REPORT ON FIELD WORKSHOP

SUSTAN and BELUCHISTAN PROVINCE

SOUTHEASTERN IRAN

09 − 19 October 2010

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The "Mars Mountains" of Beluchistan
Coastal Highway — Beris to Lipar
Thursday, 14 October 2010

Report on Field Workshop, Sistan and Beluchistan Province, Southeastern Iran

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This field workshop was organized under the auspices of UNESCAP in the aftermath of the previous workshop, held in Tehran from 01 to 05 May 2010. The goals of the field workshop were (i) to obtain testimonies from elderly witnesses of the 1945 Makran tsunami and organize them into a homogeneous scientific database; and (ii) to explore the possibility of obtaining, through trenching, paleotsunami data regarding both the 1945 event and any possible predecessors. In addition to these fundamental goals, information was also gathered regarding the effects of the 2004 Sumatra tsunami, as well as of extreme meteorological events, such as Cyclone Gonu in 2007.

The team assembled in Tehran on 09 October 2010. Trainers included Professor Emile A. Okal (France; Northwestern University), Professor Hermann M. Fritz (Switzerland; Georgia Institute of Technology), Professor C.P. Rajendran (India; Center for Earth Science Studies), Dr. Eko Yulianto (Indonesian Institute of Science), and Mr. Majid Shah-Hosseini (Iran; CEREGE).

For logistical reasons, the team split into two groups. One group, led by Professor Okal and comprising Mr. Mohammad Ali Hamzeh and Professor Javad Ghasemzadeh operated from a base at the Research Station of the Iranian National Institute of Oceanography in Chahbahar, and focused exclusively on surveying the 1945 tsunami along the coast of the Province of Sistan and Beluchistan. The second group, led by Professor Fritz, operated in the Province of Hormozgan, and focused on the paleotsunami and meteorological aspects. The present report is limited to the activities of the Chahbahar group.

Reconstructing the 1945 tsunami in Sistan-and-Beluchistan Province

Professor Okal and Mr. Hamzeh flew from Tehran to Chahbahar in the morning of Sunday, 10 October. Field work started in the afternoon, following a visit to the Research Station.

General Remarks

While we tried very hard to recover information about our witnesses, the question of their age often remains unresolved. Several witnesses claiming to be in their early sixties, had unquestionably vivid memories of the tsunami which should then have predated their birth. By contrast, younger family members had a general tendency to extrapolate the age of their elderly relatives, one adolescent even describing his grandfather as being 100 years old while offering him a sporty ride on his moped; in our opinion, this witness was probably in his early seventies, as suggested by his status as a bachelor at the time of the 1945 tsunami. It is with such reservations that we offer estimates of the age of our witnesses.

Similarly, the times given by witnesses for the observation of natural phenomena are generally approximate. Whenever possible, we attempted to ascertain them using reference activities (e.,g., morning prayer).

Tiss

On Sunday afternoon, 10 October, we visited the jetty in the port area of Tiss, a suburb of Chahbahar. We met a fisherman in his sixties, who related the story of his late father who had observed the water running up in the drainage channel of the village of Tiss, across the bay, up to the vicinity of the village mosque (Figure 1). This transect was surveyed on Monday, 11 October, with a run-up of 1.65 m and an inundation of 1289 m **(Site Number 01).**

An additional testimony, not directly relevant to the Iranian survey, was obtained from a 62−yr. old man who had heard from a sailor who had been in Jiwani (on the Pakistani side of the border) during the 1945 tsunami, and witnessed the emergence of a new island, to a reported height of 15 m above sea level; this island is said to be gradually coming down now.

Regarding the 2004 Indonesian tsunami, we obtained the testimony of Mr. Abdalghani Siahuee, who described an anomalous sound around 11 a.m. (07:30 GMT), followed an hour later by flooding of the jetty up to a[n uncorrected] height of 3.35 m **(Site Number 21)**, resulting in several boats breaking their moorings.

Konarak

On Tuesday, 12 October 2010, we traveled to the western shores of the Bay of Chahbahar, home of the major fishing community of Konarak, and later to the port of Pozm.

A first witness gave us a precise report of the inundation of the 1945 tsunami reaching to the middle of the block past the mosque, and related that the water penetrated into a house adjacent to the mosque, disrupting a week-long wedding ceremony. The witness remembers being about 12−13 years old at the time, but claims to be only 67 in 2010.

A second witness confirmed inundation of the mosque, but was clearly confused in terms of dates, claiming to have been in his twenties at the time, but only 60 years old in 2010.

A third, and in our opinion more reliable, witness confirmed that the water penetrated the mosque, disrupted morning prayers (estimated around 4 a.m. local time), broke windows and left a few people injured with broken limbs, although no deaths were known to him in Konarak. One month later, he traveled to Pasni and Ormora (in Pakistan), where the city had been totally destroyed. This witness claimed to have been 20 to 25 years old at the time and to be in his eighties now.

The combination of these testimonies is translated into a surveyed run-up of 3.05 m and an inundation of 52 m **(Site Number 02;** Figure 2**).**

Regarding the 2004 tsunami, witnesses indicating flooding to the front of the coastal road, for a run-up of 2.20 m and an inundation of 26 m **(Site Number 22)**.

Pozm

We could not find witnesses of the 1945 tsunami in Pozm, where the 2004 tsunami was remembered by a number of witnesses on the port jetty. The latter, measured at 1.80 m above sea level, was not flooded to its top. In the village (Figure 3), a witness indicated that his boat, which he was cleaning, was beached during the ebbing phase, and later floated back. At the estuary of the river, the sea ran up to 1.10 m on the local beach **(Site Number 23)**, and 1.95 m on a bluff near the town schoolyard **(Site Number 24)**.

Chahbahar

Thanks to proactive groundwork by Mr. Hamzeh prior to the survey, we were able to interview several reliable witnesses in the city of Chahbahar itself on Monday, 11 October (Figure 4). Among them, we had a long interview in his house with Mr. Rahmat Khodadian, who claims to be 75 years old, clearly a very educated person, who indicated an arrival of the waves around 03:30 a.m., and an inundation reaching to the present location of the Bank Melli, near the downtown beach. This location **(Site Number 03)** was surveyed on 13 October for a run-up of 3.65 m and an inundation of 367 m. The witness mentioned as his only known ancestral memory of major inundation following an earthquake a case "about 200 years ago in India", which is most probably the 1819 earthquake in Gujarat, during which the Rann of Kuchchh was flooded, but without generation of a genuine tsunami by this continental earthquake. This observation reinforces the absence of ancestral memory from true tsunamigenic events other than the 1945 one along the Makran coast. Mr. Khodadian also mentioned that the telegraph cable (presumably from Europe) was not severed in Chahbahar, by contrast with the situation farther East, as reported in the Indian press, suggesting that the Indian cable was cut by a local submarine landslide.

We also interviewed a female witness, aged about 13 at the time of the tsunami, who recalled the destruction, by the waves, of straw houses in the low lands neighboring the beach, resulting in several fatalities, a description which would generally agree with the run-up surveyed at Site Number 03.

During the 2004 Indonesian tsunami, the main cargo harbor of Chahbahar saw some 500-ton boats break their moorings and wander inside the harbor, reportedly around 5 p.m. local time, *i.e.,* 13:30 GMT or 5 to 6 hours after the arrival of the first waves. These episodes are reminiscent of similar effects in Toamasina, Madagascar; Le Port, Réunion; Dar-es-Salaam, Tanzania, and Salallah, Oman. They are attributable to the arrival of higher frequency components of the tsunami, dispersed outside the shallow-water approximation, and capable of setting ports in resonance.

Ramin

Ramin is a village located 12 km East of Chahbahar on the coastal highway. It is built at an altitude of about 15−20 m, behind dunes topping at an estimated 40 m. It features an improved harbor, next to a small beach which drains a river bed (dry at the time of our visit). To the East, the coast transforms into a series of cliffs, on which a large number of imbricated boulders (Figure 5) have been deposited by catastrophic ocean waves, whose origin (tsunami or cyclone) remains unclear. We identified a witness who reported to us that the boulders were reached by the 1945 tsunami, but that they had been present before. We interpret this information as a splash on the cliff at a height of 7.15 m **(Site Number 04).**

Lipar

Lipar is a small community located at the mouth of a major river (also named Lipar) which drains a vast hinterland plain, capable of retaining some water in the form of intermittent lakes and marshes after heavy precipitations, following the building of a levee damming the Lipar. The coastal road crosses the valley on an artificial causeway. Lipar is presently inhabited by about a dozen people, but in 1945, a community existed at the foot of the cliffs, some 3 km inland.

We identified as a witness Mr. Ghalamhossein Dadshahpour, who used to live in Lipar but now living in Ramin, who remembered being in his early teens at the time of tsunami (and claims to be 73 years old in 2010). We drove him in our field vehicle to the beach in Lipar,

where he guided our survey (Figure 6). He described three big waves coming in "the early morning", and which carried boulders from the sea to the berm at the estuary (lately covered with sediments). Based on his recollections, we measured **(Site Number 05)** a run-up of 2.80 m for an inundation of 540 m, to the present huts (which did not exist in 1945); the tsunami penetrated some 3−4 km inside the river bed (now beyond the damming levee).

Beris

On Thursday 14 October, we traveled to the easternmost part of the shoreline, and visited the communities of Beris and Pasabandar. Because of security constraints, it was not possible to pursue the survey East of Pasabandar in the immediate vicinity of the Pakistani border (distant only 20 km at this point), but it is doubtful that any elderly witnesses could have been found in Gavater given that the area has seen development only recently, in the form of an extensive shrimp farm.

Beris is a fishing port established in a natural bay sheltered by a prominent headland. The main village is, at least at present, established behind the headland, at an altitude of about 50 m, but in 1945, some people lived in huts on the low lands in the vicinity of the beach. Our witness, Mr. Khaled Baluch remembers being about 10 years old at the time of the tsunami, but claimed to be 80 to 90 years old; a more probable figure being about 75 (Figure 7). He recalled that the earthquake was indeed felt, but weakly, around 1 a.m. (a remarkable estimate, the correct time being 1:30 a.m. GMT+3:30), and that three waves came 3 to 4 hours later. Ships in the harbor were smashed against each other, breaking anchorages. Mr. Baluch had no knowledge of any ancestral memory of similar events going back at least three generations. His descriptions were corroborated by a second witness, Mr. Khalil Taherat, said to be 82 years old, who confirmed three waves reaching to the front of the beachside mosque. This point **(Site Number 06)** was surveyed for a run-up of 5.60 m and an inundation of 212 m.

In 2004, currents in the port resulted in the break-up of a vessel which had remained docked; the others boats were at sea at the time.

Pasabandar

This is the last important fishing village before the Pakistani border. The village is built on an uplifted promontory reaching an estimated altitude of 25 to 30 m above sea level. We obtained a testimony from Mr. Adam Baluch, obviously an educated man, fluent in Arabic, and who recalled being about 12 years old at the time of the tsunami (which essentially agrees with his claimed age of 76 years). He described three waves coming at dawn (around 4 a.m.), splashing about midway up the promontory **(Site Number 08)**, at an altitude surveyed at 13.9 m, and 61 m from the sea. He further described the water as reaching to the base of the hills along the road to Gavater. This point **(Site Number 07)** was estimated at an altitude of 10 m, for an inundation of 660 m, measured to the nearest point of coastline (Figure 8). Mr. Baluch further commented that the waves reached up to 10 km inland along the river bed.

Regarding the 2004 tsunami, the wharf at Pasabandar was not inundated, corresponding to a flow depth of 1.0 m, based on a description by a number of witnesses **(Site Number 25)**.

Tang

Finally, on Friday 15 October, we explored the Western part of the province in the communities of Tang and Bir Daf. In neither of them, could we find witnesses of the 1945 tsunami. In Tang, the only elderly man in town, Mr. Shahul Neshat, claiming to be 75 years

old, could not remember any such event. By contrast, in 2004 several witnesses described 3 waves arriving in late morning which deposited a boat at the maximum storm surge water mark, and sank another one during an ebbing phase. Based on these witnesses' testimony, we surveyed a run-up of 1.1 m for an inundation of 229 m at this location **(Site Number 26)**, protected by a barrier island (Figure 9).

Bir Daf

To the West, the community of Bir Daf is built 1.5 km inland. The beach slopes quickly to a berm of dunes (Figure 10). A witness described to us the arrival of 2 waves, around 8 a.m. (which is probably erroneous), and a run-up half-way up the berm, to a height of 3.8 m, for an inundation of 35 m **(Site Number 27)**.

Additional data points from the Western Group

We include in this report data points surveyed by the Western team led by Professor Fritz. The team obtained one witness report of the 1945 tsunami at Souraf **(Site Number 09;** Figure 11**)** and 4 reports for the 2004 events **(Site Numbers 28−31)**.

Data Processing

All the data points listed in this report were surveyed using a hand-held GPS device. The exact time at which the survey took place was recorded to allow a tidal correction. The latter made use of the tidal computation algorithm on the web site of the French Service Hydrographique et Océanographique de la Marine, by averaging the tidal computations available for Muscat, Oman and Karachi, Pakistan.

The entire dataset for 1945 is appended as Table 1, that for 2004 as Table 2. The datasets are presented graphically on Maps 1 and 2.

Other Activities

- *Seminar at Chahbahar Maritime University*

  On Saturday evening, 16 October 2010, and at the invitation of Professor Ghasemzadeh, Professor Okal gave a lecture introducing the general concepts of tsunamis, their effects and the role of scientists in their mitigation, to a group of several students in a large auditorium of the University. This lecture, translated in real time by Dr. Ghasemzadeh, was followed by a questions-and-answers session, lasting until 10:30 p.m.

- *Keep Clean the Beaches*

  On Sunday, 17 October 2010, Professor Okal joined his Iranian colleagues on the beaches to the East of Chahbahar, where school children were involved in a clean-up effort of accumulated garbage (Figure 12). On this occasion, he gave a short lecture about the resilience of plastic components as a threat to the food chain, both to the children and to a local television station.

All the participants in the field workshop flew back to Tehran on Monday, 18 October. A debriefing session (Figure 13) was held at the Iranian National Institute of Oceanography on Tuesday 19 October, where the initial results of the field work were presented, and certificates awarded to all participants.

Conclusions

- We were able to build a set of 9 data points for the 1945 Makran tsunami. While most run-up values are in the 3−m range, they ramp up to significantly higher values near the Pakistani border.

  It is clear that this study would benefit from being extended to the Pakistani side of the border, where the testimony of witnesses who were on travel in Pakistan in 1945 confirms a much higher level of inundation and destruction.

- The witnesses generally described a series of three waves, arriving between 3:30 and 4:30 a.m. In this respect, the phenomenon is clearly delayed with respect to direct propagation from the epicentral area. This delay would be compatible with the generation of the tsunami by an ancillary phenomenon, such as an underwater landslide. It could also be attributable to propagation as an edge wave on the continental shelf.

  In a most remarkable testimony, one witness recalled feeling the earthquake "around 1 a.m. (21:30 GMT)" in Beris. The earthquake took place at 21:56 GMT and its shear waves would have been felt in Beris within one minute of occurrence.

- The witnesses we interviewed did not possess any ancestral memory of comparable events prior to the occurrence of the 1945 tsunami. By contrast, one of our witnesses expressed a memory of the distant earthquake of 1819 in the Rann of Kuchchh. This would suggest that the Makran earthquake of 1851, reported by Ambraseys and Melville [1982] to have occurred to the West of the 1945 shock, was of comparably lower magnitude.

- The 2004 Sumatra tsunami had significant run-up, in the 3−4 m range, along the whole surveyed segment of coastline. It involved delayed response effects in the port of Chahbahar, due to the dispersed arrival of the higher frequency components of the tsunami.

Acknowledgments

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In addition, we gratefully acknowledge the support of the Iranian National Institute for Oceanography, particularly its Director, Dr. Vahid Chegini, as well as Mr. Majid Naderi, Mr. Nima Kiani and Ms. Fahimeh Foroughi in Tehran. In Chahbahar, we are grateful to our host at the Research Station of INIO, Mr. Mohammad Ali Hamzeh and his staff, in particular our driver, who took a personal interest in the project, and provided translation from the Beluchi language during our interviews. We thank Professor Javad Ghasemzadeh for his welcome at the Chahbahar Maritime University, in particular for arranging the seminar.

TABLE 1: Dataset for 1945 Makran tsunami

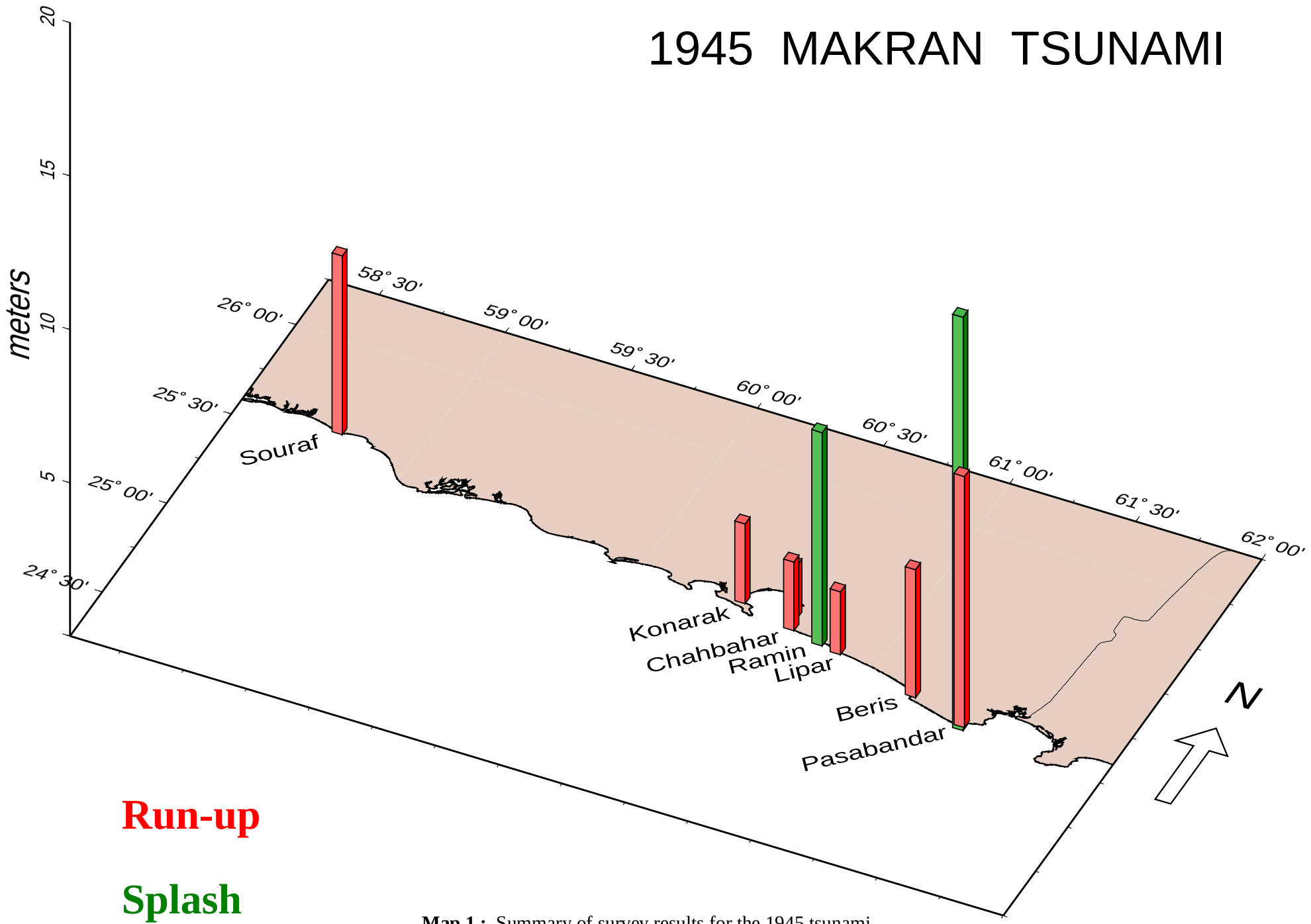
Number	Latitude	Longitude	Vertical amplitude (m)		Nature	Inundation	Date and time	Location
			Raw	Corrected	(†)	(m)	surveyed (GMT)	
01	25.35663	60.60562	2.00	2.01	R	1289	11-OCT-2010 05:50	Tiss
02	25.35383	60.40205	3.05	3.04	R	52	12-OCT-2010 07:25	Konarak
03	25.29643	60.62480	3.65	2.62	R	367	13-OCT-2010 12:08	Chahbahar
04	25.26528	60.75295	7.15	6.96	S		13-OCT-2010 07:59	Ramin
05	25.25090	60.83202	2.80	2.39	R	540	13-OCT-2010 06:26	Lipar
06	25.15668	61.17877	5.60	4.87	R	212	14-OCT-2010 11:54	Beris
07	25.08618	61.40825	10.00	9.55	R	660	14-OCT-2010 10:10	Pasabandar
08	25.06988	61.41115	13.90	13.48	S	61	14-OCT-2010 09:43	Pasabandar
09	25.57596	58.69028	7.00	6.80	R	406	13-OCT-2010 07:58	Souraf

† R: Run-up; S: Splash

TABLE 2: Dataset for 2004 Sumatra tsunami

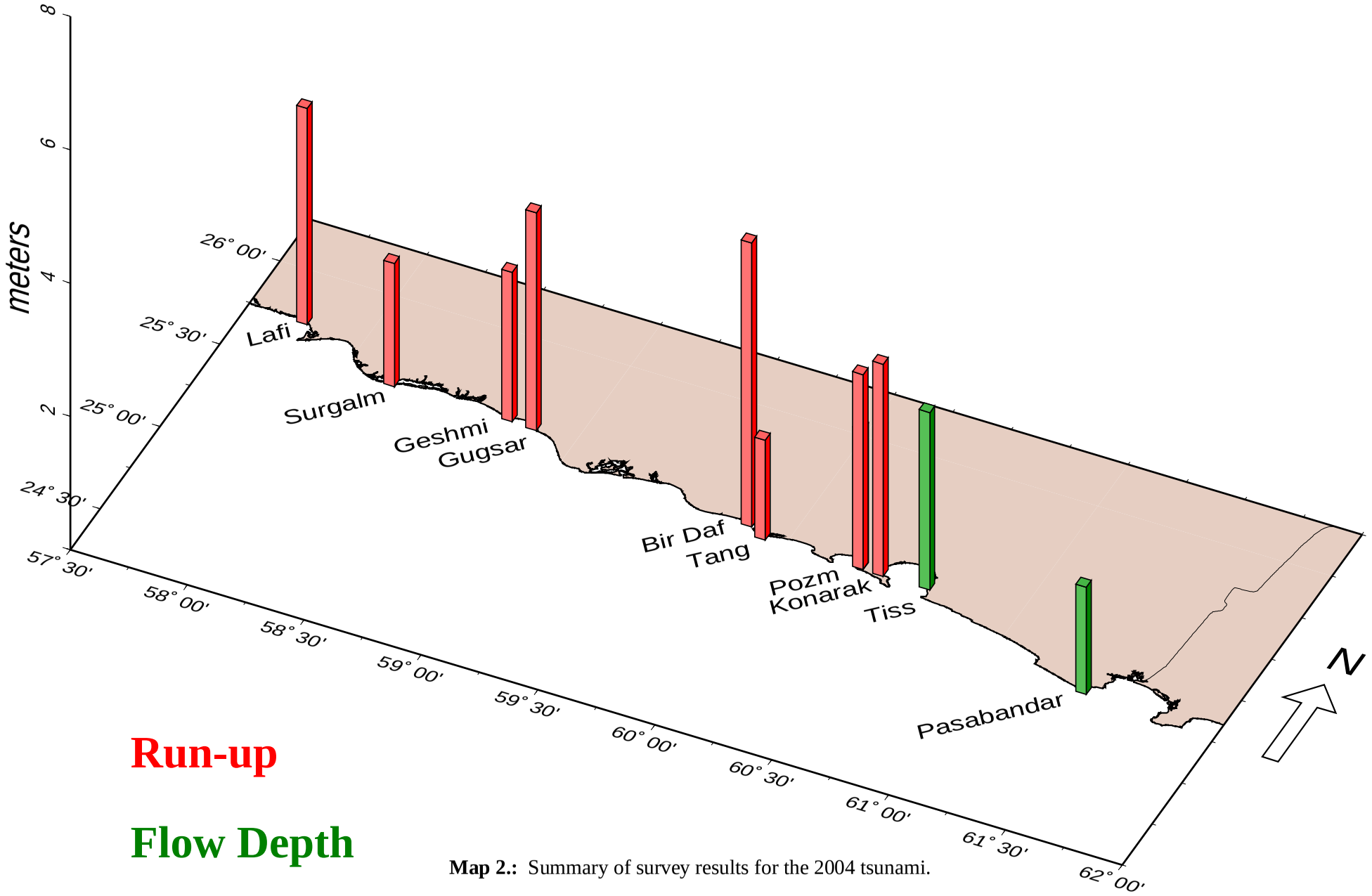
Number	Latitude	Longitude	Vertical amplitude (m)		Nature	Inundation	Date and time	Location
			Raw	Corrected	(†)	(m)	surveyed (GMT)	
21	25.35523	60.60022	3.35	2.66	F		10-OCT-2010 11:05 GMT	Tiss Harbor
22	25.35383	60.40205	2.20	3.18	R	26	12-OCT-2010 06:52 GMT	Konarak
23	25.36018	60.31382	1.10	2.09	R		12-OCT-2010 08:23 GMT	Pozm
24	25.35823	60.31350	1.95	2.92	R		12-OCT-2010 08:30 GMT	Pozm
25	25.06838	61.41687	1.00	1.61	F		14-OCT-2010 09:55 GMT	Pasabandar
26	25.35720	59.89457	1.10	1.50	R		15-OCT-2010 08:47 GMT	Tang
27	25.40330	59.81385	3.80	4.26	R	35	15-OCT-2010 10:02 GMT	Bir Daf
28	25.56027	58.81188	2.30	3.27	R	39	12-OCT-2010 06:48 GMT	Gugsar
29	25.56922	58.70377	1.80	2.24	R	62	13-OCT-2010 05:31 GMT	Geshmi
30	25.56746	58.20059	1.60	1.85	R	21	15-OCT-2010 06:00 GMT	Surgalm
31	25.74627	57.73561	3.10	3.24	R	55	16-OCT-2010 07:26 GMT	Lafi

† R: Run-up; F: Flow depth



Map 1.: Summary of survey results for the 1945 tsunami.

2004 SUMATRA TSUNAMI



Map 2.: Summary of survey results for the 2004 tsunami.

Figure 1.: Interview of a 62−yr old witness on the jetty of the port of Tiss, in the suburbs of Chahbahar *(Top)*.

Based on the story of his late father, we reconstructed the inundation of the 1945 tsunami, which reached the mosque in the background of the *bottom* frame **(Site Number 01)**

Sunday, 10 October 2010

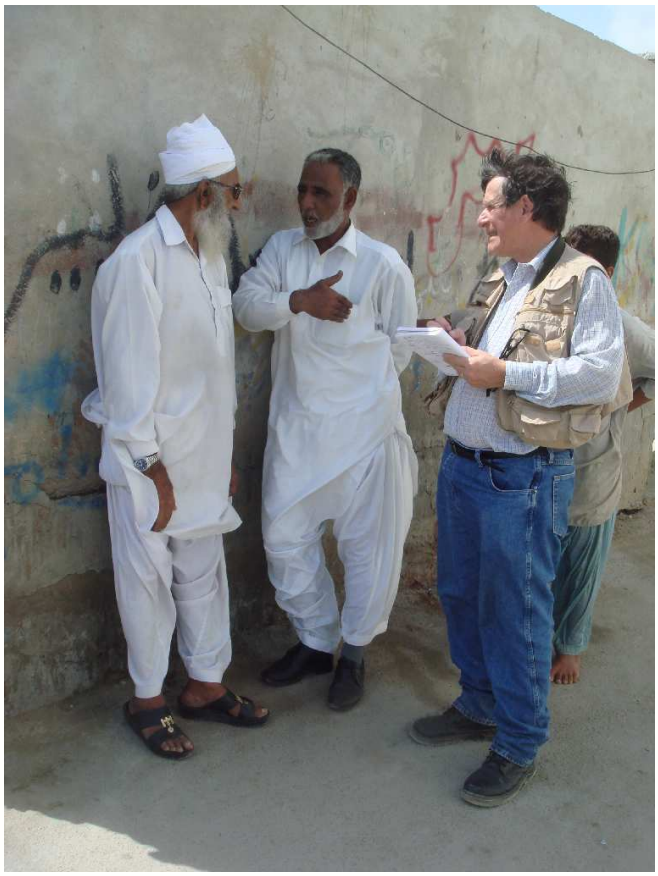


Figure 2.: Interviews in the port city of Konarak. First witness *(Top)* and third witness *(Bottom)*.

Tuesday, 12 October 2010

Figure 3.: Surveying the 2004 tsunami in Pozm. **Sites Number 23** *(Top)* and **24** *(Bottom).*

Tuesday, 12 October 2010

Figure 4.: Interviews and surveying in Chahbahar. *Top Left*, from left to right: Prof. Ghasemzadeh, Prof. Okal, Mr. Hamzeh, INIO Driver, Witness *(Monday, 11 October 2010); Bottom Left:* **Site Number 03** *(Wednesday, 13 October 2010).* Arrow shows present Bank Melli building reached by wave in 1945. Interview photos courtesy J. Ghasemzadeh.

Figure 5.: Interview *(Top; Tuesday, 12 October 2010)* and surveying *(Bottom; Wednesday, 13 October 2010)* at Ramin. Note the boulders deposited on the cliff at an altitude of about 7 m above sea level. Photographs courtesy J. Ghasemzadeh.

Figure 6.: Surveying at Lipar **(Site Number 05)**. *Top:* Surveying on the beach by Mr. Hamzeh, Prof. Ghasemzadeh *(left)*, and Prof. Okal *(right)*, accompanied by 1945 witness Mr. Dadshahpour. *Bottom:* View of the Lipar estuary *(right)* and hinterland flood plain *(left)* from nearby lookout.

Wednesday, 13 October 2010.

Figure 7.: *Top:* The port of Beris, sheltered by a large promontory. *Center:* Interview of 1945 witness Mr. Beluch. *Left to Right:* Prof. Ghasemzadeh, Prof. Okal (taking notes), INIO driver (back to camera). *Bottom:* **Site Number 06** near Beris mosque.

Thursday, 14 October 2010

Figure 8.: *Top*: Interview of 1945 witness Mr. Baluch (shown with grandchildren) at Pasabandar; *Left to Right:* Mr. Hamzeh, INIO driver, Prof. Okal. *Center:* Survey **Site Number 08** along cliff; note road to port, built since 1945. *Bottom:* Estuarine plain North of Pasabandar. The 1945 tsunami flooded it, reaching to the base of these hills, at **Site Number 07**. Top and Center courtesy J. Ghasemzadeh.

Thursday, 14 October 2010

Figure 9.: Surveying of the 2004 Sumatra tsunami at Tang **(Site Number 26).** In the back, note barrier island offering protection to the site. Photographs courtesy J. Ghasemzadeh.

Friday, 15 October 2010.

Figure 10.: Surveying of the 2004 Sumatra tsunami at Bir Daf **(Site Number 27).** Photographs courtesy J. Ghasemzadeh.

Friday, 15 October 2010.

Figure 11.: *Top:* Interview of 1945 witness *(right)* at Souraf **(Site Number 09)**. *Bottom:* Survey at Souraf. Photographs courtesy H.M. Fritz.

Wednesday 13 October 2010.

Figure 12.: Professor Okal (with dark hat) joins schoolchildren participating in the clean-up of the beach at Chahbahar.

Sunday, 17 October 2010.

Figure 13.: Group photograph at the conclusion of the workshop, at the Headquarters of INIO in Tehran.

Tuesday, 19 October 2010.