Report to the Twelfth Session of the IOC Group of Experts On the Global Sea Level Observing System (GLOSS)

Chilean Sea Level Network: Current State

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Introduction

Since 1941, the Chilean Navy Hydrographic and Oceanographic Service (SHOA) has established a sea level network that currently comprises 34 sea level recorders covering a long coast of more than 4000 kilometers in the mainland, as well as in some islands and in the Antarctic Continent (see fig.1).

During 1999 an extensive hardware upgrading process was initiated. It considered the deployment of 18 data collecting platforms with satellite transmission data capabilities (VAISALA model 555C) and 1 self-contained platform (AANDERAA model 3634) that replaced most of the old dry purged recording tide gauge.

With the occurrence of the tsunami of February the 27th 2010, that struck a vast region of Chile, SHOA has overtaken many improvements in the Chilean Tsunami Warning System. In this context, from May of 2010, SHOA initiated an upgrading and densification of the Chilean sea level network, installing the VAISALA model MAWS110 DCP for replacing the older 555c models, adding and secondary sea level sensor operating through radar measurements as well as redundant transmission system for the collected data.

In the northern region of Chile where the distances among populated areas are far greater, some of the new stations installed, considered transmission system through INMARSAT-BGAN satelite network as a primary channel and text messages through cell phone GPRS network, as a secondary channel. Additionally, at SHOA headquarters were installed more powerful servers to implement the METMAN 400 data administration and visualization system, strengthening the capabilities in data availability and response.

At present, San Pedro, (Lat: 47º 43’S ; Long: 74º 54’W), Puerto Soberanía (Lat: 62º 29’S ; Long: 59º 38’W) and Rada Covadonga, (Lat: 63º 19’S ; Long: 57º 55’W), are the only sea level stations operating with AANDERAA devices being the data downloaded in those places during annual field campaigns.

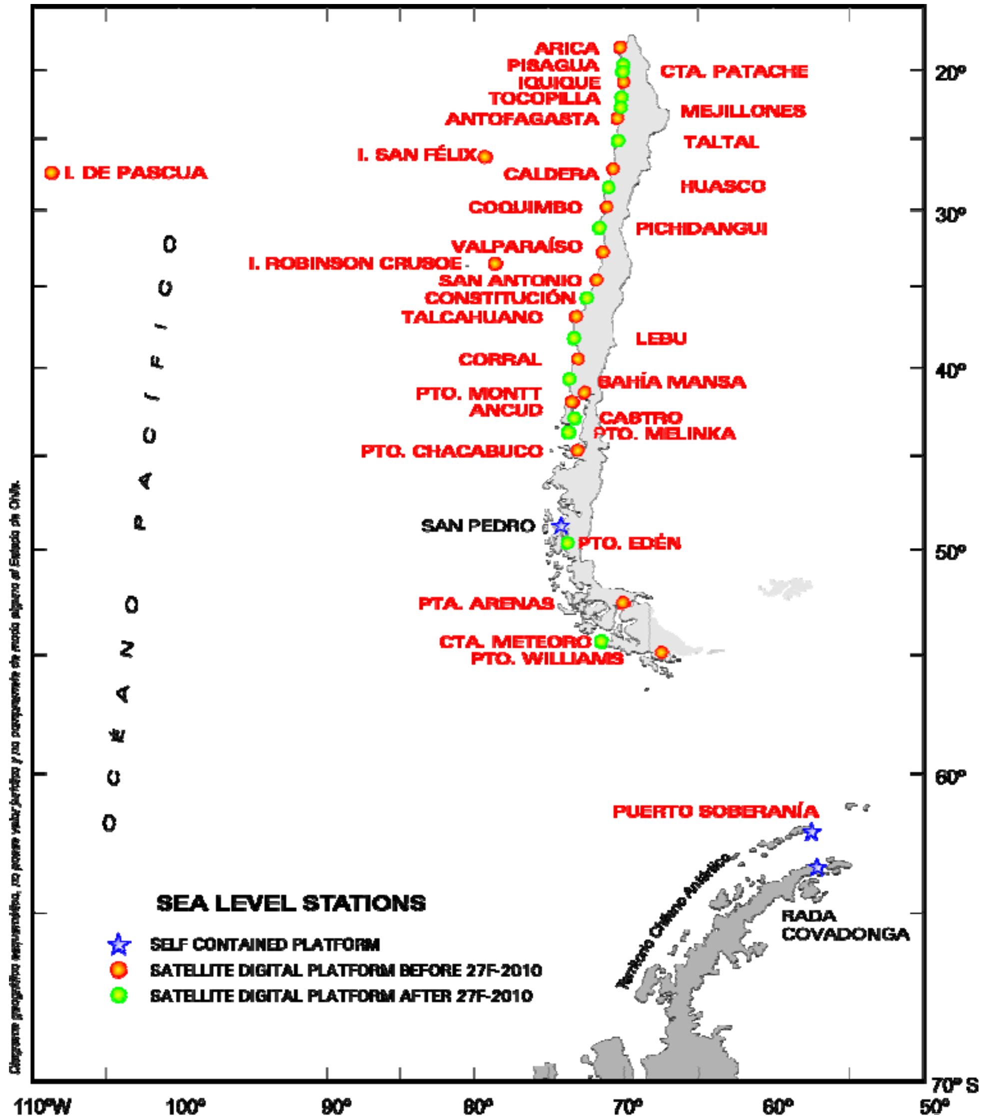

Figure 1 : Chilean Sea Level Network

By the end of 2011, SHOA will finish the installation of the last two MAWS110 to complete the 2010-2011 upgrade and expansion process for the Chilean Sea Level Network within the framework of the National Tsunami Warning System.

The new stations capabilities have allowed us to achieve a reliable network supplying data for operational and scientific purposes.

Telemetry Systems and Data Transmission Frequency

The below table resumes the telemetry capabilities as scheduled by the end of 2011.

Number	Sea Level Station	Telemetry Configuration	Data Transmission Frequency		
			Satellite	**VPN**	**GPRS**
1	Arica	GOES/VPN	5 minutes	1 minute	N/A
2	Pisagua	GOES/VPN	5 minutes	N/A	N/A
3	Iquique	GOES/VPN	5 minutes	1 minute	N/A
4	Patache	GOES/GPRS	5 minutes	N/A	5 minutes
5	Tocopilla	BGAN/GPRS	1 minute	N/A	5 minutes
6	Mejillones	GOES/GPRS	5 minutes	N/A	5 minutes
7	Antofagasta	GOES/VPN	5 minutes	1 minute	N/A
8	Taltal	BGAN/GPRS	1 minute	N/A	5 minutes
9	Caldera	GOES/VPN	5 minutes	1 minute	N/A
10	Huasco	BGAN/GPRS	1 minute	N/A	5 minutes
11	Coquimbo	GOES/VPN	5 minutes	1 minute	N/A
12	Pichidangui	BGAN/GPRS	1 minute	N/A	5 minutes
13	Quintero	GOES/GPRS	5 minutes	N/A	5 minutes
14	Valparaíso	GOES/VPN	5 minutes	1 minute	N/A
15	San Antonio	GOES/VPN	5 minutes	1 minute	N/A
16	Constitución	GOES/GPRS	5 minutes	N/A	5 minutes
17	Talcahuano	GOES/GPRS	5 minutes	N/A	5 minutes
18	Lebu	GOES/GPRS	5 minutes	N/A	5 minutes
19	Corral	GOES/VPN	5 minutes	1 minute	N/A
20	Bahía Mansa	GOES/GPRS	5 minutes	N/A	5 minutes
21	Puerto Montt	GOES/VPN	15 minutes	1 minute	N/A
22	Ancud	GOES/VPN	10 minutes	1 minute	N/A
23	Castro	GOES/GPRS	10 minutes	N/A	5 minutes
24	Pto. Melinka	GOES/GPRS	5 minutes	N/A	5 minutes
25	Puerto Chacabuco	GOES/VPN	10 minutes	1 minute	N/A
26	I. San Pedro	Self Contained			
27	Puerto Edén	GOES/VPN	15 minutes	1 minute	N/A
28	Punta Arenas	GOES/GPRS	15 minutes	N/A	5 minutes
29	Puerto Williams	GOES/GPRS	15 minutes	N/A	5 minutes
30	Caleta Meteoro	GOES/VPN	15 minutes	1 minute	N/A
31	I. San Félix	GOES	5 minutes	N/A	N/A
32	I. Robinson Crusoe	GOES/VPN	5 minutes	1 minute	N/A
33	I. de Pascua	GOES/VPN	5 minutes	1 minute	N/A
34	Puerto Soberanía	GOES	1 hour	N/A	N/A
35	Rada Covadonga	Self Contained			

N/A: Not available

Puerto Soberanía (Antarctic Navy Base “A. Prat”) Sea Level Station

Chile has conducted sea level observations in the Antarctic since 1947, initially with the installation of short period stations during the summer, giving rise to records of greater extension once the experience in the installation and operation of tide instruments in this hostile environment was acquired. Therefore, in 1983, tide gauge station Puerto Soberania (Base Prat) was installed, operating without interruptions and becoming part of the national tide gauge network until the cease of its operation in January, 2004. The base was reactivated by the end of 2008 and one Aanderaa platform with the associated submerged transducer has been operating there since. The installation of new equipment VAISALA MAWS 110 DCP has been scheduled to mid December 2011, transmitting data through the GOES satellite system at the 1 hour assigned time window.

The maintenance of this station will be carried out annually during the hydrographic campaigns that are developed in the Antarctic. Figure 2 shows a view of the pier in which the pressure transducer and tide staff were installed while the DCP was located into the facilities of the navy base.

Figure 2 : Pier in Puerto Soberanía (Base Prat)

Status of GLOSS Stations in Chile

The eight chilean stations that have been considered in the GLOSS core network are as follows :

GLOSS ID.	Location	Status
137	I. Pascua Lat : 27º 09' S Lon: 109º 27' W	• Field Unit : VAISALA MAWS110 • Sea Level Sensors : - Differential Pressure Transducer KELLER PR-36XW/H - Radar model VEGAPULSE62 • Record Spans : 1970 – 2003 • Gaps : 1980 ; 1982 ; 1983 • Monthtly Height Data up to 2010, has been sent to PSMSL • Hourly Height Data up to 2010, has been sent to UHSLC
74	Antofagasta Lat : 23º 39' S Lon: 70º 24' W	• Field Unit : VAISALA MAWS110 • Sea Level Sensors : - Differential Pressure Transducer KELLER PR-36XW/H - Radar model VEGAPULSE62 • Record Spans : 1970 – 2003 • Gaps : • Monthtly Height Data up to 2010, has been sent to PSMSL • Hourly Height Data up to 2010, has been sent to UHSLC
175	Valparaíso Lat : 33º 02' S Lon: 71º 37' W	• Field Unit : VAISALA MAWS110 • Sea Level Sensors : - Differential Pressure Transducer KELLER PR-36XW/H - Radar model VEGAPULSE62 • Record Spans : 1944 – 2003 • Gaps : 1971 - 1981 • Monthtly Height Data up to 2010, has been sent to PSMSL • Hourly Height Data up to 2010, has been sent to UHSLC
176	I.J.Fernández Lat : 33º 37' S Lon: 78º 50' W	• Field Unit : VAISALA MAWS110 • Sea Level Sensors : - Differential Pressure Transducer KELLER PR-36XW/H - Radar model VEGAPULSE62 • Record Spans : 1985 – 2003 • Gaps : • Monthtly Height Data up to 2010, has been sent to PSMSL • Hourly Height Data up to 2010, has been sent to UHSLC
177	I.San Félix Lat : 26º 17' S Lon: 80º 07' W	• Field Unit : VAISALA MAWS110 • Sea Level Sensors : - Differential Pressure Transducer KELLER PR-36XW/H - Radar model VEGAPULSE62 • Record Spans : 1989 – 2003 • Gaps : • Monthtly Height Data up to 2010, has been sent to PSMSL • Hourly Height Data up to 2010, has been sent to UHSLC
178	P.Montt Lat : 41º 29' S Lon: 72º 58' W	• Field Unit : VAISALA MAWS110 • Sea Level Sensors : - Differential Pressure Transducer KELLER PR-36XW/H - Radar model VEGAPULSE62 • Record Spans : 1945 – 2003 • Gaps : • Monthtly Height Data up to 2010, has been sent to PSMSL • Hourly Height Data up to 2010, has been sent to UHSLC

GLOSS ID.	Location	Status
180	I.D.Ramírez Lat : 56º 30’ S Lon: 68º 43’ W	• Non – Operational (closed in 1998) • Record Spans : 1991 – 1997 • Gaps : • Monthtly Height Data up to 1997, has been sent to PSMSL • Hourly Height Data up to 1997, has been sent to UHSLC
189	P. Soberanía (Base Prat) Lat : 62º 29’ S Lon: 59º 38’ W	• Field Unit : Currently AANDERAA 3634 • Sea Level Sensors : Differential Pressure Transducer 3791A manufactured by AANDERAA • Record Spans : 1984 – 2003 • Gaps : 2004 – 2008 • Station closed in January 2004 and reactivated in January 2009. Data under quality control • Monthtly Height Data up to 2002, has been sent to PSMSL • Hourly Height Data up to 2002, has been sent to UHSLC

BGAN-Inmarsat Communication Protocols

The Chilean Earthquake and Tsunami of February 27th 2010, demonstrated the need to rely on several redundant communication Networks to ensure the timely reception of sea level data. Our Service decided to implement BGAN / GPRS dual communication protocols at intermediate stations in the northern part of the country to achieve independent data coverage from the stations already using GOES satellite network.

The BGAN Inmarsat network is a private satellite Network, offering voice and data services with a global coverage. In July 2010 our Service signed a contract with BGAN Service provider named “Stratos” thru their representative in Chile “Globalsat Latam”, installing five stations in November 2010 in Pichidangui, Huasco, Taltal, Tocopilla and Pisagua across a 1.400 Km stretch of coast.

This system uses a Thrane&Thrane® Explorer 300 transmitting antenna, which requires data input using Ethernet protocol and a Lantronics® DXE421 Ethernet/RS232 converter to transform the data supplied by the DCP.

Initially the service considered five transmitting antennas and one receiver based at Valparaiso. The daily traffic per station was around 75 Kb per hour or 1.6 Mb per day, plus an additional 100 Kb per connection to the network. This amount has to be doubled as each Kb is charged for transmission as well as reception.

During the first months of use the data transmission experienced varied results with some stations achieving averages percentages of transmission of 94 %, while other only reached 60 or 70 %. One of the causes of these differences was associated with a low power signal for latitudes between 19° S and 32°S, which was around 50 dB in all the stations. While this signal power was in the lower limit of operational conditions according to the antenna's manufacturer, some sites achieved good transmission percentages.

Nevertheless in some sites the antennas experienced brief periods of instability on their signal power reception, causing them to close and open their connection to the Network, several times per minute, thus exponentially increasing the traffic and the associated cost, without achieving a successful connection until the antenna was manually reset on site.

This instability made this system unsuitable for emergency use and unreliable as a communication protocol for a Tsunami Warning System supposed to be operated 24/7.

After extensive research from engineers at Stratos, Inmarsat and Vaisala, found a hardware incompatibility between the Lantronics® RS232/Ethernet converter. Based on these findings, Vaisala proposed to change the used RS232/Ethernet converter for a different brand, adopting the Digi® PortServer TS HMEI as a more reliable solution.

Preliminary tests showed a consistent and reliable connection, clearing the use of these new converters on the field from July 2011. During the past months the successful percentage of data transmission has reached 99.8% without experiencing any instability, additionally the new RS232/Ethernet converters have decreased the number of characters contained in each messages thus lowering the daily traffic to 0.47 Mb per antenna or 0.94 Mb per day considering transmission and reception for each station.

Currently our BGAN stations are sending data from the pressure and radar sea level sensors as well as rate of change for each one of them. The DCP is also set to send on each transmission the current data and repeat the previous transmission in case the system did not receive it. This strategy is also applied to GPRS modems that during each transmission repeat the previous two, effectively lowering the amount of gaps in the sea level time series.

The monthly charge is around 225 US Dollars per each station considering transmission and reception of the data. At present we use a pre-paid service which probably will be changed to post-paid service, which would ensure less expensive bills.