustrates the considerable recovery of the beach by sand accumulation related to wave action under regular conditions.

Figure 41. Discontinuous and elongated lagoons between the beach and the relatively stable area covered by dense vegetation of Isla Portillos. Image captured from a video recorded by Nicaragua with a drone during the first site visit in December 2016.

Figure 42. Oblique aerial view taken by the Costa Rican drone during the second site visit in March 2017, showing the discontinuous lagoons between the beach and the area covered by dense vegetation of Isla Portillos. Note that the lagoons were much less extensive than during the first site visit (see **figure 41** for comparison).

Figure 43. Western sector of the coast of Isla Portillos, close to the mouth of the San Juan River, where the lagoons or coastal lakes terminate before the mouth of the San Juan River. Image captured from a video recorded by Nicaragua with a drone during the first site visit in December 2016.

(e) Spit of Isla Portillos

107. This is a narrow and coast-parallel spit at the mouth of the San Juan River that grows by littoral drift from the northwest extremity of Isla Portillos. This ephemeral accumulation deflects the final course of the San Juan River and displaces its mouth towards the west (**Fig. 21**). This sensitive feature has experienced significant changes in the last few decades related to sedimentation and erosion processes with the consequent alterations in the configuration and position of the San Juan River mouth (**Fig. 44**).

108. Costa Rica in its pleadings proposes the base of this sand spit as the starting-point of the maritime boundary: "*at the base of the sand spit extending northwest from Isla Portillos, because no reliable base points can be derived from this ephemeral low-lying feature*".

109. In the first site visit the base of the spit was located at point Pv on the western edge of the tree vegetation growing on slightly higher ground, and where the loose sand deposit of the spit started (**Figs. 45, 46**). No changes were observed in the second site visit at this spot. During the first visit (December 2016) the spit was just around 210 m long at low tide, most probably due to significant erosion caused by the Hurricane Otto in the previous month (**Fig. 46**).

110. In the second visit it was about 880 m long, indicating a rapid growth in length of ca. 670 m in about 3 months (**Figs. 13, 47**).

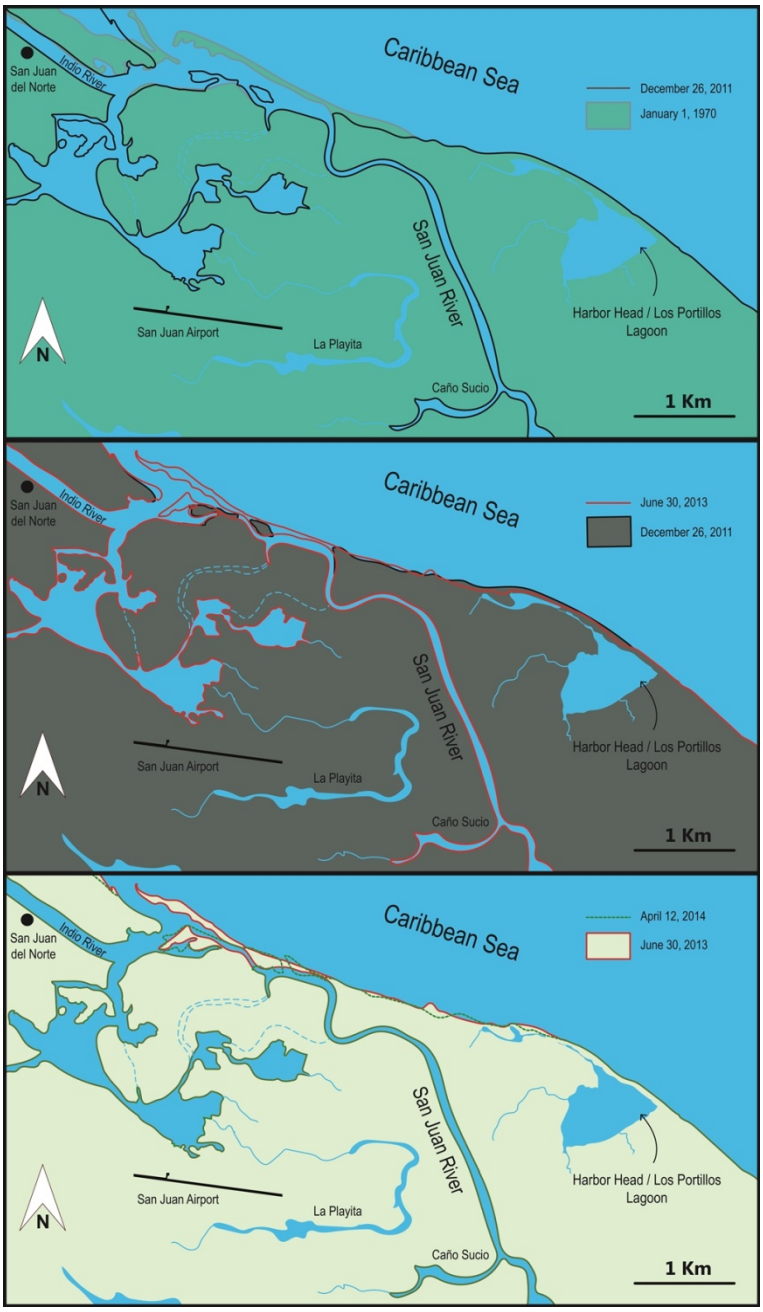

Figure 44. Sequence of maps illustrating the main changes in the coastline identified comparing satellite images from different dates (January 1970, December 2011, June 2013, April 2014). The satellite images were retrieved from the historical imagery of GoogleEarth. Note the substantial modifications experienced by the spit of Isla Portillos at the mouth of the San Juan River (right bank).

Figure 45. The Nicaraguan delegation measuring the geographical co-ordinates at the base of the sand spit of Isla Portillos (point Pv). Image taken during the first site visit on 5 December 2016.

Figure 46. Image captured by the drone of the Nicaraguan delegation in December 2016, showing the spit of Isla Portillos and the mouth of the San Juan River on its eastern bank. The spit was most probably diminished by erosion associated with the Hurricane Otto (24 November 2016). The star indicates the location of point Pv.

Figure 47. Spit of Isla Portillos and the mouth of the San Juan River on its eastern bank (arrow) during the second site visit. The spit experienced a significant westward growth by sand accretion between the first and the second visit (see Figure 46 for comparison). Image captured by the drone of the Costa Rican delegation in March 2017.

*

Table 1. Geographical co-ordinates measured by the topographical teams of Nicaragua and Costa Rica during the site visits and used in this Report (WGS 1984 coordinate system)

FIRST SITE VISIT					
Code	**Name**	**Nicaragua**		**Costa Rica**	
Prm	River mouth first	205021.82 E	1210725.30 N	205021.99 E	1210725.29 N
Prmb	River mouth second	204965.88 E	1210750.48 N	204966.09 E	1210750.50 N
Pv	Vegetation	205128.22 E	1210619.32 N	205128.41 E	1210619.28 N
Ple	Lagoon east	208431.57 E	1209509.95 N	208431.78 E	1209510.01 N
Plw	Lagoon west	207785.83 E	1209959.32 N	207786.05 E	1209959.36 N
Pch	Channel	207625.75 E	1210079.78 N	207625.97 E	1210079.78 N
Pa2	Marker "A2"	208421.21 E	1209499.91 N	208421.59 E	1209499.94 N

SECOND SITE VISIT					
Code	**Name**	**Nicaragua**		**Costa Rica**	
Prm2	River mouth second visit	204365 E	1211067 N	204365.522 E	1211066.661N
Plw2	Lagoon west 2	207787 E	1209944 N	207786.928 E	1209944.489 N
Ple2	Lagoon east 2	208424 E	1209504 N	208424.307 E	1209503.772 N
Pleb	Lagoon east beach	208466 E	1209545 N	208466.029 E	1209545.191 N
Pp1	Probing	207762 E	1209980 N	207761.942 E	1209979.925 N
Pp2	Probing	207757 E	1209975 N	207756.618 E	1209974.599 N
Pp3	Probing	207763 E	1209969 N	207763.006 E	1209969.442 N
Pp4	Probing	207760 E	1209966 N	207760.412 E	1209966.129 N
Pp5	Probing	207762 E	1209965 N	207769.610 E	1209950.925 N
Pp6	Probing	207757 E	1209968 N	207778.587 E	1209947.785 N
Pp7	Probing	207770 E	1209951 N	207777.632 E	1209958.058 N
Pp8	Probing	207779 E	1209948 N	207787.449 E	1209968.646 N
Pp9	Probing	207781 E	1209949 N	207767.465 E	1209986.806 N
Pp10	Probing	207783 E	1209954 N		
Pp11	Probing	207778 E	1209958 N		
Pp12	Probing	207787 E	1209969 N		
Pp13	Probing	207768 E	1209987 N		
PairNE	GPR airport	204562 E	1208499 N	204561.467 E	1208498.913 N
PairSE	GPR airport	204553 E	1208420 N	204553.131 E	1208419.741 N
PairNW	GPR airport	204382 E	1208512 N	204381.651 E	1208512.200 N
PairSW	GPR airport	204374 E	1208433 N	204373.640 E	1208433.157 N

*

III. ANSWERS TO THE QUESTIONS OF THE COURT

111. Our mission was to "advise the Court regarding the state of the coast between the point suggested by Costa Rica and the point suggested by Nicaragua in their pleadings as the starting-point of the maritime boundary in the Caribbean Sea", and in particular to answer four specific questions (see paragraph 5).

112. It is recalled that, in the case concerning *Maritime Delimitation in the Caribbean Sea and the Pacific Ocean (Costa Rica* v. *Nicaragua)*, the Parties each submitted only one pleading (a Memorial for Costa Rica and a Counter-Memorial for Nicaragua).

113. In its Memorial, Costa Rica claims that the starting-point of the maritime delimitation between the Parties on the Caribbean side is

> *"on the right bank of the San Juan River at its mouth: the point at which the line dividing the land territories of the two States intersects the coast. That point is located at the north-western extremity of Costa Rica's Isla Portillos, where Costa Rica's land territory and Nicaragua's waters of the San Juan River meet the Caribbean Sea" (Memorial of Costa Rica, para. 4.13).*

Costa Rica places the starting-point of the delimitation

> *"at the base of the sand spit extending northwest from Isla Portillos, because no reliable basepoints can be derived from this ephemeral low-lying feature. The co-ordinates of the starting point in the Caribbean… are 10° 56' 26.0" N and 83° 41' 53.0" W" (Memorial of Costa Rica, para. 4.15).*

114. In its Counter-Memorial, Nicaragua agrees that the starting-point of the maritime boundary is "the point at which the line dividing the land territories of the two States intersects the coast" (Counter-Memorial of Nicaragua, para. 3.34). It submits however that this point is to be found about 3.6 km east of that suggested by Costa Rica (*ibid.*, paras. 3.35, 3.48, 3.52). Recalling the 1858 Treaty of Limits, the 1888 Cleveland Award and the Alexander Awards, it considers that the starting-point of the land boundary (and the maritime delimitation) is the extremity of Punta de Castilla, which it places near the north-eastern corner of Los Portillos/Harbor Head Lagoon. According to Nicaragua, the starting-point of the sea delimitation is located at 10° 55' 49.7" North and 83° 40' 0.6" West (*ibid.*, paras. 3.38-3.48, 3.52).

115. The present Report will therefore focus on the area situated between the two points defined above. Their approximate location is shown in **Figure 48** below.

Figure 48. Annotated satellite image from June 2013 (Digital Globe; U.S. Geological Survey) indicating the approximate location of the starting-points of the maritime boundary proposed by Costa Rica (CR) and Nicaragua (N).

(1) Answer to the first question

116. In its Order of 31 May 2016, the Court first asked the authors of the present Report the following question:

> *"(a) What are the geographical co-ordinates of the point at which the right bank of the San Juan River meets the sea at the low-water line?"*

117. As the sequence of sketches in **Figure 44** illustrates, the position of the mouth of the San Juan River experiences continuous variations, mainly related to changes in the spit of Isla Portillos, *i.e.*, westward growth by accumulation of sand and destruction by erosion (**Figs. 46, 47**). The growth of the spit by sediment accretion is a progressive process, whereas its destruction, including the opening of channels, may occur rapidly by strong waves (*e.g.*, hurricanes) and floods of the San Juan River. Consequently, the mouth of the San Juan River and its right bank are highly mobile.

118. The geographical co-ordinates of the point where the San Juan River meets the sea on the right bank at the low-water line were measured by the topographers of both delegations during the first and second site visits (**Table 2**). In the first site visit the point (Prmb) was measured on 6 December 2016 by both Parties on exactly the same point at 11:25-11:27 a.m. (low-tide time) (**Table 2; Fig. 49**). In the second site visit the point (Prm2) was measured on 14 March 2017 by both Parties on exactly the same point at 8:16-8:17 a.m. (low-tide time) (**Table 2, Fig. 50**). The distance between both points is 670 m, indicating an average growth rate of 6.8 m/day.

6 December 2016 at 11:25-11:27 a.m. (first site visit)		
Costa Rica	204966.090 E	1210750.500 N
Nicaragua	204965.88 E	1210750.48 N
14 March 2017 at 8:16-8:17 a.m. (second site visit)		
Costa Rica	204365.52 E	1211066.66 N
Nicaragua	204365 E	1211067 N

Table 2. Geographical co-ordinates (WGS 1984) of the point at which the right bank of the San Juan River meets the sea at the low-water line, measured during the two site visits by the topographical teams of both Parties.

Figure 49. Measurement of co-ordinates by Costa Rica (left) and Nicaragua (right) of the point at which the right bank of the San Juan River (Prmb) meets the sea at low tide (6 December 2016, at 11:25-11:27 a.m.).

Figure 50. Measurement of co-ordinates by Nicaragua (left) and Costa Rica (right) of the point at which the right bank of the San Juan River (Prm2) meets the sea at low tide (14 March 2017, at 8:16-8:17 a.m.).

(2) Answer to the second question

119. In the Order of 31 May 2016, the second question put by the Court to the authors of the present Report was:

> *"(b) What are the geographical co-ordinates of the land point which most closely approximates to that identified by the first Alexander Award as the starting-point of the land boundary?"*

(a) The starting-point of the land boundary identified by the first Alexander Award

120. In order to answer the second question of the Court, we first have to recall some historical and factual elements.

121. As indicated by the Court in the Judgment it rendered on 16 December 2015 in the cases *Certain Activities carried out by Nicaragua in the Border Area (Costa Rica* v. *Nicaragua)* and *Construction of a Road in Costa Rica along the San Juan River (Nicaragua* v. *Costa Rica)*:

> *"[f]ollowing hostilities between the two States in 1857, the Governments of Costa Rica and Nicaragua signed on 15 April 1858 a Treaty of Limits, which was ratified by Costa Rica on 16 April 1858 and by Nicaragua on 26 April 1858 (hereinafter the '1858 Treaty'). The 1858 Treaty fixed the course of the boundary between Costa Rica and Nicaragua from the Pacific Ocean to the Caribbean Sea." (Judgment, para. 59)*

122. The Court also recalled that, according to Article II of the 1858 Treaty:

> *"'The dividing line between the two Republics, starting from the Northern Sea [i.e. the Caribbean sea], shall begin at the end of Punta de Castilla, at the mouth of the San Juan de Nicaragua river, and shall run along the right bank of the said river up to a point three English miles distant from Castillo Viejo . . .' [In the Spanish original: 'La línea divisoria de las dos Repúblicas, partiendo del mar del Norte, comenzará en la extremidad de Punta de Castilla, en la desembocadura del río de San Juan de Nicaragua, y continuará marcándose con la margen derecha del expresado río, hasta un punto distante del Castillo Viejo tres millas inglesas…']" (Judgment, para. 71)*

123. As the Court indicated,

> *"Following challenges by Nicaragua on various occasions to the validity of the 1858 Treaty, Costa Rica and Nicaragua signed another instrument on 24 December 1886, whereby the two States agreed to submit the question of the validity of the 1858 Treaty to the President of the United States, Grover Cleveland, for arbitration. In addition, the Parties agreed that, if the 1858 Treaty were found to be valid, President Cleveland should also decide 'upon all the other points of doubtful interpretation which either of the parties may find in the treaty'. On 22 June 1887, Nicaragua communicated to Costa Rica 11 points of doubtful interpretation, which were subsequently submitted to President Cleveland for resolution. The Cleveland Award of 1888 confirmed, in its paragraph 1, the validity of the 1858 Treaty and found, in its paragraph 3 (1), that the boundary line between the two States on the Atlantic side 'begins at the extremity of Punta de Castilla at the mouth of the San Juan de Nicaragua River, as they both existed on the 15th day of April 1858'" (Judgment, para. 60)*

124. As further indicated by the Court in its Judgment of 16 December 2015 (see para. 61), subsequent to the Cleveland Award, Costa Rica and Nicaragua agreed in 1896, under the Pacheco-Matus Convention on border demarcation, to establish two national Demarcation Commissions, each composed of two members (Art. I). The Pacheco-Matus Convention further provided that the Commissions would include an engineer, appointed by the President of the United States of America, who "shall have broad powers to decide whatever kind of differences may arise in the course of any operations and his ruling shall be final" (Art. II). United States General Edward Porter Alexander was so appointed.

125. During the demarcation process, which began in May 1897 and was concluded in 1900, General Alexander rendered five awards.

126. In his first Award, dated 20 December 1897, General Alexander stated that the boundary line:

> "*must follow the . . . branch . . . called the Lower San Juan, through its harbor and into the sea. The natural terminus of that line is the right-hand headland of the harbor mouth." (RIAA, Vol. XXVIII, p. 217.)*

He then defined the initial part of the boundary starting from the Caribbean Sea in the following terms:

> *"The exact spot which was the extremity of the headland of Punta de Castill[a] [on] April 15, 1858, has long been swept over by the Caribbean Sea, and there is too little concurrence in the shore outline of the old maps to permit any certainty of statement of distance or exact direction to it from the present headland. It was somewhere to the northeastward, and probably between 600 and 1,600 feet distant, but it can not now be certainly located. Under these circumstances it best fulfills the demands of the treaty*

and of President Cleveland's award to adopt what is practically the headland of to-day, or the northwestern extremity of what seems to be the solid land, on the east side of Harbor Head Lagoon.

I have accordingly made personal inspection of this ground, and declare the initial line of the boundary to run as follows, to wit:

Its direction shall be due northeast and southwest, across the bank of sand, from the Caribbean Sea into the waters of Harbor Head Lagoon. It shall pass, at its nearest point, 300 feet on the northwest side from the small hut now standing in that vicinity.

On reaching the waters of Harbor Head Lagoon the boundary line shall turn to the left, or southeastward, and shall follow the water's edge around the harbor until it reaches the river proper by the first channel met. Up this channel, and up the river proper, the line shall continue to ascend as directed in the treaty." (Ibid., p. 220.)

127. A sketch illustrating this initial part of the boundary in the geographic situation prevailing at the time was attached to this first Award (*ibid.*, p. 221) (see **Figure 51** below).

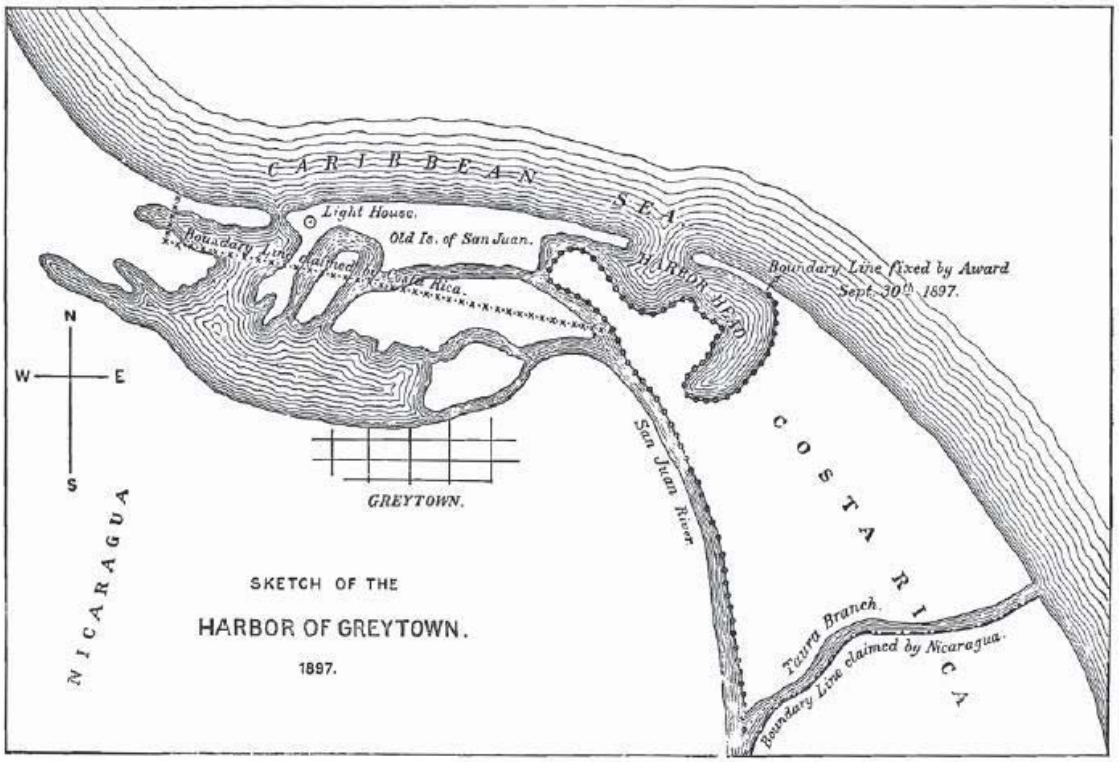

Figure 51. Printed sketch-map attached to Alexander's First Award

128. Following this First Award, the proceedings of the Demarcation Commissions recorded the co-ordinates of the starting-point of the land boundary by reference to the center of Plaza Victoria in old San Juan de Nicaragua (Greytown) and other points on the ground (see further on this below).

(b) Geographical co-ordinates of the land point which most closely approximates to that identified by the first Alexander Award as the starting-point of the land boundary

129. The second question of the Court can be interpreted in two different ways:

(i) First option

130. One alternative is to "adopt what is practically the headland of to-day, or the northwestern extremity of what seems to be the solid land, on the east side of Harbor Head Lagoon" as it exists in 2016-2017. This approach coincides with that followed in the first Alexander Award, dated 20 December 1897.

131. Although the headland of Punta de Castilla has experienced significant retreat due to coastal erosion (*e.g.*, **Fig. 22**), it still exists as a geomorphic and geographical feature in the landscape. The point that represents the northwestern extremity of relatively more solid land on the east side of Los Portillos/Harbor Head Lagoon was identified and measured in the first site visit at point Ple (**Figs. 18, 27**; **Table 1**). This spot is located at the contact between the relatively stable surface covered by tree vegetation on the eastern margin of the lagoon (**Fig. 23**), and the accumulation of easily erodible loose sand that forms the spit-barrier of Los Portillos/Harbor Head Lagoon (**Fig. 25**). The spot in the shoreline at which the projection perpendicular to the coast of point Ple meets the low-water line at low tide was measured in the second site visit by the topographical teams of both parties on 15 March 2017 at 8:57 a.m. (point Pleb, **Figs. 18, 35; Table 1**).

(ii) Second option

132. Another alternative is to adopt "the land point" as it exists today which is geographically closest to the point identified by Alexander and the Demarcation Commissions as the starting-point of the land boundary, which is now in the Caribbean Sea due to coastal erosion.

133. With regard to this second option, in a first stage we need to locate with modern geographical co-ordinates the starting-point identified by Alexander and in the proceedings of the Demarcation Commissions, whose position was defined in relation to several markers and points. In a second stage we can determine the closest land point.

134. For the first of these stages, it is necessary to retrace a number of events.

a. Works of the Demarcation Commissions and General Alexander (1897-1899)

135. On 2 October 1897, the Demarcation Commissions, together with General Alexander, "having proceeded with a personal inspection of the place designated by the arbiter as the initial point of the boundary line... established the spot where the monument that will serve as a boundary marker on the Atlantic Coast should be placed". It is indicated that "the aforementioned spot is provisionally marked by a straight line of three hundred English feet measured from the hut referred to in the arbitral award and in the direction that will be stated further on" (*Proceedings of the Costa Rica-Nicaragua Demarcation Commissions (1897-1900), Proceedings VI*, reproduced at Ann. 4 of Nicaragua's Counter-Memorial).

136. On 2 March 1898, the Demarcation Commissions "proceeded first and foremost to emplace the Monument that determined the Initial Point of the dividing line on the Coast of the Caribbean Sea, linking it with the center of Plaza Victoria in San Juan del Norte" (*Proceedings of the Costa Rica-Nicaragua Demarcation Commissions (1897-1900), Proceedings X*, reproduced at Ann. 5 of Nicaragua's Counter-Memorial).

137. The location of the Initial Point or first marker was measured by triangulation with respect to a marker placed in the center of Plaza Victoria in the old town of San Juan del Norte (Greytown), taking that center as the origin (see **Figure 52** below). The distance from the center of Plaza Victoria to the Initial Marker was 4715.55 m with a geodetic azimuth of 244º 50' 23" (measured in direction S-W-N-E). The text of the Proceedings indicates 244º 50' 23" and the sketch 244º 50' 25" for the azimuth between the marker of Plaza Victoria and the Initial Marker (**Fig. 52**).

Most probably the latter value was a clerical error introduced by the drafter, since the former one is indicated repeatedly in the text.

138. Proceedings X of 2 March 1898 also indicate that it was agreed to place another reference marker on the opposite margin of Los Portillos/Harbor Head Lagoon, at 1139 m from the Initial Marker, with an azimuth of 66° 41' 05" (see point A/A_m on **Figure 52** below). The figure indicates the azimuth measured from the other edge of the triangulation line 246° 41' 05").

139. The markers located at the Initial Point and the center of Plaza Victoria had iron pipes approximately 40 cm in diameter and 2 m long filled with concrete. The iron pipe of the marker placed in the center of Plaza Victoria was buried so that its upper end appeared at ground level. The proceedings indicate that this marker was located opposite to the place where the old church of San Juan del Norte used to be situated, implicitly indicating that the church had already disappeared.

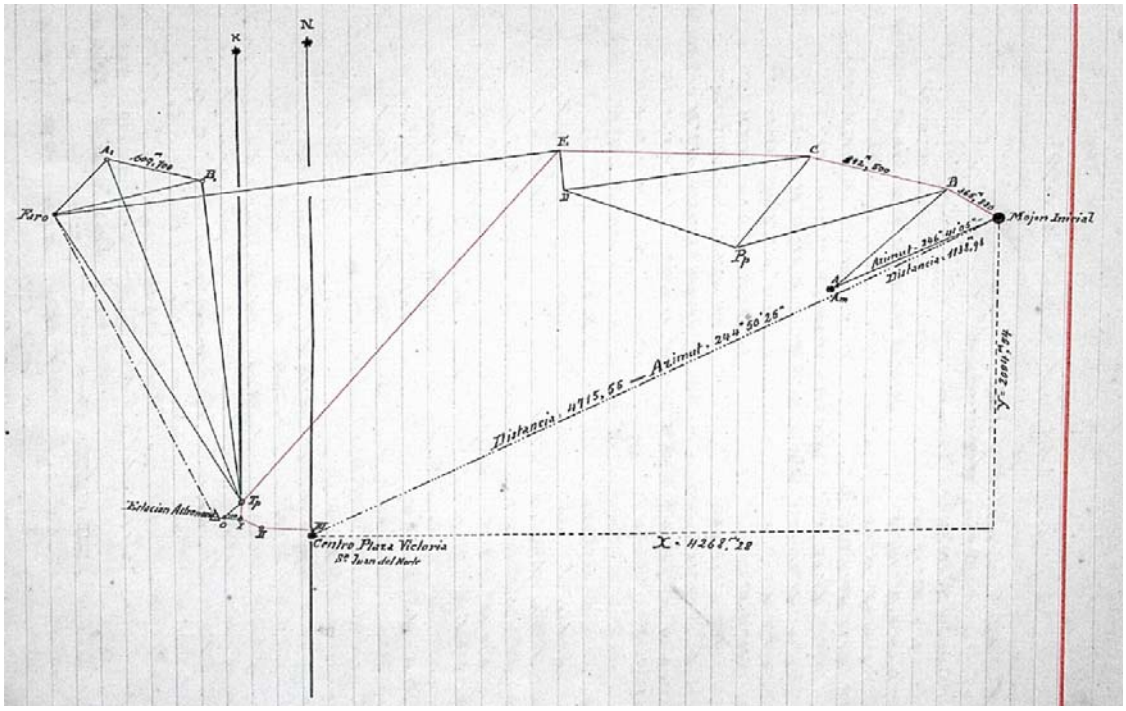

Figure 52. Sketch included in Proceedings X of the Costa Rica-Nicaragua Demarcation Commissions, showing the relative co-ordinates of the Mojón Inicial (Initial Marker) with respect to the marker placed in the center of Plaza Victoria.

140. Proceedings X also included a chart with co-ordinates for the first segment of the land boundary, and a sketch showing that portion of the boundary and the location of the Initial Marker (Mojón Inicial) (see **Figure 53** below).

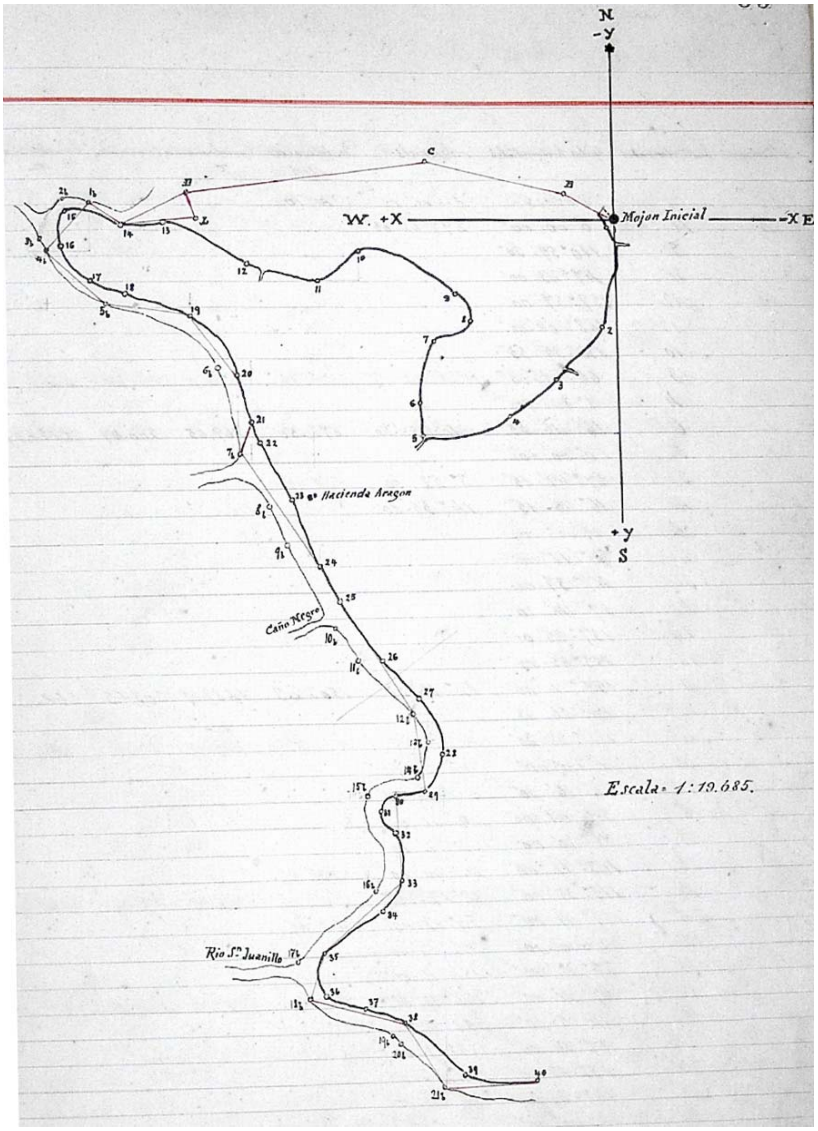

Figure 53. Sketch of the San Juan River and Los Portillos/Harbor Head Lagoon showing the first segment of the land boundary and the location of the Initial Marker (*Proceedings X of the Costa Rica-Nicaragua Demarcation Commissions*).

141. On 3 June 1898, Andrés Navarrete, member of the Costa Rican Commission, took to San Juan del Norte the piece of granite with four engraved bronze plates on its sides to be emplaced at the location of the Initial Marker (Mojón Inicial). On 23 December 1898, this "piece of granite was placed with the bronze plates on which the mandated inscriptions were engraved, and the points of reference were built in Harbor Head and in Victoria Square, having fully complied with the resolution of the Arbiter, General E. P. Alexander" (*Proceedings of the Costa Rica-Nicaragua Demarcation Commissions (1897-1900), Proceedings XIV and XV*, reproduced at Anns. 6 and 7 of Nicaragua's Counter-Memorial).

142. On 13 June 1899, the Commissions recorded that "given the circumstance that the monument that is the starting-point in Harbor Head has been tipped over by the sea and that both Commissions wish to conserve the monument as the sign for beginning the line, they have arranged to rebuild it at a point that can preserve it from invasions by the sea, and connecting it geodetically with the point it previously occupied" (*Proceedings of the Costa Rica-Nicaragua Demarcation Commissions (1897-1900), Proceedings XVI*, reproduced at Ann. 8 of Nicaragua's Counter-Memorial).

143. On 19 August 1899, recalling that the "initial marker, placed near Punta de Castilla, [had] completely disappeared due to the force of the elements" and that they had "to preserve the position of said Punta de Castilla and the initial marker by means that facilitate the exact placement of those points at any given time", the Commissions explained that:

> "*it is hereby agreed to build three masonry markers according to the map herein copied [and reproduced below as* ***Figure 54****] and in the points marked by the triangulation performed, according to the calculation and map surveyed for such purpose and included in these Minutes." (Proceedings of the Costa Rica-Nicaragua Demarcation Commissions (1897-1900), Proceedings XX, reproduced at Ann. 9 of Nicaragua's Counter-Memorial)*

144. The map includes the distances and azimuths of all the triangulation lines between the following markers and points:

C: Punta de Castilla

I: Initial Marker (Mojón Inicial, destroyed by the sea)

A: Main Marker (Mojón Principal)

A_m, A_1: Auxiliary markers (Mojones auxiliares)

145. All the points of this new triangulation were related with the marker located in the center of Plaza Victoria.

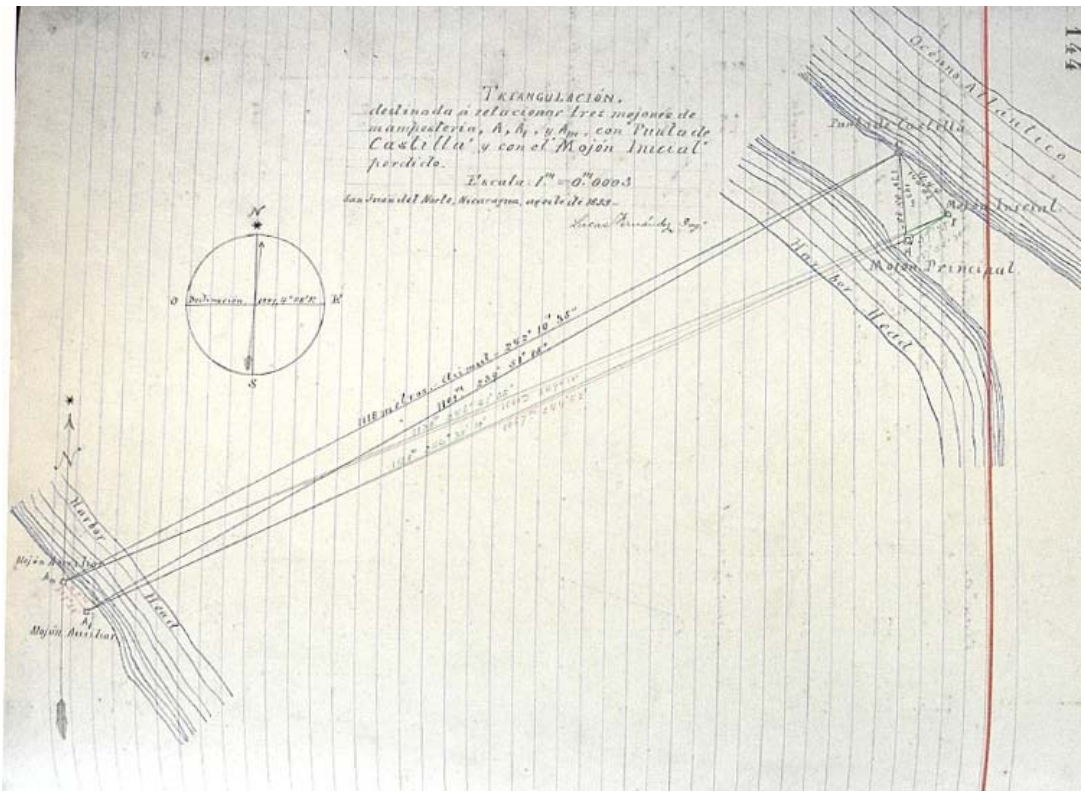

Figure 54. Triangulation measurements obtained in August 1899 between Punta de Castilla (C), Initial Marker (I), Main Marker (A), and auxiliary markers A_m and A_1. Note that Punta de Castilla is located 91.44 m to the NW (140º 52') of the Initial Marker (*Proceedings XX of the Costa Rica-Nicaragua Demarcation Commissions*).

146. Proceedings XX described graphically two types of markers (**Fig. 55** below):

— Modelo A for the Main Marker A;

— Modelo B for auxiliary markers A_m and A_1. The latter were buried 1.2 m in the ground, were 2.25 m high, and their northern façade were engraved indicating the distance to Punta de Castilla and the corresponding azimuth.

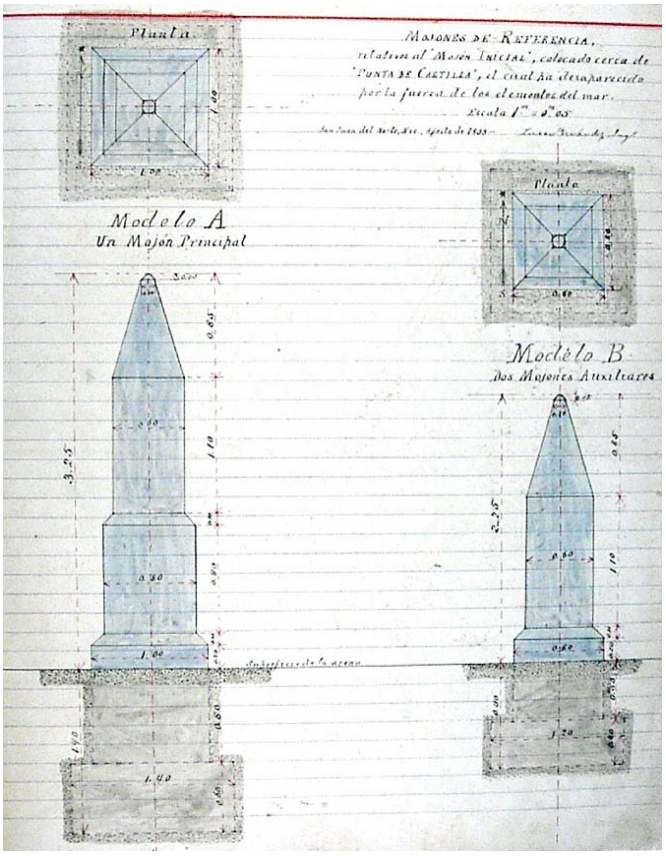

Figure 55. Sketch showing the geometrical features and parameters of the two types of markers installed for facilitating the exact placement of Punta de Castilla and the Initial Marker at any given time (*Proceedings XX of the Costa Rica-Nicaragua Demarcation Commissions*).

b. Works of the Sub-Commission on Limits and Cartography established by Costa Rica and Nicaragua (2002-2005)

147. It is further important to recall that, on 6 September 2002, Costa Rica and Nicaragua decided to reactivate the Sub-Commission on Limits and Cartography they contemplated in 1997 "to begin conversations conducive to defining the maritime delimitation between both countries" (Memorial of Costa Rica, Ann. 29 and 30).

148. This Sub-Commission of Limits and Cartography met on several occasions afterwards.

— Meeting of 25 March 2003 (Second meeting)

149. The Minute of the second meeting of the said Sub-Commission (dated 25 March 2003) indicated that, with regard to the work for delimitation on the Caribbean Sea, "[t]he Sub-Commission considered it necessary to work on documents to calculate with modern procedures the co-ordinates of marker number one, based on the topographic survey created by Engineer Alexander

in 1900" (*Minute of the Second Meeting of the Sub-Commission on Limits and Cartography*, 25 March 2003, Memorial of Costa Rica, Ann. 32; Counter-Memorial of Nicaragua, Ann. 13).

— Meeting of 4 September 2003 (Third meeting)

150. The Minute of the third meeting (dated 4 September 2003) specified that the Nicaraguan Institute of Territorial Studies (hereinafter "INETER") had indicated, in a report, that "in the XXth Minutes of the Alexander Commission of 1899, it is clear that Marker One had disappeared because of the sea, thus a triangulation of markers was ordered to locate the initial point. During the visit of 21 February 20[0]3, both delegations found a marker at that triangulation" although it is not clear which marker it was (*Minute of the Third Meeting of the Sub-Commission on Limits and Cartography*, 4 September 2003, Memorial of Costa Rica, Ann. 33; Counter-Memorial of Nicaragua, Ann. 14).

— Meeting of 24 to 27 November 2003 (Fourth technical meeting)

151. At its fourth technical meeting, held from 24 to 27 November 2003, the Sub-Commission recorded that "[i]n compliance with the agreements of the Third meeting … on September 4, 2003, the Technical Groups of Nicaragua and Costa Rica proceeded with the field Works to determine the modern co-ordinates for Marker 1, which disappeared in 1899 due to the force of the sea" (*Minute of the Fourth Technical Meeting of the Sub-Commission on Limits and Cartography*, 24-27 November 2003, Counter-Memorial of Nicaragua, Ann. 15).

152. It is indicated that, on 24 November 2003, the Nicaraguan technical team, "accompanied by a guide — Mr. Hedly Thomas, who is familiar with the place … went toward San Juan del Norte (Greytown), to locate one of the key points of the triangulation that Engineer and Arbiter Alexander, carried out in 1897; this point was called by the Arbiter, 'The Center of Victoria Square', and was marked at such time with a 40 cm diameter iron rod filled with concrete and buried 2 meters deep". Since the guide assured that the rod was covered by very thick undergrowth, it was decided to clean the area. Nevertheless, the rod could not be found on that day. On 26 November 2003, a delegation from both States used metal detectors but still could not find the rod (*ibid.*).

153. The Minute further indicated that, on 25 November 2003, a marker was located at Los Portillos/Harbor Head Lagoon (**Fig. 56**). This marker was reported as the "First Marker". It was measured by both Parties for 2:50 hours with hand-held GPS devices and

> *"an excavation was also performed around the landmark, where one of the sides was marked with a letter 'A' accompanied by another illegible symbol, confirming that the dimensions are the same … as the design of the type A boundary landmarks for the demarcation of limits between Nicaragua and Costa Rica of 1897, pursuant to the Minutes of Arbiter E. P. Alexander." (the original Spanish reads as follows: "una excavación en el contorno del mismo, en donde se descubrió en uno de sus lados la letra 'A' acompañada de otro símbolo ilegible, confirmando que las dimensiones son iguales al diseño del modelo tipo A de los mojones fronterizos para los trabajos de demarcación de limites entre Nic. y C.R. de 1897 conforme a las Actas del Arbitro E.P. Alexander.") (Ibid.)*

154. It was further stipulated that this Marker "is the same one located during the first technical visit to Punta [de] Castilla, which took place on February 21, 2003." (*Ibid.*)

Figure 56. Marker found in the beach by the Sub-Commission on Limits and Cartography on 21 February 2003 and on 25 November 2003. The side exposed by the excavation was marked with a letter "A" accompanied by another illegible symbol. This marker was measured by both Parties for 2:50 hours with hand-held GPS devices.

155. The Minute then recorded that, on the same day (25 November 2003), the Costa Rican delegation found another marker on the right/east bank of the Los Portillos/Harbor Head Lagoon, which was engraved on one of its sides with "the letter 'A2'" (**Figs. 3, 32**).

156. On 26 November 2003, a third marker was found, of "Model Type A… inclined and submerged in Los Portillos Lagoon by approximately 98 mt, to the south of the first Marker found on the coast on Tuesday, November 25" (*ibid.*) (**Fig. 57**). Nicaragua measured the co-ordinates of this marker with a hand-held GPS device (83º 40' 24.4''N, 10º 56' 2.3''W).

Figure 57. Submerged marker found on 26 November 2003 in Los Portillos/Harbor Head Lagoon. Co-ordinates were measured by Nicaragua with a hand-held GPS.

— Meeting of 30 June 2005

157. At the meeting of the Sub-Commission of Limits and Cartography held on 30 June 2005, INETER presented a report on the "Calculation of the geodesic position of Marker one from the land border between Nicaragua and Costa Rica", based on "the location of Marker A2 which was found in restorable conditions, 100 years after its installation" (*Minute of the Fourth Meeting of the Sub-Commission on Limits and Cartography*, 30 June 2005, Memorial of Costa Rica, Ann. 36). The Minute explained that:

> *"Said Marker will serve to determine the geodesic position of the starting point (Marker 1), in addition to the placement of the marker on the coast, which is linear with Marker A2 and Marker 1." (Ibid.)*

158. The report mentioned in the minute is not, however, part of the documents communicated to the authors of the present Report.

*

c. First investigation phase

159. In light of the above, in the initial phase of our investigation we tried to determine the geographical co-ordinates of the Initial Marker (Mojón Inicial) using any of the markers and the triangulation measurements (azimuths and distances) recorded in the Proceedings X and XX of the Costa Rica-Nicaragua Demarcation Commissions (**Figs. 34, 36**). It is indispensable to know the precise location of at least one the markers to apply this approach. However, it had to be ruled out since we were not able to find any of the markers, as explained below:

Marker "A2" located on the eastern edge of Los Portillos/Harbor Head Lagoon (see para. 155 of the present Report, and **Figs. 3, 32**)

160. This conspicuous monument was examined during the first and second site visits. It is engraved with a "Δ" or an "A" and a symbol similar to a reversed "s" as subscript on its western side and cannot be ascribed to any of the markers recorded in the Proceedings of the Costa Rica-Nicaragua Demarcation Commissions (**Fig. 58**). It could be an unrecorded monument emplaced in more recent times.

Figure 58. Inscription on the western side of the monument located on the eastern side of Los Portillos/Harbor Head Lagoon. Image taken during the first site visit (7 December 2016).

Marker found in the beach by the Sub-Commission on Limits and Cartography on 21 February 2003 and on 25 November 2003 and marked with a letter "A" accompanied by another illegible symbol (**Fig. 56**)

161. This marker was measured by both Parties for 2:50 hours with hand-held GPS devices. The Parties provided to the authors of this Report the co-ordinates measured by Nicaragua (10º 56' 1'' N, 83º 40' 23'' W) and Costa Rica (10º 56' 5'' N, 83º 40' 22'' W), as well as the average co-ordinates (10º 56' 03'' N, 83º 40' 22.5'' W).

162. During our first site visit we located the average geographical co-ordinates in the sea, at some distance from the shore. Assuming that the marker found could correspond to auxiliary marker A_m, and using the average co-ordinates as well as the distance and azimuth between auxiliary markers A_m and A_1 (45 m, 319º 22') (**Fig. 54**), we located the probable position of marker A_1 in a spot situated on the beach, close to the swash zone of the waves. The upper semicircular area of 15 m radius about this point was investigated by probing using iron rods with limited penetration (*ca.* 0.5 m), without obtaining a satisfactory result (**Fig. 59**).

163. Between the first and second site visits, the projection of the different geographical co-ordinates on a georeferenced satellite image of 2003 revealed that the co-ordinates measured by Costa Rica were the most reliable, since they were the only ones that fell on the beach (**Fig. 60**).

164. In the second site visit, the co-ordinates of Costa Rica (10º 56’ 5’’ N, 83º 40’ 22’’ W) were located around 100 m off the shoreline, indicating significant coastal retreat between 2003 and 2017. Consequently, the possibility of looking for this marker at a spot currently submerged under the sea was discarded.

Figure 59. Investigation by probing in an area around the point estimated for the location of marker A_1, assuming that the marker found in the beach in 2003 was marker A_m and the average co-ordinates were the best approximation for its location. Image taken on 9 December 2016 during the first site visit.

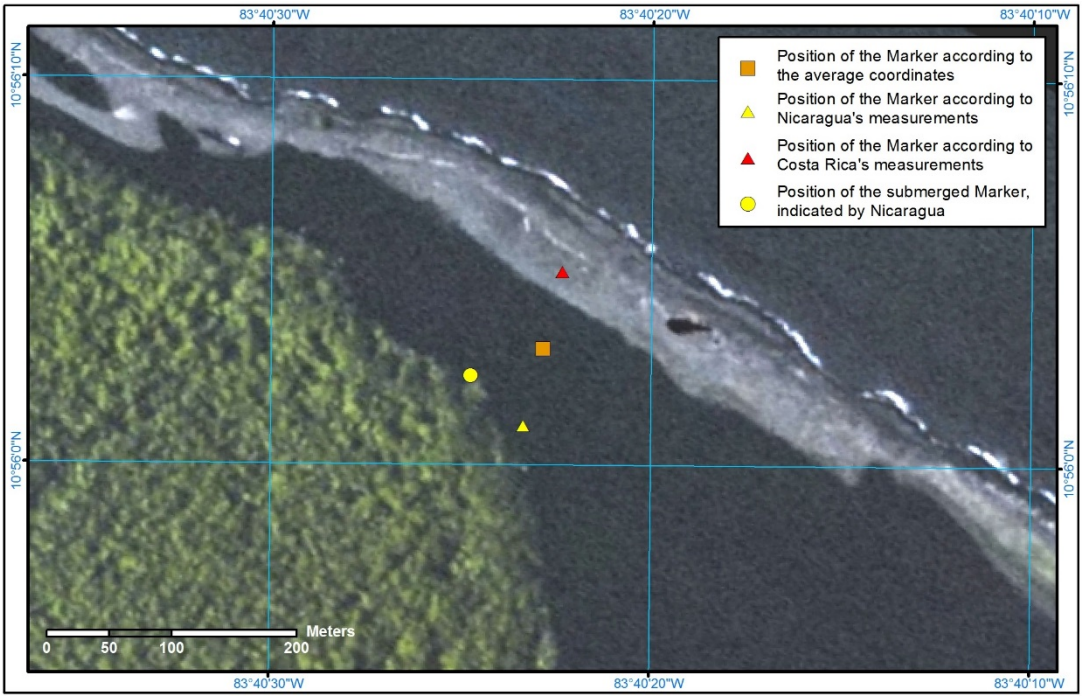

Figure 60. Projection on a satellite image from 2003 of the co-ordinates measured by Nicaragua and Costa Rica for the markers found in 2003 in the beach (square representing average co-ordinates and triangles the measurements of the Parties) and submerged in the lagoon (yellow circle).

Marker found on 26 November 2003 submerged in Los Portillos/Harbor Head Lagoon and measured by Nicaragua with a hand-held GPS device (83º 40' 24.4''N, 10º 56' 2.3''W) (**Fig. 57**)

165. During the second site visit, we investigated the area around the co-ordinates provided by Nicaragua for this marker using three approaches:

(1) Metal detector of the Nicaraguan delegation, despite the fact that the Proceedings of the Costa Rica-Nicaragua Demarcation Commissions do not specify whether the auxiliary markers were built with any iron element;

(2) GPR of the Costa Rican delegation (GSSI system with shielded 400 MHz antenna), acquiring a total of 12 profiles 27 m long (**Fig. 61**). These profiles with a spacing of 2 m, covered a rectangular area of around 600 m^2 (co-ordinates of corners: 207793.287/1209974.172; 207777.644/1209958.519; 207771.856/1209990.760; 207757.174/1209974.547; see **Figure 18**). The spacing of the profiles was adequate to detect a buried marker 0.8-1.2 m wide (see **Figure 55**), since the GPR system investigates a band that widens with depth. The width of the investigation footprint at a depth of 2 m would be around 0.8 m, considering a velocity of 0.1 m/ns for the propagation of the electromagnetic waves in sand (Conyers and Goodman, 1997; Neal, 2004). The GPR data was processed in the field and the anomalies were investigated by excavating a circular pit of about 2 m in diameter and driving in the ground iron rods 2 m long at a spacing of around 0.4 m. This approach did not provide a satisfactory result;

(3) A large area, mostly including the one previously investigated with the GPR (**Fig. 18**), was prospected perforating the ground with the 2 m long iron probes at a spacing of around 0.4 m (**Fig. 62**). The co-ordinates measured along the perimeter of the surveyed area are indicated in table 1 (Pp1-Pp13 of Nicaragua and Pp1-Pp9 of Costa Rica). In the upper part of the beach the ground was lowered around 1 m by excavating with shovel before using the probes. The few spots where the rods could not pierce the sand were checked by excavating with shovel without finding any sign of the marker.

Figure 61. GPR survey carried out in an area enclosing the co-ordinates measured by Nicaragua for the marker found in 2003 submerged in Los Portillos/Harbor Head Lagoon. A total of 12 GPR profiles 27 m long were acquired with a spacing of 2 m. Pink flags indicate the starting and end points of the profiles.

Figure 62. Partial view of the area investigated with GPR, metal detector and iron rods around a point established with the co-ordinates measured in 2003 by Nicaragua for the marker found submerged in the water. The sticks driven into the sand, with a spacing of around 0.4 m, mark the points investigated by probing with 2 m long iron rods. Excavations were carried out at the location of the GPR and metal-detector anomalies, as well as along the higher part of the beach, in order to introduce the probes at a lower elevation and increase the investigation depth.

Marker placed in the center of Plaza Victoria built with an iron pipe 40 cm in diameter and 2 m long fully embedded in the ground

166. The approximate location of this marker was estimated by georeferencing several historical maps (explained below). On the basis of the results of this analysis we defined an investigation area in the airport of San Juan del Norte, including a 180 m long section of the airstrip and the adjacent 25 m wide bands on both sides bounded by the airport fences. The co-ordinates of the corners of this investigation area (ca. 13,500 m^2) are indicated in **Table 1** (points PairNE, PairSE, PairNW, PairSW, see **Figure 9**).

167. The whole area was investigated with the metal detector provided by the Nicaraguan delegation (**Fig. 63**). All the anomalies, except those found in the airstrip made of reinforced concrete, were checked by excavating with pick and shovel. A large number of metal objects were found buried in the ground as deep as 0.8 m.

168. The whole area was investigated with the GPR provided by the Nicaraguan delegation, except a 60 m x 25 m zone associated with the SW corner of the investigation area due to problems with the batteries (co-ordinates: 204437/1208455, 204377/1208460, 204436/1208435, 204374/1208433, see **figure 9**).

169. The GPR profiles could show diffraction hyperbolas or local lateral changes in the diffraction pattern related to the iron rod of the marker or the foundation of the marker, respectively. The performance of this shallow geophysical technique is adversely affected by the presence of vegetation, clay, sediments with high moisture content and a shallow water table. The GPR data was acquired with a GSSI system and a 200 MHz antenna, adequate for the purpose of our investigation (**Fig. 64**). A total of 136 profiles were collected with a spacing of 1.55 m and an aggregate investigation length of 8.16 km.

170. This method proved very ineffective mainly due to the shallow water table, intercepted in some test pits at depths between 0.3 and 0.7 m, as well as the high moisture content and dense weed at the surface. Nonetheless, the anomalies identified in the GPR profiles were checked with the metal detector and by manual excavations obtaining negative results.

171. This investigation strongly suggested that the marker of Plaza Victoria was located in the area nowadays covered by the airstrip and that it was removed during the construction of the airport.

Figure 63. Survey with the metal detector of Nicaragua of the selected 180 m long portion of the airstrip at San Juan del Norte. Image taken during the second site visit on 13 March 2017.

Figure 64. Prospecting for the marker of Plaza Victoria in the airstrip of the San Juan del Norte airport with a GPR (Ground Penetrating Radar) of the Nicaraguan delegation using a 200 MHz shielded antenna. The vegetation in the northern flank of the airstrip was being cleared for GPR and metal detector surveying. Image taken during the second site visit on 13 March 2017.

d. Second investigation phase

172. Given that we were not able to find any of the markers recorded in the Proceedings of the Demarcation Commissions, the best approach for identifying the land point which most closely approximates the estimated position of the Initial Marker (Mojón Inicial) is: (1) locating the position of the center of Plaza Victoria by georeferencing historical maps; (2) calculating the location of the Initial Marker (Mojón Inicial) using the triangulation data of Proceedings X (distance of 4715.55 m and a geodetic azimuth of 244º 50' 23" measured counter-clockwise); and (3) determining the land point closest to this location.

i. Location of the center of Plaza Victoria

173. The geographic co-ordinates in the WGS84 system of the center of Plaza Victoria have been estimated using two historical maps:

— Map of Greytown Harbor of 1899, produced by the Nicaragua Canal Commission (provided by Costa Rica on 20 October 2016, **Fig. 65**). This map was selected because it includes co-ordinates, has sufficient degree of detail, is contemporaneous to the sketches included in the Proceedings of the Costa Rica-Nicaragua Demarcation Commissions (1987-1900), and shows the configuration of Greytown in concurrence with the Map of Greytown of 1888 (provided by Nicaragua on 20 October 2016, **Fig. 66**).

— Map of Greytown of 1888, in which Plaza Victoria is clearly visible and labeled (**Fig. 66**).

174. These historical maps have inaccuracies and distortions related to the old mapping techniques used, the scarcity of stable reference points in the constantly changing coastal environment, the varying mapping scales, and the distortion of the paper on which they were drafted. However, they provide sufficient information for locating the center of Plaza Victoria with an acceptable degree of accuracy for the objectives of our report.

175. Initially, the Map of Greytown Harbor of 1899 was georeferenced and imported to WGS84 and UTM 17N using already georeferenced basemaps and assigning co-ordinates to Ground Control Points (GCPs, common points recognizable in the already georeferenced basemaps and the map that needs to be georeferenced).

176. The main basemap used in this georeferencing step was the Map of San Juan del Norte of 1966, produced by the US Army using aerial photographs taken in 1960 (provided by Nicaragua and Costa Rica on 20 October 2016, **Fig. 67**). This map was previously georeferenced in NAD27 (North America Datum of 1927) and converted to WGS84 with ArcGIS v10.3 software. We also used as a basemap the satellite image of 18 December 2009 acquired by RapidEye sensor, which was already georeferenced when purchased from Digital Globe (**Fig. 68**).

177. The Map of Greytown Harbor of 1899 was georeferenced selecting eight GCPs (**Fig. 69**) and applying a linear (affine) transformation, obtaining a total Root Mean Square (RMS) error of 12.46 m. Despite the low number of GCPs and their uneven distribution, mostly concentrated in the western part of the map, the georeferencing was acceptable as indicated by the spatial correlation between the natural and man-made features represented in the 1899 Map of Greytown Harbor and the corresponding ones in the basemaps (**Figs. 70, 71, 72, 73**). The reliability of the georeferencing is also supported by the alignment of the co-ordinates measured in the site visits along the northern boundaries of the cemeteries with the southern edge of a street (**Fig. 71**), and the northern edge of the high vegetation south of the landing strip of San Juan del Norte Airport (**Fig. 73**).

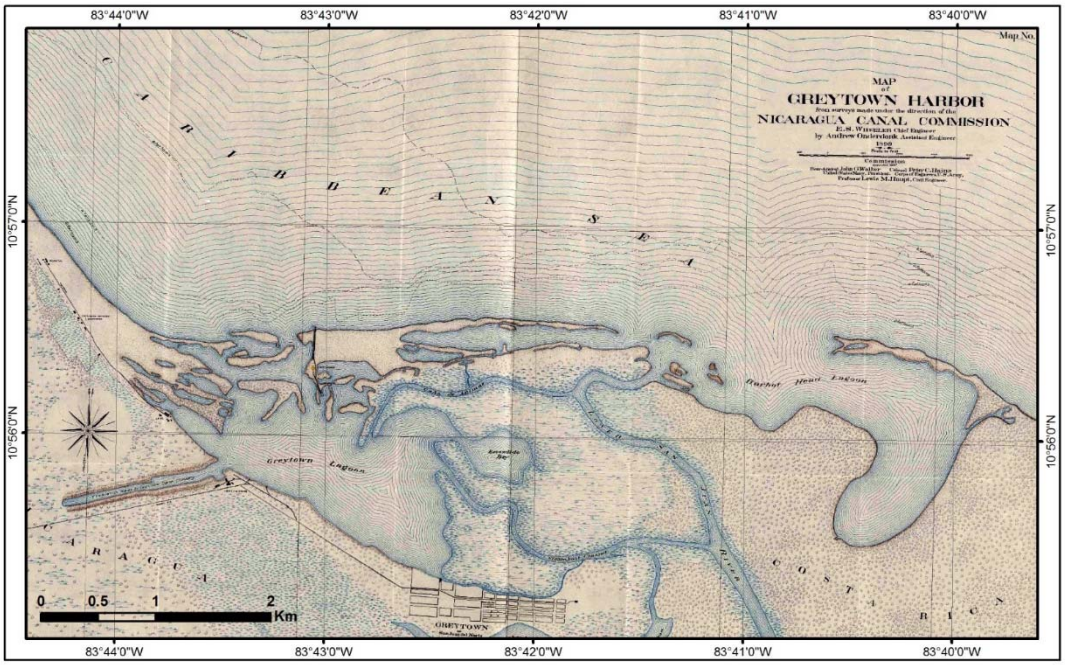

Figure 65. Georeferenced Map of Greytown Harbor of 1899, produced by the Nicaragua Canal Commission.

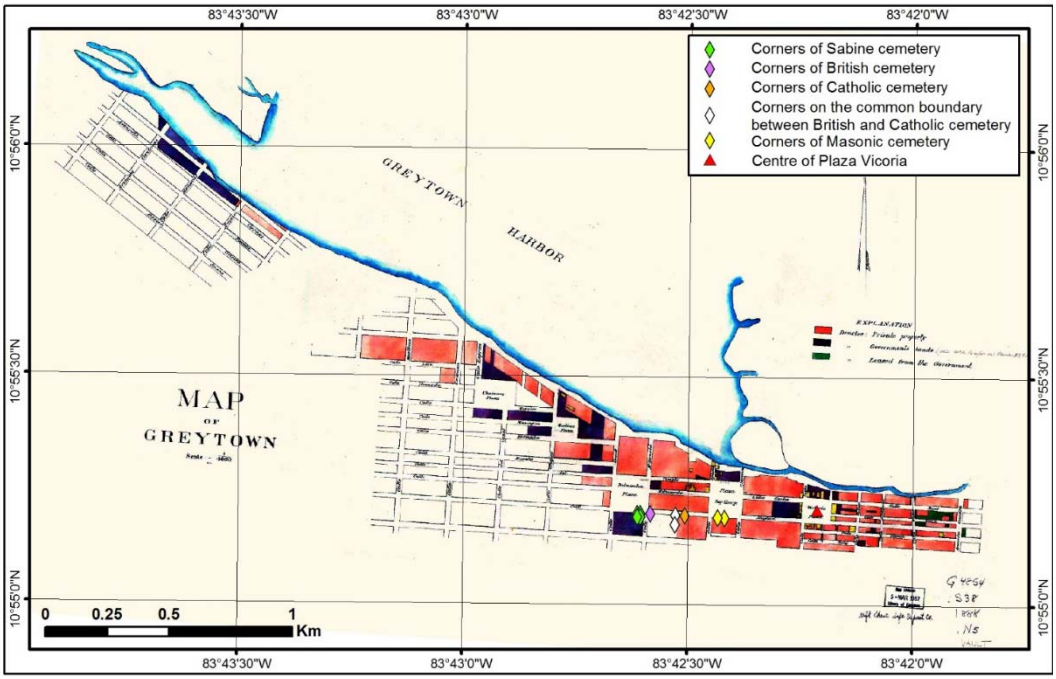

Figure 66. Georeferenced Map of Greytown of 1888 showing the center of Plaza Victoria and the corners of the cemeteries measured with GPS by the Parties.

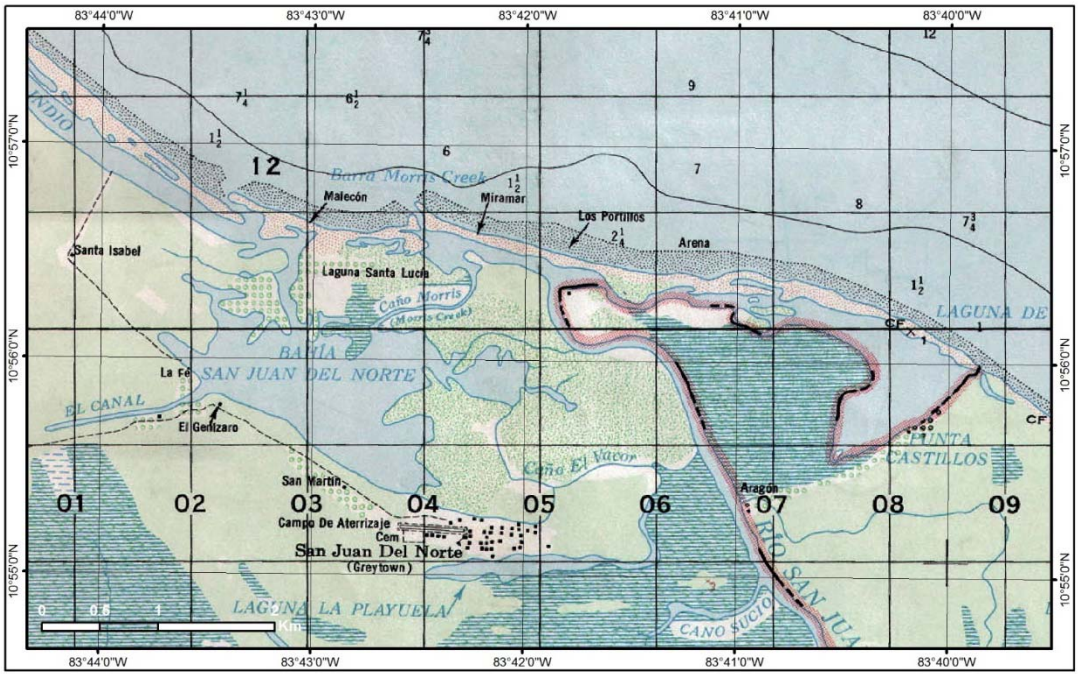

Figure 67. Georeferenced Map of San Juan del Norte of 1966 produced by the US Army, used as basemap for georeferencing the Map of Greytown Harbor of 1899.

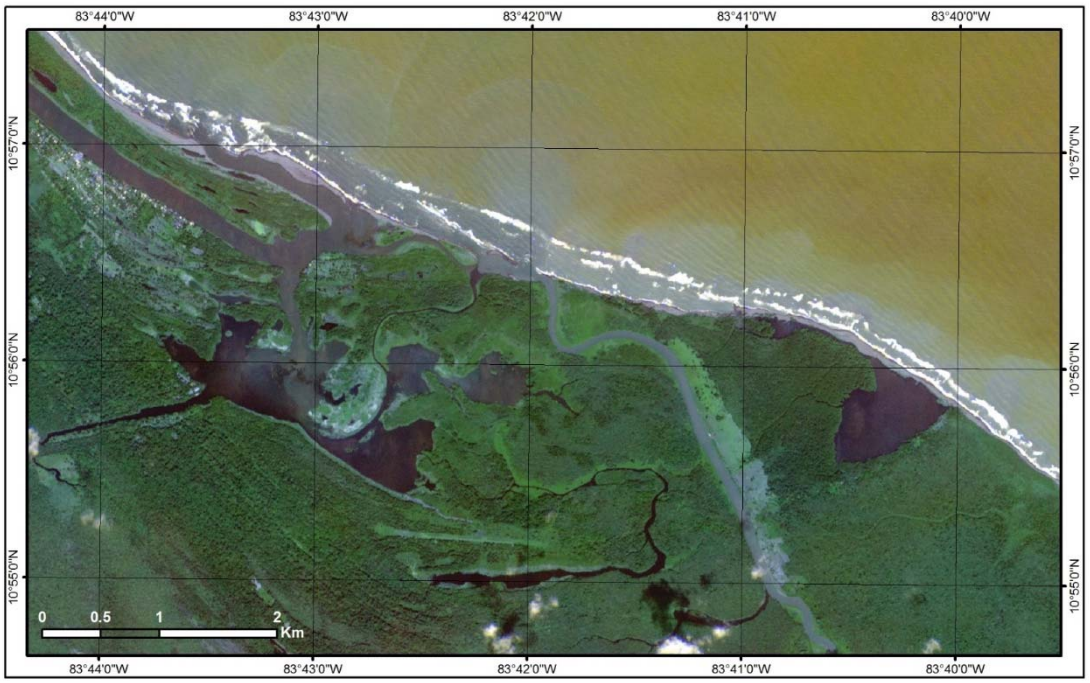

Figure 68. Georeferenced satellite image of 18 December 2009 acquired by RapidEye sensor, used as basemap for georeferencing the Map of Greytown Harbor of 1899.

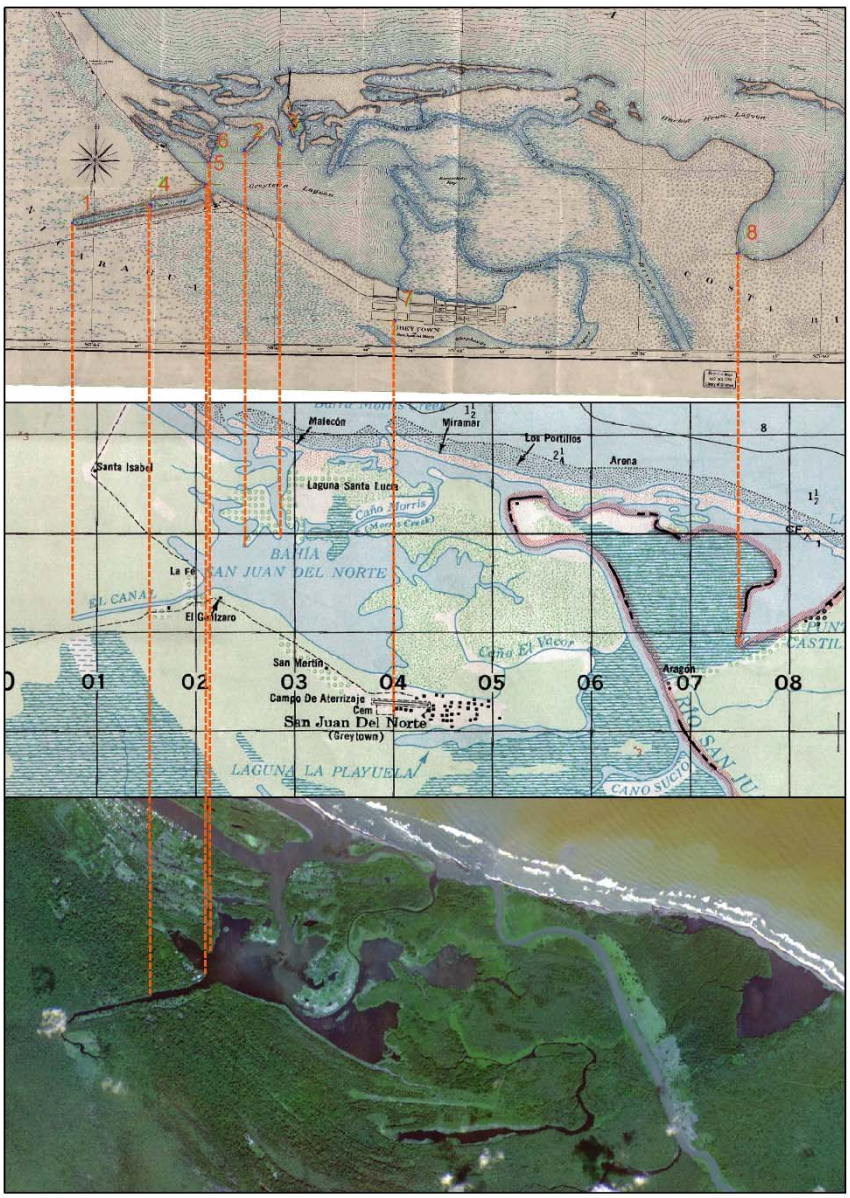

Figure 69. Ground Control Points used for georeferencing the Map of Greytown Harbor of 1899 (top) using as basemaps the Map of San Juan del Norte of 1966 (center) and a satellite image from 2009 (bottom).

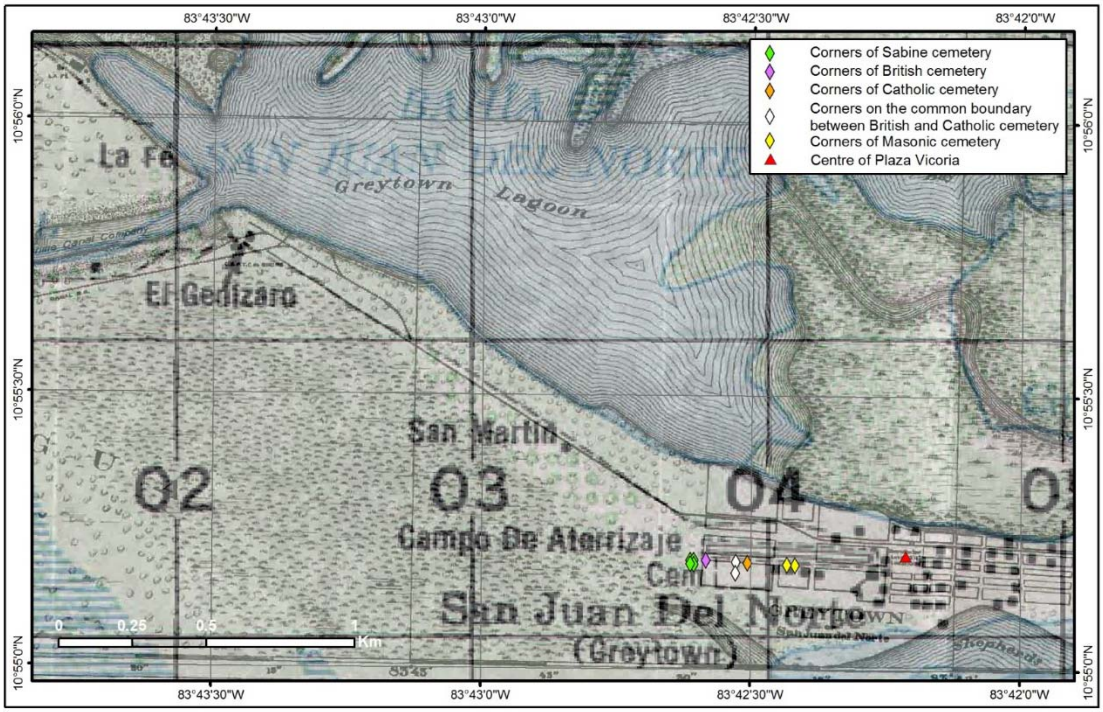

Figure 70. Transparent overlay of the Map of Greytown Harbor of 1899 on the Map of San Juan del Norte of 1966 with the corners of the cemeteries measured by the Parties, depicting the estimated center of Plaza Victoria.

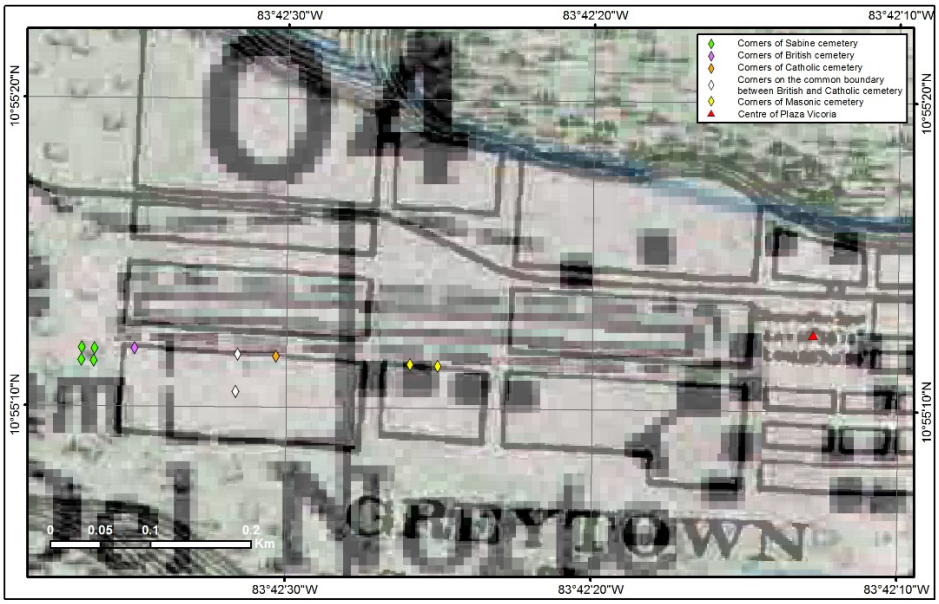

Figure 71. Transparent overlay of the Map of Greytown Harbor of 1899 on the Map of San Juan del Norte of 1966 showing the alignment of the corners of the cemeteries measured by the Parties with a street (enlargement of the previous figure).

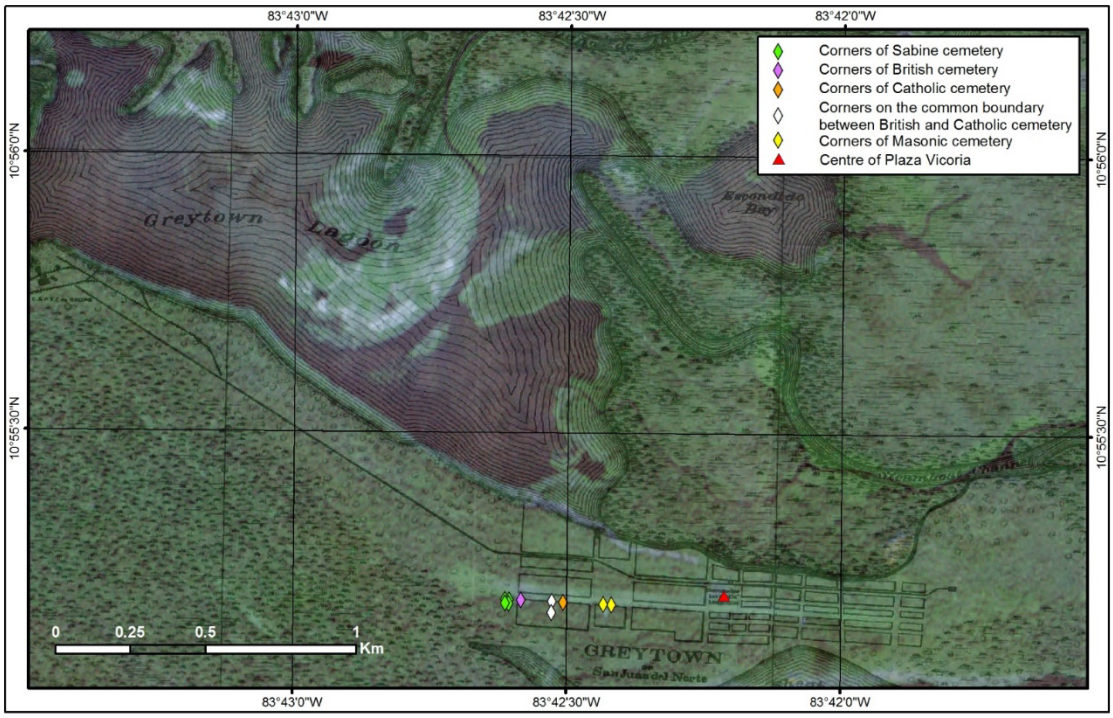

Figure 72. Transparent overlay of the Map of Greytown Harbor of 1899 on the satellite image of 2009 with the corners of the cemeteries measured with GPS by the Parties, depicting the estimated center of Plaza Victoria.

Figure 73. Transparent overlay of the Map of Greytown Harbor of 1899 on the satellite image of 2009 showing the alignment of the corners of the cemeteries measured with GPS by the Parties with the linear edge of the high vegetation south of the landing strip (enlargement of the previous figure).

178. The validity of the georeferencing was also checked using the map of Punta de Castilla of 1988 by the Instituto Geográfico Nacional of Costa Rica (produced with aerial images of 1961 and updated with images of 1987), which was georeferenced in NAD27 and converted to WGS84

(provided by Costa Rica and Nicaragua), the aerial images of 1961 and 1987 provided by Nicaragua, and the aerial image of 1961 provided by Costa Rica (**Fig. 74**). These aerial images were previously georeferenced using the satellite images of 2009 and 2016 obtained from Digital Globe.

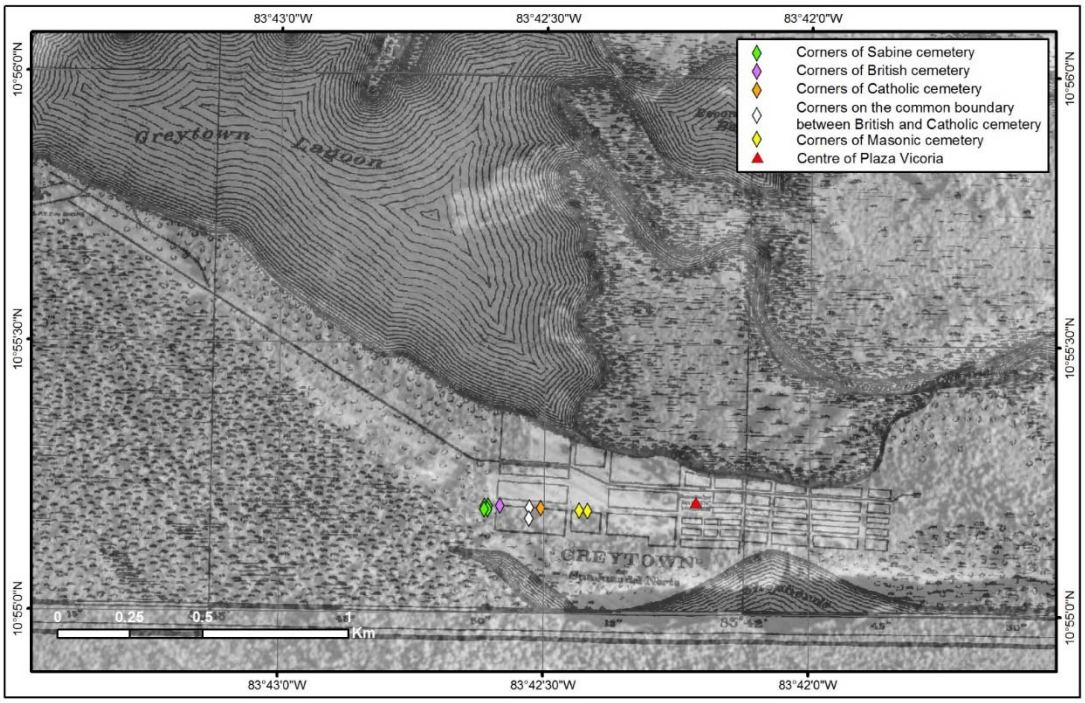

Figure 74. Transparent overlay of the Map of Greytown Harbor of 1899 on the aerial photograph of 1961 provided by Costa Rica, with the corners of the cemeteries measured with GPS by the Parties, depicting the estimated center of Plaza Victoria.

179. The precise position of the center of Plaza Victoria was estimated by georeferencing the Map of Greytown of 1888 (**Fig. 66**) using the previously georeferenced Map of Greytown Harbor of 1899 as a basemap. The configuration of the urban area is quite similar on both maps. The georeferencing was implemented using 20 evenly distributed GCPs in the urban area (**Fig. 75**) and applying a linear transformation, resulting in a total RMS error of 3.44 m.

180. The centroid of Plaza Victoria was positioned at 10°55'12.462"N, 83°42'12.413"W in WGS84, which is 204483.237 Easting, 1208469.486 Northing in UTM 17N. This point is located in the landing strip of San Juan del Norte, within the central sector of the area investigated with GPR and metal detector during the second site visit. An error margin of 20 m can be approximately estimated for these co-ordinates considering the accumulated errors of the two georeferencing steps and the errors associated with the historical maps (inaccuracies, distortion, scale). Overlays of the georeferenced Map of Greytown of 1888 on the 1961 aerial image (provided by Costa Rica on 20 October 2016) (**Figs. 76, 77**) and the 2009 satellite image (**Figs. 78, 79**) are shown below.

Figure 75. Map of Greytown of 1888 (top) and Map of Greytown Harbor of 1899 (bottom) indicating the 20 GCPs used for georeferencing the 1888 map and depicting the estimated location of the center of Plaza Victoria.

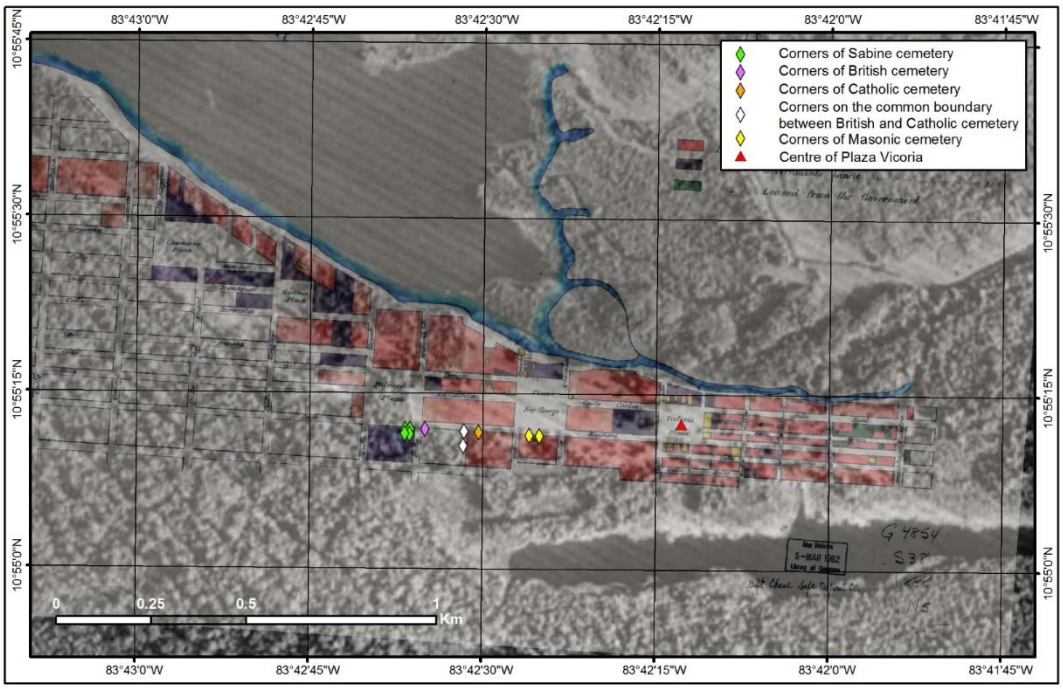

Figure 76. Transparent overlay of the georeferenced Map of Greytown of 1888 on a georeferenced aerial photograph of 1961, with the corners of the cemeteries measured by the Parties and the estimated center of Plaza Victoria.

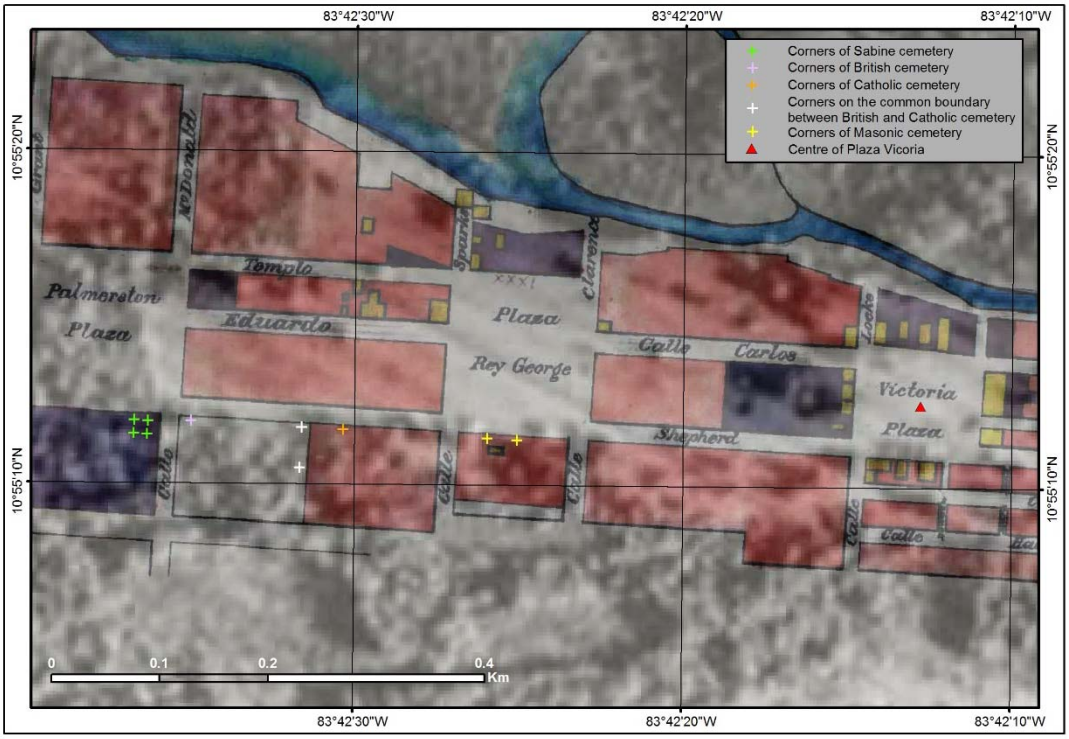

Figure 77. Transparent overlay of the georeferenced Map of Greytown of 1888 on a georeferenced aerial photograph of 1961, with the corners of the cemeteries measured by the Parties and the estimated center of Plaza Victoria (enlargement of the previous figure).

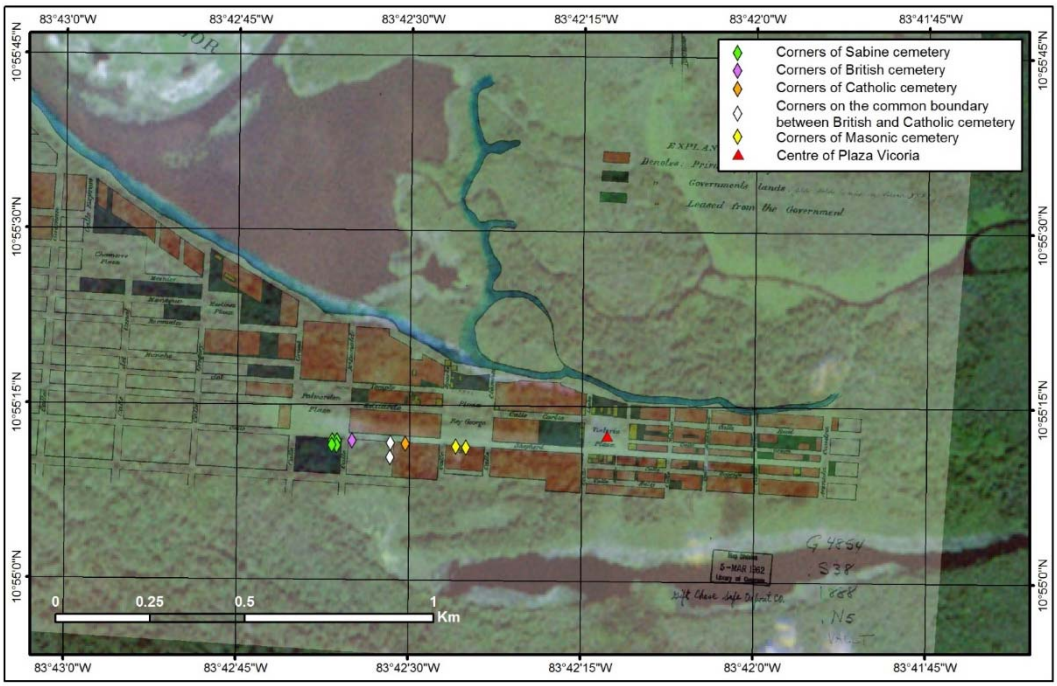

Figure 78. Transparent overlay of the georeferenced Map of Greytown of 1888 on the georeferenced satellite image of 2009 with the corners of the cemeteries measured by the Parties and the estimated center of Plaza Victoria.

Figure 79. Transparent overlay of the georeferenced Map of Greytown of 1888 on the georeferenced satellite image of 2009 with the corners of the cemeteries measured by the parties and the estimated center of Plaza Victoria (enlargement of the previous figure).

ii. Location of the Initial Marker (Mojón Inicial)

181. The co-ordinates of the Initial Marker (Mojón Inicial) were calculated using the Cartesian co-ordinates (4268.28 m. East, 2004.54 m. North) and polar co-ordinates (distance 4715.55 m., south azimuth 244°50'23") from the center of Plaza Victoria indicated in Proceedings X of the Demarcation Commissions (**Fig. 52**). The co-ordinates calculated for the Mojón Inicial are 10°56'18.898"N, 83°39'52.536"W in WGS84, corresponding to 208751.395 Easting, 1210474.312 Northing in UTM 17N (**Fig. 80**).

182. The co-ordinates of the rest of the points depicted in the triangulation sketch included in Proceedings X were also calculated following the same approach.

183. Subsequently, we calculated the co-ordinates of Punta de Castilla using the triangulation data between the Initial Marker and Punta de Castilla indicated in Proceedings XX of the Demarcation Commissions (**Fig. 81**). The co-ordinates calculated for Punta de Castilla are 10°56'21.191"N, 83°39'54.44"W in WGS84, corresponding to 208694.17 Easting, 1210545.321 Northing in UTM 17N. The error margin associated with the location of these points can be grossly estimated at 20 m.

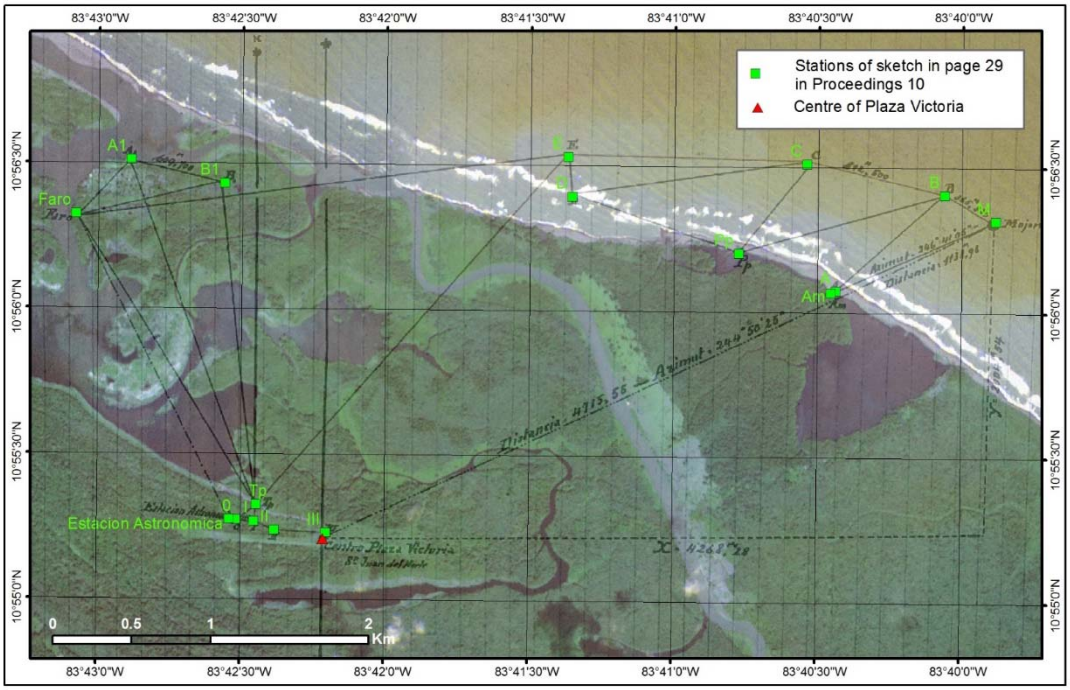

Figure 80. Transparent overlay of the sketch of Proceedings X of the Costa Rica-Nicaragua Demarcation Commissions (1897-1900) on the satellite image of 2009. The overlay was produced using the co-ordinates calculated for the center of Plaza Victoria and the triangulation data included in Proceedings X.

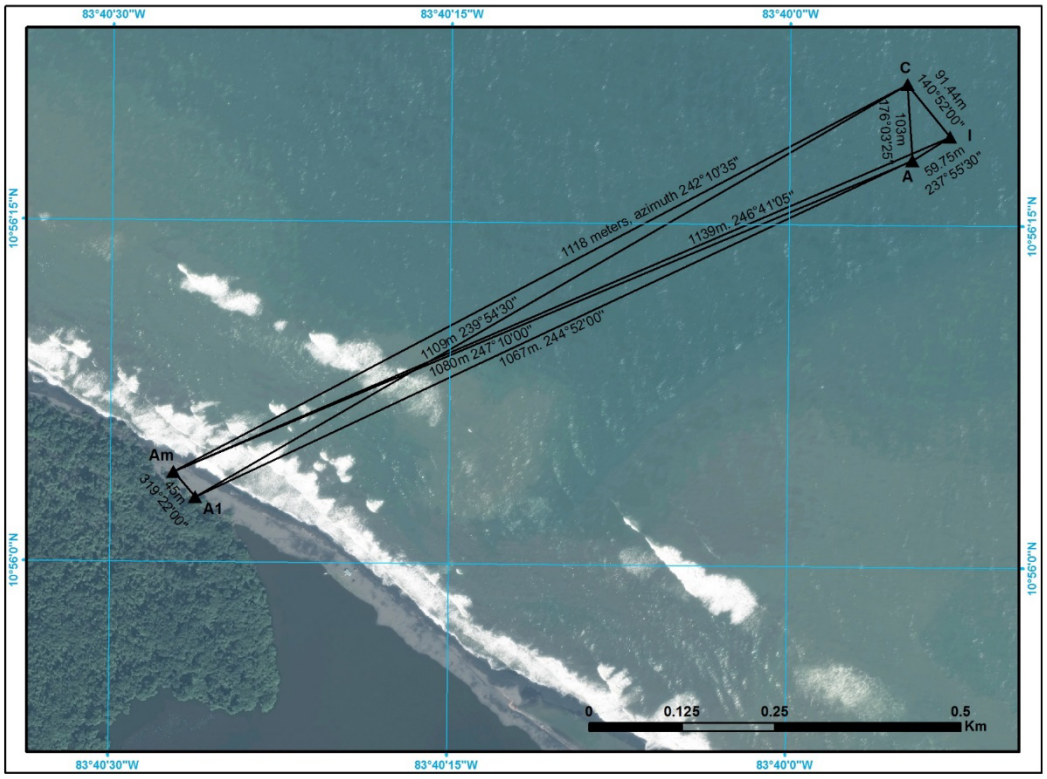

Figure 81. Triangulation sketch included in Proceedings XX of the Costa Rica-Nicaragua Demarcation Commissions (1897-1900) projected on a Worldview image of 2016. I stands for Initial Marker and C for Punta de Castilla.

iii. Land point which most closely approximates the Initial Marker

184. The closest land points to the locations estimated for the Initial Marker and Punta de Castilla have been determined using the most recent available satellite image of 22 January 2016. The closest land point to the Initial Marker is located at a distance of 909 m on the spit-barrier of Los Portillos/Harbor Head Lagoon at 10°56'18.898"N, 83°39'52.536"W in WGS84, or 208751.398 Easting, 1210474.305 Northing in UTM 17N (**Figs. 82, 83**). The closest land point to Punta de Castilla is located at a distance of 941 m on the spit-barrier of Harbor Head/Los Portillos Lagoon at 10°55'54.122"N, 83°40'8.93"W (WGS84), or 208246.568 Easting, 1209716.975 Northing in UTM 17N (**Figs. 84, 85**). The error margin in the location of those points is equivalent to the error margin estimated for the positioning of the Initial Marker and Punta de Castilla. Nonetheless, the position of the closest land points changes due to the frequent variations in the spit-barrier of Los Portillos/Harbor Head Lagoon.

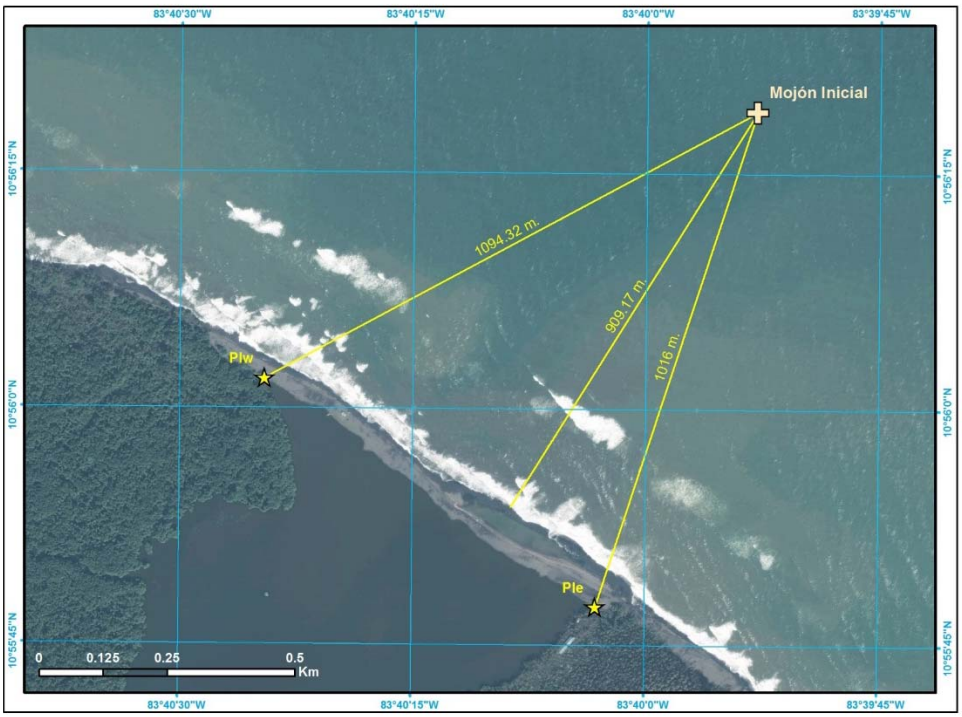

Figure 82. Distances between the location estimated for the Initial Marker to the closest land point on a satellite image from 22 January 2016 and points Plw and Ple measured during the first site visit.

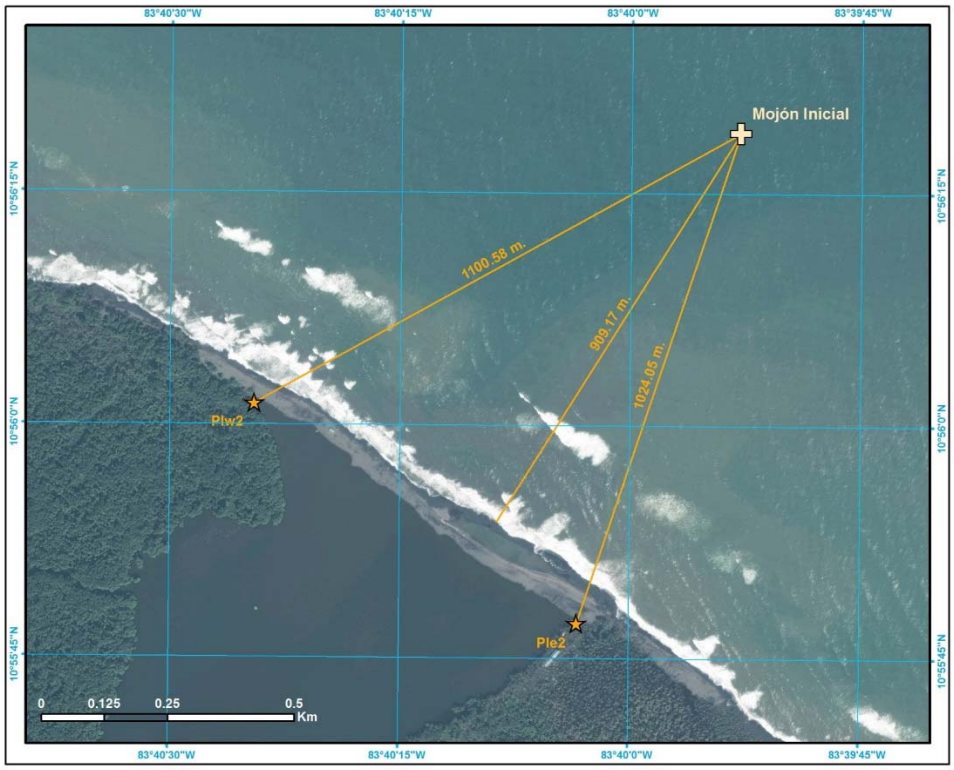

Figure 83. Distances between the location estimated for the Initial Marker to the closest land point on a satellite image from 22 January 2016 and points Plw2 and Ple2 measured during the second site visit.

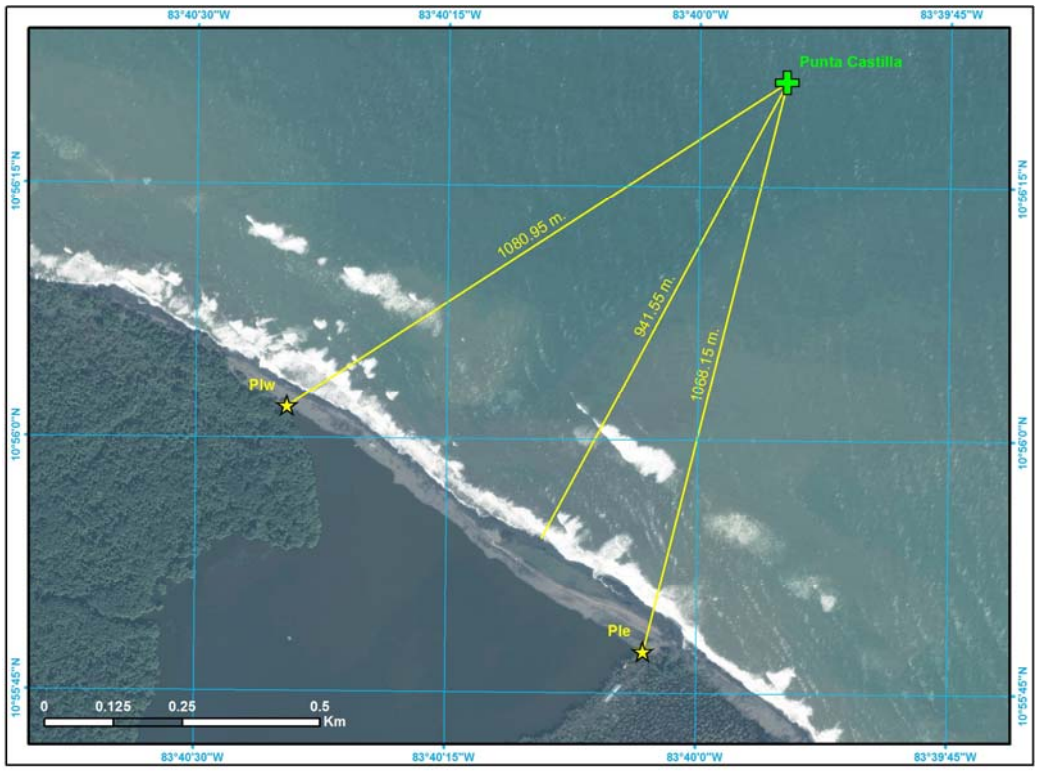

Figure 84. Distances between the location estimated for Punta de Castilla to the closest land point on a satellite image from 22 January 2016 and points Plw and Ple measured during the first site visit.

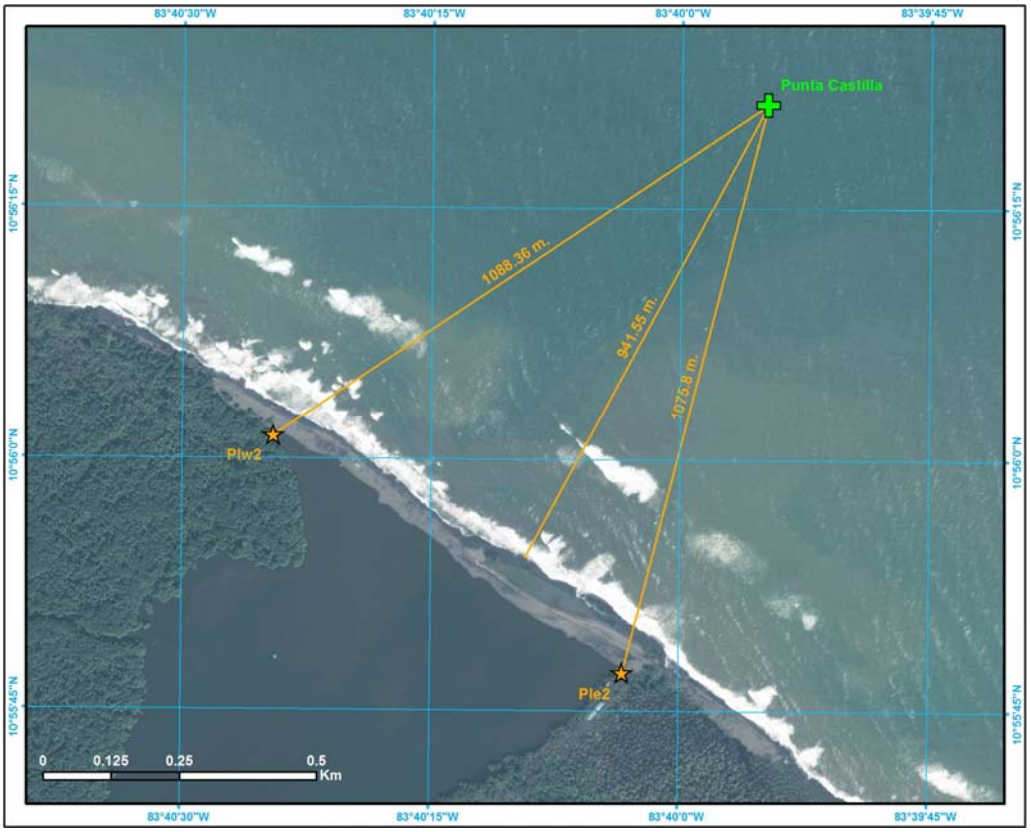

Figure 85. Distances between the location estimated for Punta de Castilla to the closest land point on a satellite image from 22 January 2016 and points Plw2 and Ple2 measured during the second site visit.

(3) Answer to the third question

185. In the Order of 31 May 2016, the third question put by the Court to the authors of the present Report read as follows:

> *"(c) Is there a bank of sand or any maritime feature between the points referred to in subparagraphs (a) and (b) above? If so, what are their physical characteristics? In particular, are these features, or some of them, permanently above water, even at high tide? Is Los Portillos/Harbor Head Lagoon separated from the sea?"*

186. Between the points referred to in questions (a) and (b), we have identified the following geomorphic features (described in section II.2) along the coastline during our site visits and using satellite images from multiple dates (**Table 3**, **Fig. 21**):

Acquisition date	Satellite sensor	Spatial Resolution (m)
18 December 2009	RapidEye	5
10 March 2011	Worldview2	0.5
26 November 2013	Worldview2	0.5
4 March 2014	Worldview2	0.5
26 September 2014	Worldview2	0.5
22 January 2016	Worldview3	0.5

Table 3. Satellite images provided by Digital Globe.

— **The sand spit-barrier that encloses or semi-encloses the Los Portillos/Harbor Head Lagoon** (Figs. 24, 25, 33, 37)

187. The observations carried out during out site visits and the available data (*e.g.*, satellite images, aerial photos) indicate that Los Portillos/Harbor Head Lagoon is commonly separated from the sea by the sand barrier. However, high energy waves related to storms or hurricanes can breach temporary channels in the barrier or in the beach allowing surface water circulation between the lagoon and the sea (**Figs. 29, 30, 31, 36, 37**).

188. During our first visit, Los Portillos/Harbor Head Lagoon was draining towards the sea through a channel breached around 200 m west of the northwestern corner of the lagoon, most probably opened by Hurricane Otto, which made landfall in the area on 24 November 2016 (**Figs. 29, 30, 31**).

189. During our second visit, the channel was closed (**Fig. 36**). The extent of the sand barrier is determined by the extent of the water body of the Los Portillos/Harbor Head Lagoon, which experiences slight changes governed by variations in the water level. The western edge of the lagoon and the sand barrier was measured during the first and second site visits, respectively, at points Plw (highest water level reached after Hurricane Otto; **Fig. 28**) and at Plw2 (**Fig. 34**). The eastern edge of the lagoon and the sand barrier were measured in the first and second site visits at points Ple (**Fig. 27**) and Ple2 (**Fig. 32**), respectively. Point Pleb (**Fig. 35**), measured in the second site visit, represents approximately the intersection between the shoreline at low tide and the projection of the northeastern corner of the Los Portillos/Harbor Head Lagoon perpendicular to the coast.

— **The coastal stretch of the portion of land designated in this Report as Isla Portillos and its beach (**Fig. 21**), which can be divided into three main sections with different characteristics, from east to west:**

(1) West of the northwest corner of Los Portillos/Harbor Head Lagoon there is section which was largely affected by active retreat in the first visit, including the channel that drained the lagoon (**Figs. 39, 40**);

(2) West of point 17P 0207176E 1210255N (WGS1984), the coast is made up of a broad sandy beach with discontinuous and coast-parallel enclosed lagoons in the backshore (**Figs. 41, 42**);

(3) In the westernmost portion, close to the mouth of the San Juan River, there are no lagoons with free-standing water in the backshore (**Fig. 43**).

190. Off the coastline, there are no features above water even at low tide, as it was observed during the two site visits. Some satellite images reveal the presence of coast-parallel shoals. These are the typical submerged sand bars that develop in the nearshore zone of sandy beaches by wave action.

(4) Answer to the fourth question

191. In its Order of 31 May 2016, the Court finally asked the authors of the present Report the following question:

"(d) To what extent is it possible, or probable, that the area concerned will undergo major physical changes in the short and long term?"

192. Multiple lines of evidence clearly indicate that the coast has experienced a rapid retreat in historical and contemporaneous times:

— General Alexander, in his first Award dated 20 December 1897, stated that *"[t]he exact spot which was the extremity of the headland of Punta de Castill[a] [on] April 15, 1858, has long been swept over by the Caribbean Sea, and there is too little concurrence in the shore outline of the old maps to permit any certainty of statement of distance or exact direction to it from the present headland. It was somewhere to the northeastward, and probably between 600 and 1,600 feet distant, but it can not now be certainly located."*

— On 13 June 1899, the Costa Rica-Nicaragua Demarcation Commissions recorded that "the monument that is the starting point in Harbor Head has been tipped over by the sea" (*Proceedings of the Costa Rica-Nicaragua Demarcation Commissions (1897-1900), Proceedings XVI*, reproduced at Ann. 8 of Nicaragua's Counter-Memorial). That monument had been placed on 23 December 1898 (*Proceedings of the Costa Rica-Nicaragua Demarcation Commissions (1897-1900), Proceedings XIV and XV*, reproduced at Anns. 6 and 7 of Nicaragua's Counter-Memorial).

— The cartographic sketch included in Proceedings X of the Costa Rica-Nicaragua Demarcation Commissions from 1898 was georeferenced in WGS84 using the co-ordinates calculated for the Initial Marker and the Cartesian and polar co-ordinates included in the Proceedings. The comparison of the georeferenced sketch with a satellite image from 2009 allows to roughly estimate a coastal retreat of 940 m on the east side of Los Portillos/Harbor Head Lagoon, yielding an average recession rate of around 8.5 m/yr (**Fig. 86**).

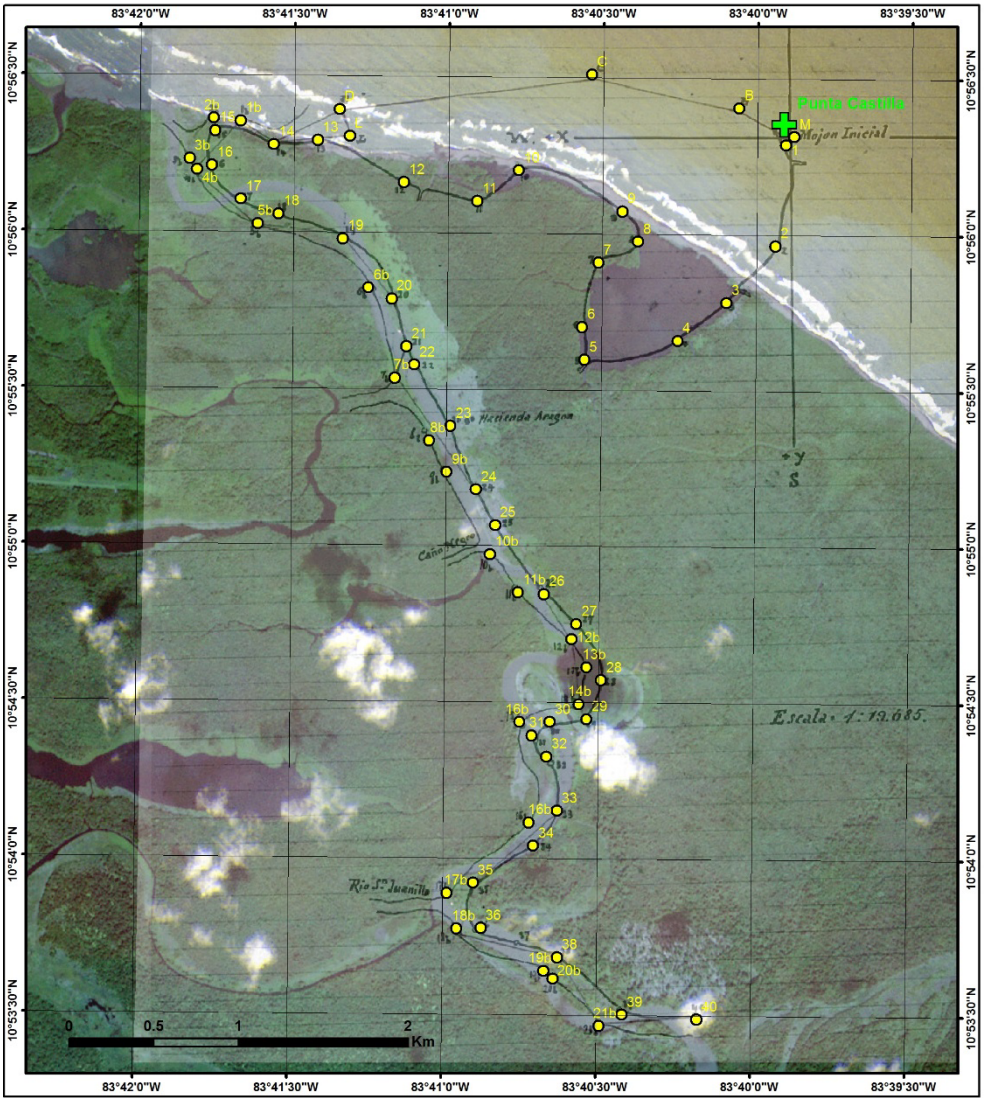

Figure 86. Overlay of the georeferenced sketch of Proceedings X of the Costa Rica-Nicaragua Demarcation Commissions from 1899 on a satellite image acquired in 2009, showing a coastal retreat of around 940 m on the eastern side of Los Portillos/Harbor Head Lagoon.

— **Figure 87** illustrates the position of the coastline mapped using satellite images from different dates (1940, 1961, 1981, 1987, 2002, 2009, 2016). It shows an overall rapid recession of the coastline.

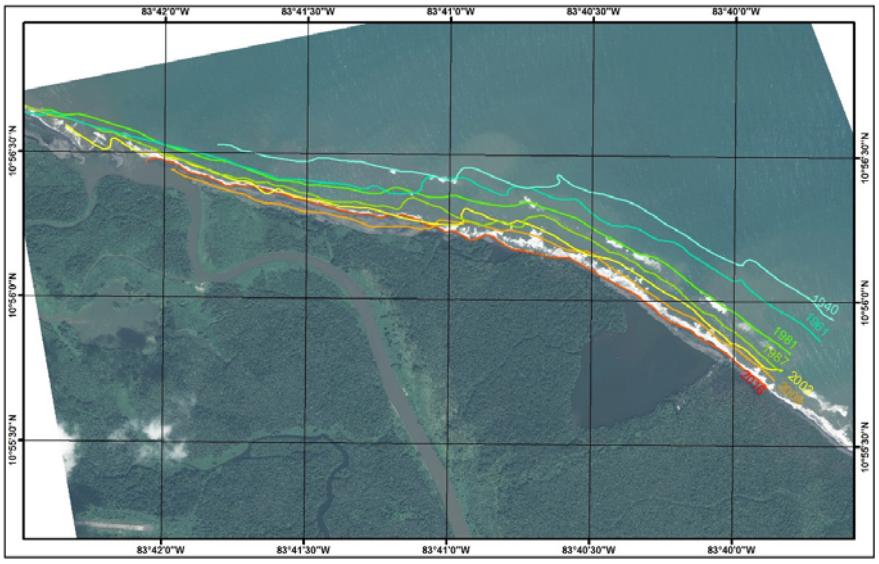

Figure 87. Satellite image from 2016 showing the position of the coastline mapped with images from multiple dates (1940, 1961, 1981, 1987, 2002, 2009, 2016).

193. This rapid coastal retreat is probably caused or favoured by the substantial reduction in discharge of the San Juan River at the expense of the Colorado River in 1861 (González, 1994). It is very likely that this trend will remain in the short and long term and that the coast will be affected by further retreat. The main physical changes that may result from the currently active coastal recession include:

(1) Reduction in the extent of Los Portillos/Harbor Head Lagoon, and eventually its disappearance;

(2) Eastward shift of the San Juan River mouth of around 1 km as a result of the eventual intersection between the coastline and the outer side of a meander currently located at ca. 300 m from the coast (**Fig. 88**).

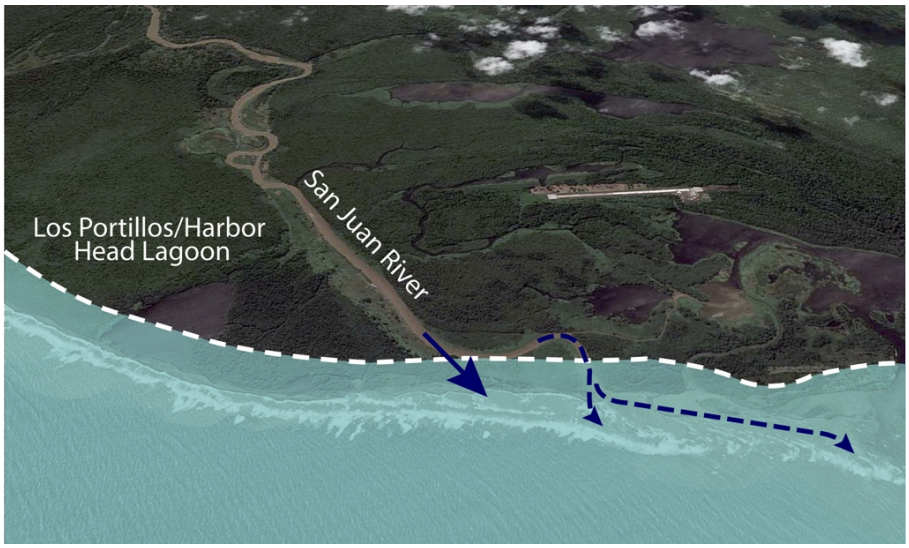

Figure 88. Hypothetical scenario considering a general 300 m retreat of the coastline. The mouth of the San Juan River could shift around 1 km to the east.

194. The spit of Isla Portillos at the mouth of the San Juan River will be affected by continuous changes like in the previous decades (**Fig. 44**) and as documented in our site visits (**Figs. 46, 47**). Most probably there will be periods of sediment accumulation and spit growth and periods of spit destruction mainly related to erosion caused by strong waves and fluvial currents. Such alterations in the spit will be accompanied by shifts in the position of the San Juan River mouth.

195. Other potential physical changes to take into consideration include sharp deviations in the path of the San Juan River (avulsion) taking advantage of secondary channels (*caños*) located on its right margin in Isla Portillos and the topographic depression of Los Portillos/Harbor Head Lagoon (*i.e.* the lagoon might become the mouth of the river).

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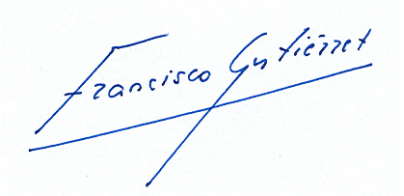
This Report was drawn up in English in one copy on 30 April 2017.

Eric Fouache



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