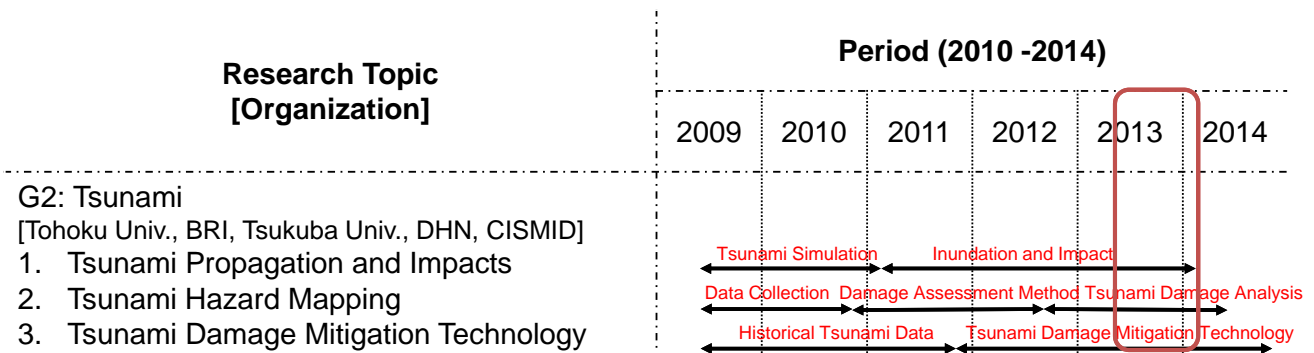


Developing Tsunami Damage Estimation and Mitigation Technologies towards Tsunami-Resilient Community

G2: Tsunami

- Shunichi Koshimura (IRIDeS, Tohoku Univ., Tsunami engineering)
 - Erick Mas (IRIDeS, Tohoku Univ., Tsunami engineering)
 - Bruno Adriano (Tohoku Univ., Tsunami modeling)
 - Gaku Shoji (Tsukuba Univ., Structural and earthquake engineering)
 - Yuji Yagi (Tsukuba Univ., Seismology)
 - Yushiro Fujii (BRI, Seismology and Tsunami modeling)
 - Hideaki Yanagisawa (Tohoku Gakuin Univ., Tsunami modeling)
-
- Atilio ASTE Evans (DHN)
 - Ceci Rodriguez (DHN)
 - Cesar Jimenez (DHN, UNMSM)
 - Nabil Moggiano (DHN)
 - Prof. Julio Kuroiwa H. (UNI)
 - Dr. Leonidas Ocola (UNMSM)
 - Sheila Yauri (IGP)
 - Miguel Estrada (CISMID)
 - Rafael Salinas (CISMID)
 - Victor Rojas, Jorge Morales (CISMID)

Project Plan



Objectives and Goals

- To assess the **potential tsunami disaster** and its impact to the Peruvian coast.
- To develop **practical technologies** to mitigate tsunami risks in Peru.
- Implementation to the **strategic plans** for disaster mitigation of Peruvian government.
- Contributions to **Pacific** tsunami disaster mitigation strategies.

Activities

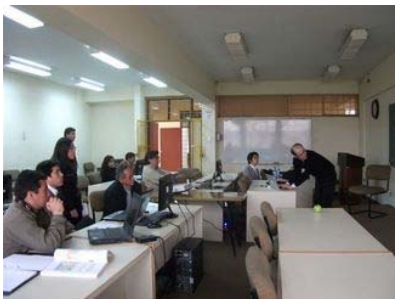
1. Transfer of tsunami numerical modeling technique
2. Post-tsunami field survey in Chile (2010 event)
3. Tsunami field survey in Camana, Peru (2001 event)
4. Verification of tsunami numerical model and tsunami source study
5. Tsunami risk assessment along the Peruvian coast
6. Tsunami source study (Historical Tsunami of 1746)
7. Mapping tsunami inundation
8. Tsunami risk perception and evacuation (La Punta, Callao)
9. Tsunami refuge building demand during evacuation (La Punta, Callao)
10. Tsunami damage assessment (La Punta, Callao)
11. Evacuation drill in 2013 (La Punta, Callao)
12. Other activities (Bathymetric survey)

3

1. Transfer of tsunami numerical modeling technique

Tsunami Modeling techniques were transferred to Peruvian researchers (TUNAMI-code to simulate tsunami generation, off-shore/near-shore propagation and coastal inundation)

1. Bruno Adriano (@BRI, now @Tohoku Univ.)
2. Cesar Jimenez (@Tohoku Univ., now @CNAT-DHN)
3. Nabil Moggiano (@CNAT-DHN)
4. Sheila Yauri (@BRI, now @IGP)
5. Jorge Morales (now @BRI, soon @Tohoku Univ.)

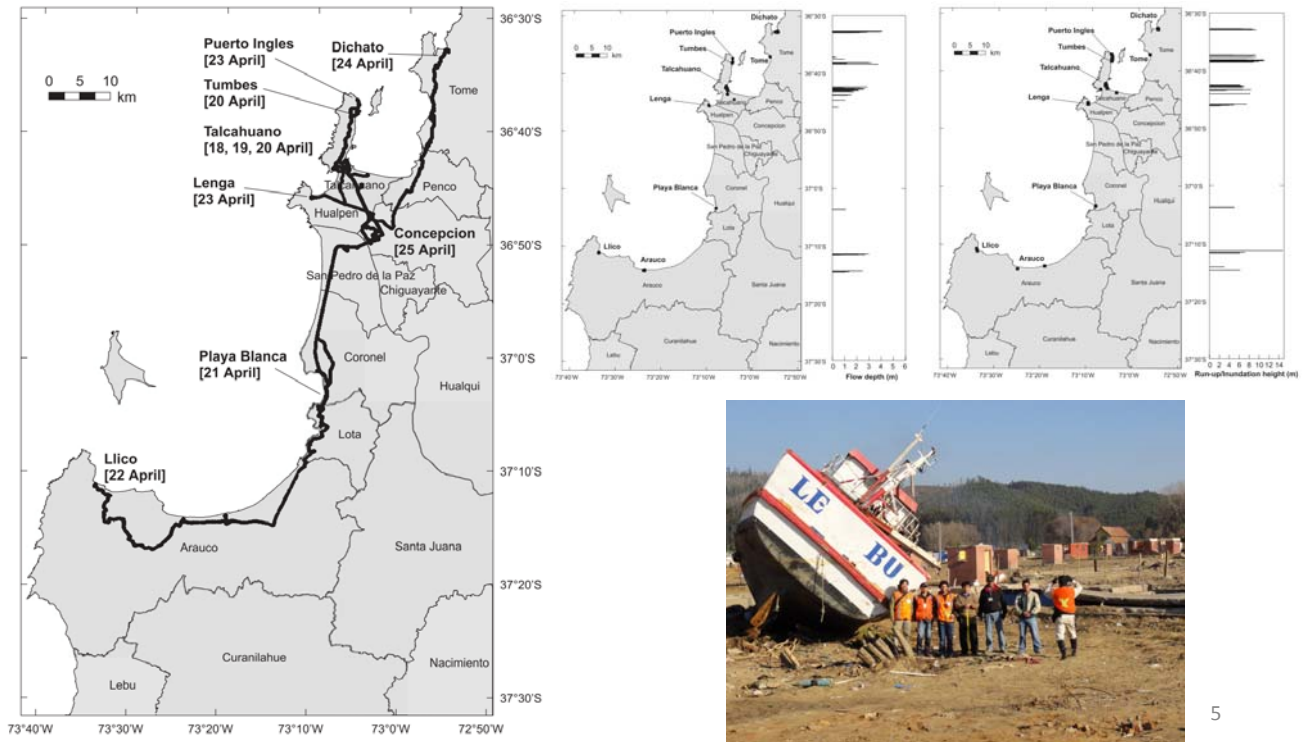


Tsunami Training Course @CISMID



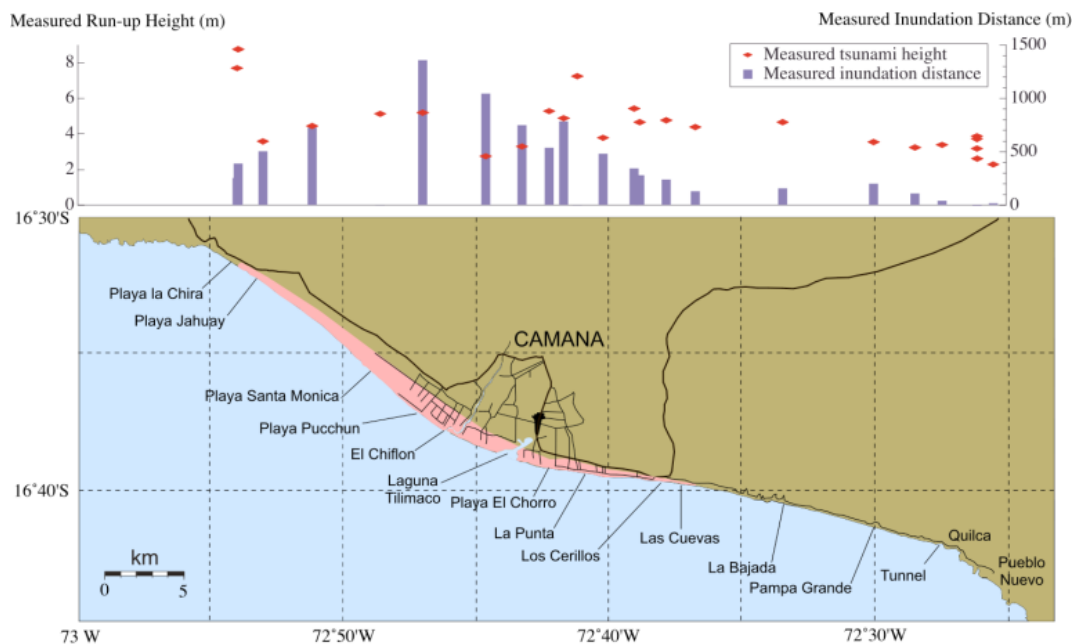
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2. Post tsunami field survey in Chile (2010 event)



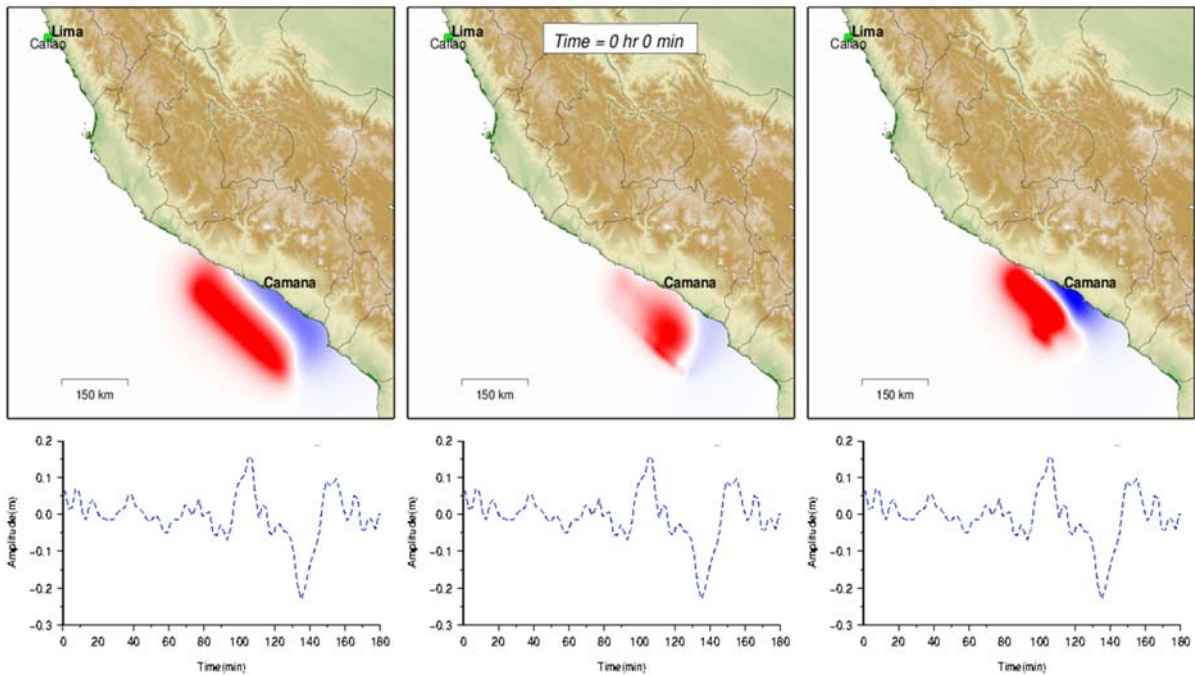
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3. Tsunami field survey in Camana, Peru (2001 event)



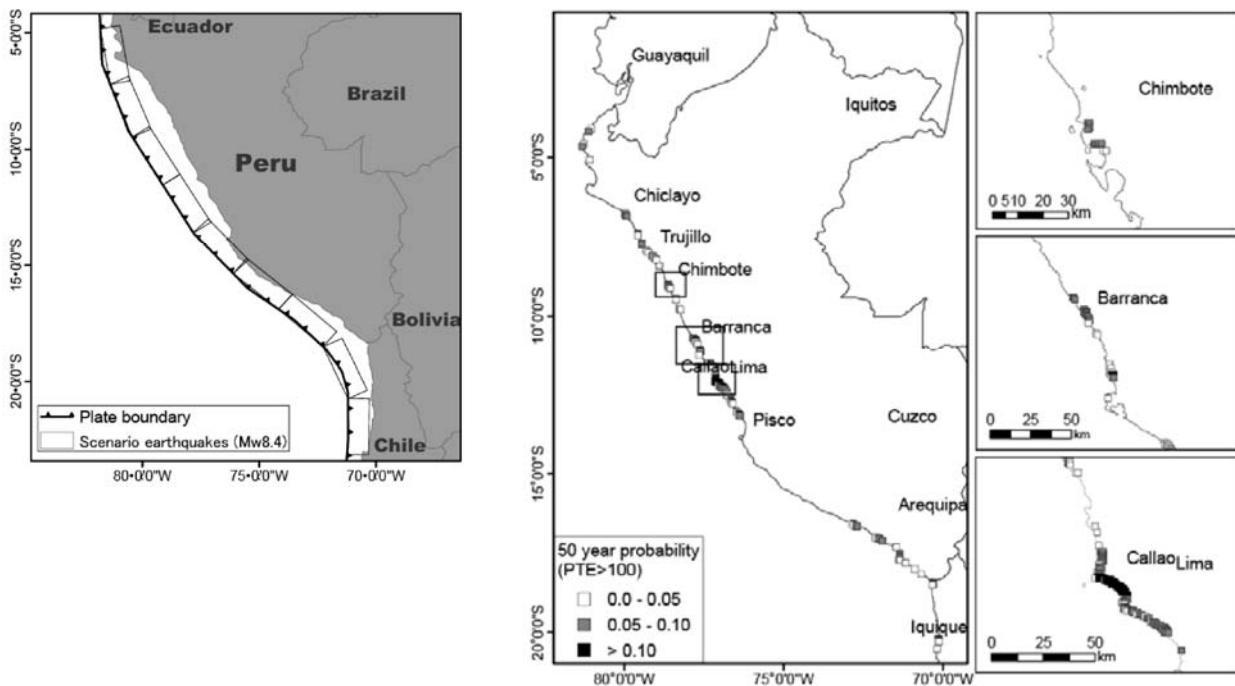
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4. Verification of tsunami numerical model and tsunami source study



7

5. Tsunami Risk Assessment along the Peruvian coast

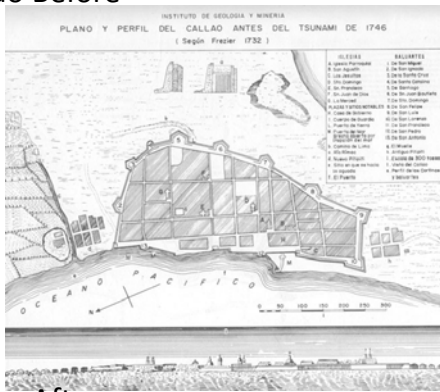


Yanagisawa, H., Koshimura, S., Yagi, Y., Fujii, Y., Shoji, G., & Jimenez, C. (2011). The Tsunami Vulnerability Assessment in Peru Using the Index of Potential Tsunami Exposure. In 8th International Conference on Urban Earthquake Engineering (pp. 1591–1595).

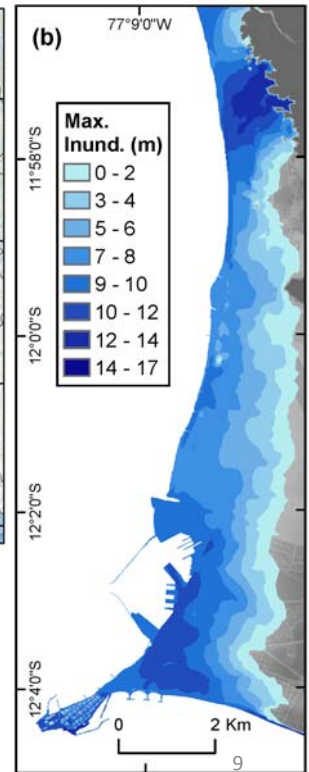
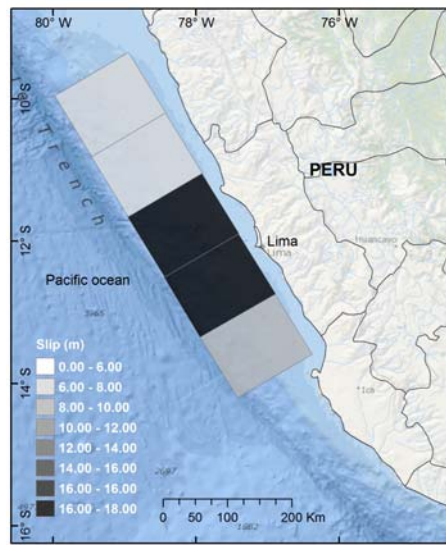
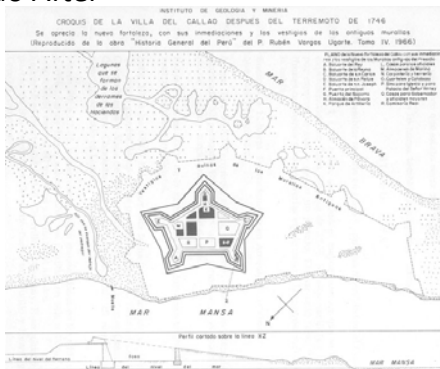
8

6. Historical Tsunami of 1746

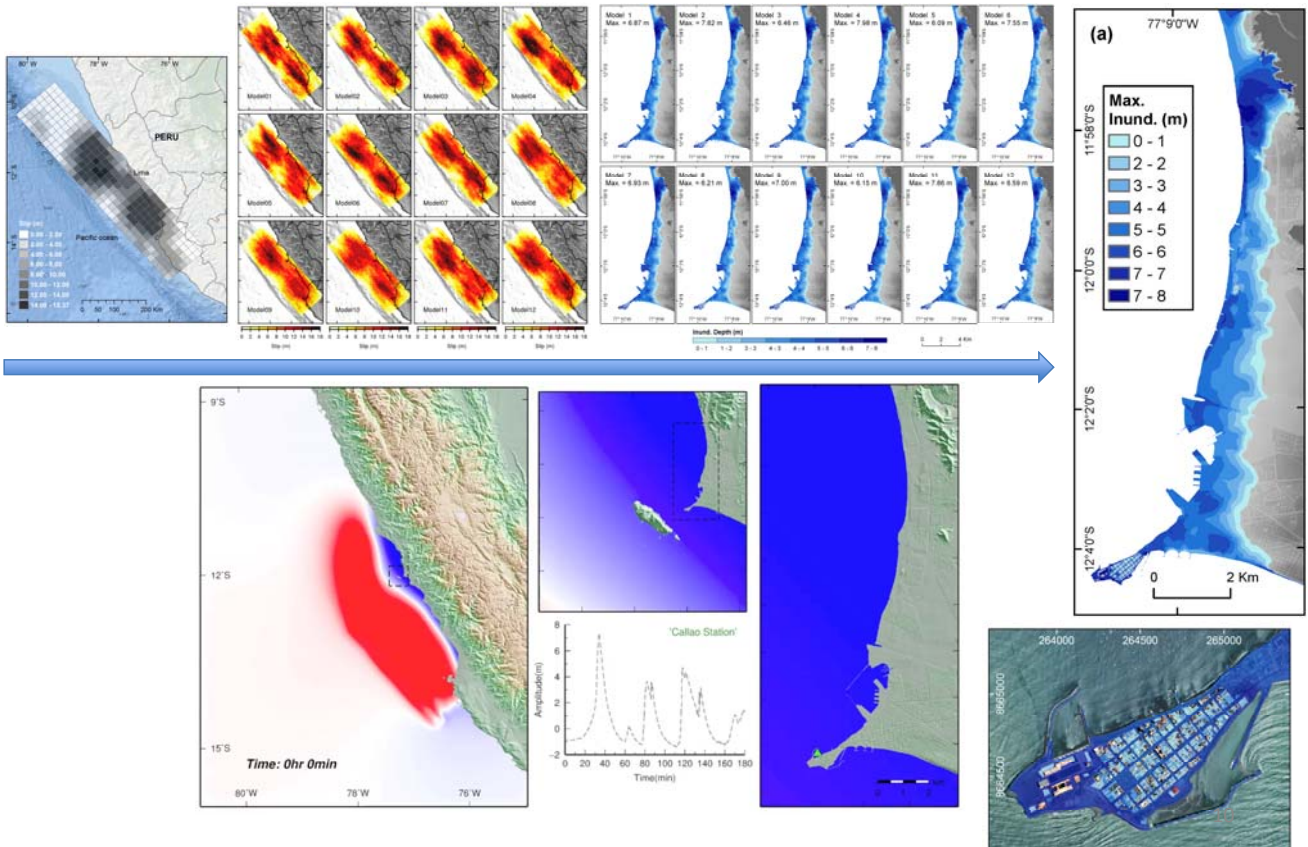
Callao Before



Callao After



7. Mapping tsunami inundation Pulido's Source

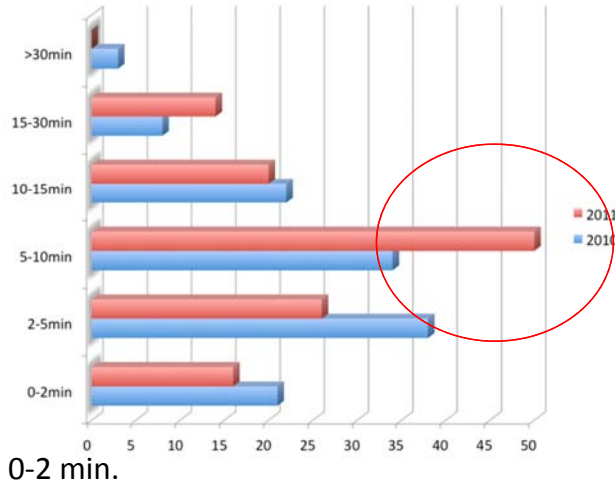


8. Tsunami risk perception and evacuation

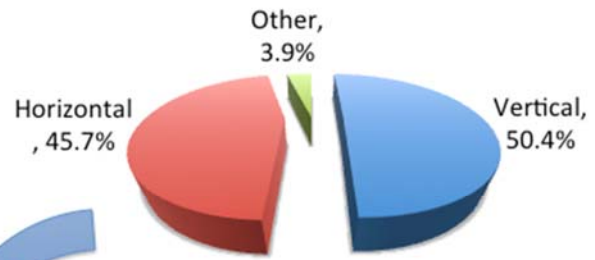
Encuesta de Comportamiento Humano en caso de Evacuación por tsunami se realizará en La Punta

Como parte del estudio y la preparación constante del municipio por aprender y mejorar ante todo tipo de emergencia, se realizará una encuesta en el distrito sobre la decisión de ir a un lugar seguro y la evacuación y selección de zona segura. Los resultados de este breve cuestionario serán compartidos con la municipalidad y servirán para elaborar el paquete de recomendaciones que viene desarrollando para una mejor preparación de la población, la Agencia de Cooperación Internacional del Japón (OCA) en convenio con el INDECOP, la Municipalidad de La Punta ha decidido apoyar y colaborar con el Ing. Edg. Mar Zambrano, estudiante de la Escuela de Graduados de Ingeniería de la prestigiosa Universidad de Tokushima en Japón, quien con esta tesis también asesorará a la municipalidad en temas de prevención y mitigación de desastres. Ing. Adán Karawa.

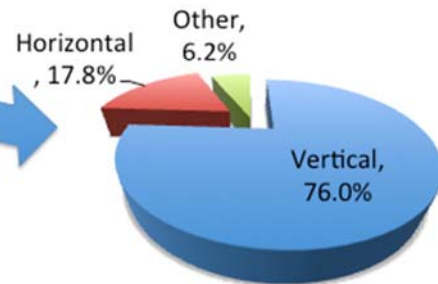
Elaboración municipal indicando que la ayuda de la comuna consistirá en respaldar y colaborar con la investigación que realizará el agrónomo adscrito en el distrito, la cual versará sobre el Mantenimiento del Comportamiento Humano y Decisión de Evacuación en caso de Tsunami. Además de escribir el texto de la acciones de supervivencia de los puntos fuertes a una eventualidad de este tipo de eventos, le permitirá obtener el grado de Doctor en el Laboratorio de Ingeniería de Tsunami.



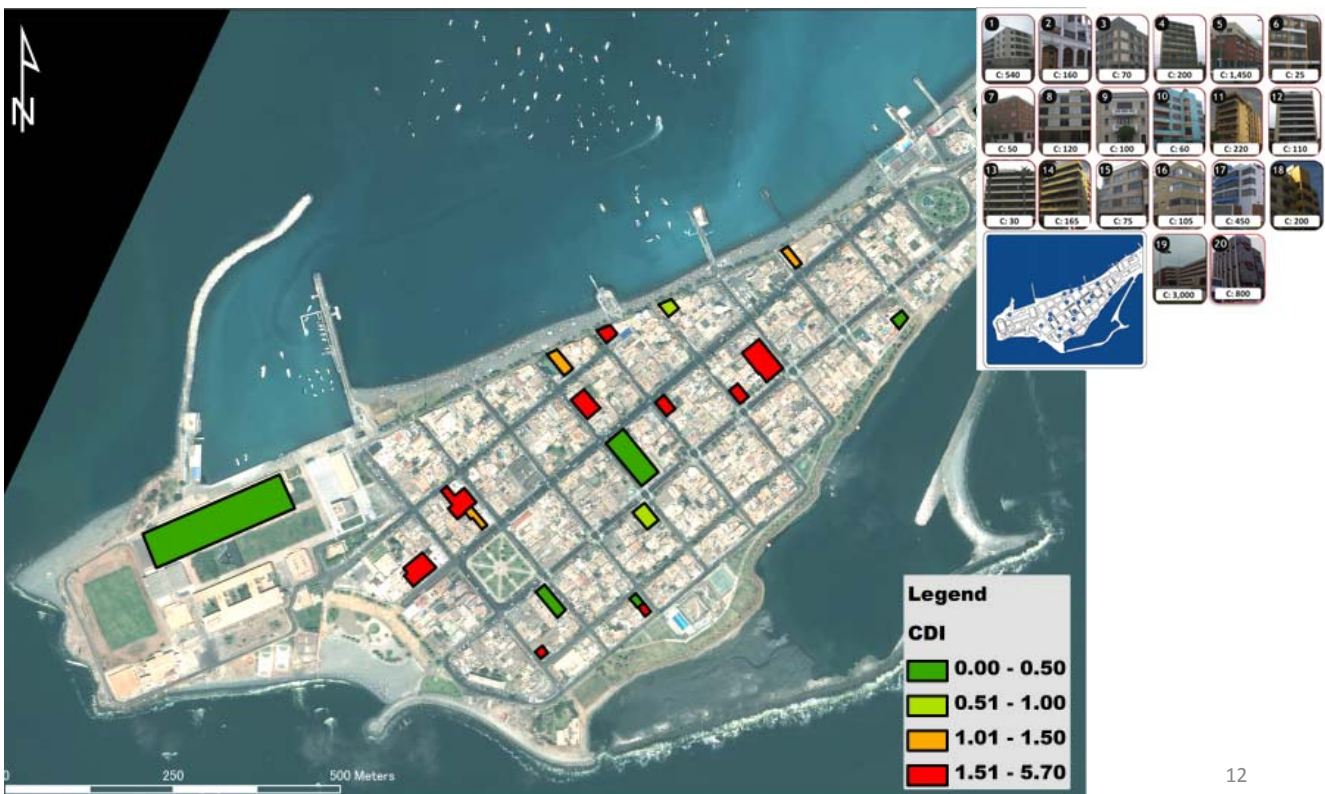
Shelter (2010)



Shelter (2011)



9. Tsunami refuge building demand during evacuation



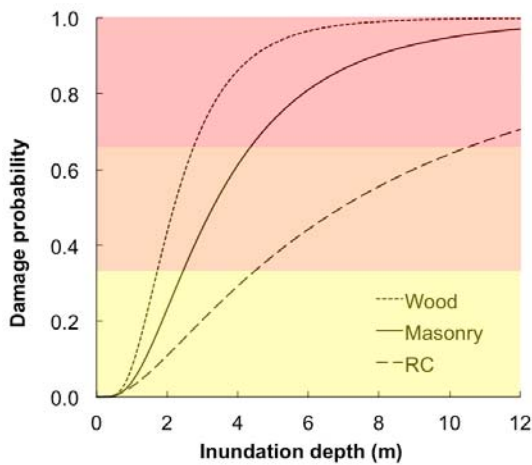


Casualty Estimation Results

Type	Horizontal			Vertical			Horiz. & Vertical		
	Avg.	S.D.	Max	Avg.	S.D.	Max	Avg.	S.D.	Max
Kids	38	2	42	4	1	7	4	1	7
Teens	29	3	34	4	1	7	4	1	8
Adult	28	1	30	4	0	5	4	0	5
Elder	47	1	50	4	1	6	4	1	6
Car	32	34	87	-	-	-	34	35	100
Total (pers.)	271	-	-	16	-	-	153	-	-

(*) Unit: person / vehicle

10. Tsunami damage assessment



Tsunami evacuation drill

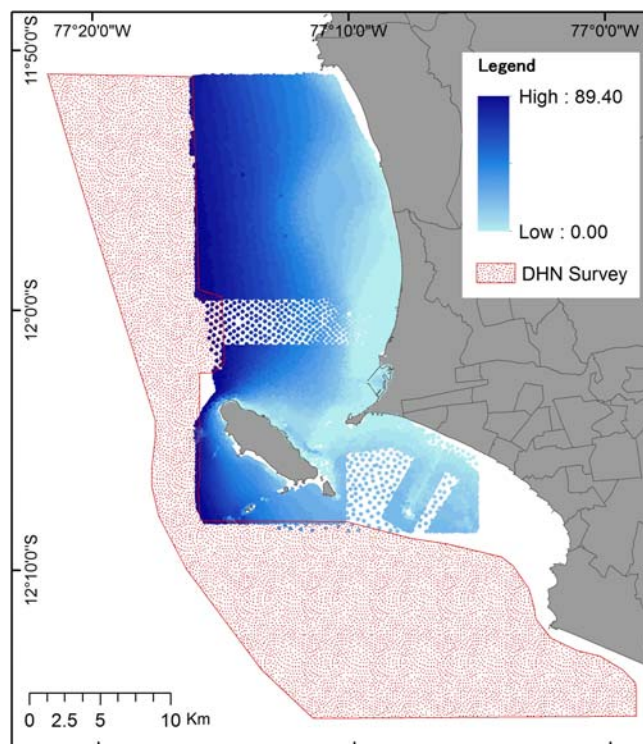


NO.	CAPACITY	SHELTERED
1	540	173
2	160	84
3	70	1
4	200	3
5	1450	305
6	25	8
7	50	18
8	120	0
9	100	17
10	60	0
11	220	79
12	110	17
13	30	4
14	165	2
15	75	8
16	105	1
17	450	16
18	200	20
19	3000	~1000
20	800	270
Total	7,930	2,026

RTV CIP Lima – Peru Society of Engineers

40% of total population

Bathymetry survey



Conferences & Publications

Book chapter

1. Mas, E., Adriano, B., Koshimura, S., Imamura, F., Kuroiwa Horiuchi, J., Yamazaki, F., Zavala, C., Estrada, M. (2014). Identifying Evacuees Demand of Tsunami Shelters Using Agent Based Simulation. In Y. A. Kontar, V. Santiago-Fandino, & T. Takahashi (Eds.), *Tsunami Events and Lessons Learned* (pp. 347–358). Springer Netherlands. doi:10.1007/978-94-007-7269-4_19
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5. Adriano, B., Mas, E., Koshimura, S., Fujii, Y., Yauri, S., Jimenez, C., Yanagisawa, H. (2013). Tsunami Inundation Mapping in Lima, for Two Tsunami Source Scenarios. *Journal of Disaster Research*, 8(2): 274–284.
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7. Mas, E., Adriano, B., & Koshimura, S. (2013). An Integrated Simulation of Tsunami Hazard and Human Evacuation in La Punta , Peru. *Journal of Disaster Research*, 8(2), 285–295.
8. Adriano, B., Mas, E., Koshimura, S. (2014). Damage probability assessment of Callao Region based on future megathrust earthquake scenarios of Central Peru. *Journal of Disaster Research (in process)*
9. Mas, E., Adriano, B., Pulido, N., Jimenez, C., Koshimura, S. (2014). Simulation of tsunami inundation from future megathrust earthquake scenarios of Central Peru. *Journal of Disaster Research (in process)*

Conferences and other presentations

1. Adriano, B., Koshimura, S., Fujii, Y. (2010). Validation of Tsunami Inundation Modeling for the June 23, 2001 Peru Earthquake. In *bulletin of International Institute of Seismology and Earthquake Engineering - Building Research Institute (ISEE-BRI)*.
2. Koshimura, S., Matsuoka, M., Matsuyama, M., Yoshii, T., Mas, E., Jimenez, C., & Yamazaki, F. (2010). Field Survey of the 2010 Tsunami in Chile. In *The 13th Japan Earthquake Engineering Symposium* (pp. 1–7).
3. Mas, E., Imamura, F., & Koshimura, S. (2010). Tsunami Hazard Mitigation and Countermeasures in Peru. In *Abstract of the 3rd International Tsunami Field Symposium*.
4. Mas, E., Imamura, F., & Koshimura, S. (2010). Basic study on Human Behavior for Tsunami Evacuation Simulation using Multi Agent System. In *Annual Meeting of the Tohoku Branch Technology Research Conference, Japan Society of Civil Engineers* (pp. 1–2) Fukushima, Japan.
5. Adriano, B., Koshimura, S., Fujii, Y. (2011). Validation of Tsunami Inundation Modeling for the June 23, 2001 Peru Earthquake. In *proceedings of 8th International Conference on Urban Earthquake Engineering, 8CUEE*.
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17. Mas, E., Adriano, B., Koshimura, S., Imamura, F., Kuroiwa Horiuchi, J., Yamazaki, F., Zavala, C., Estrada, M. (2012). Identifying Evacuees Demand of Tsunami Shelters Using Agent Based Simulation (2012). In *The American Geophysical Union (AGU) Fall Meeting 2012*. San Francisco, California, USA.
18. Mas, E., Imamura, F., Koshimura, S. (2012). Developing an Integrated Tsunami and Agent Based Evacuation Simulator. In *Annual Meeting of the Tohoku Branch Technology Research Conference, Japan Society of Civil Engineers*
19. Mas, E., Imamura, F., & Koshimura, S. (2012). Study on Tsunami Evacuation Building Demand through the Agent Based Simulation of Tsunami Evacuation in La Punta , Peru. In *Japan Geoscience Union Meeting 2012*. Makuhari, Chiba, Japan.
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24. Adriano, B., Mas, E., Koshimura, S. (2013). Application of tsunami fragility functions for building damage assessment: two different approaches. *The 9th APRU Research Symposium on Multi-Hazards around the Pacific Rim*.
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28. Mas, E., Adriano, B., Pulido, N., Koshimura, S. (2014). Simulation of tsunami inundation from future megathrust earthquake scenarios of Central Peru. *Japan Geoscience Union Meeting 2014, JpGU*. April 28 – May 2, Yokohama, Japan.

Schedule for 2014

Tsunami Propagation/Inundation Mapping

Date	Topic	Organization
2011-2012	Developing archives of historical tsunami data, propagation simulation, inundation mapping.	IGP, DHN, CISMID, Tohoku Univ., BRI
2014	Updating Callao Tsunami Inundation Mapping with new bathymetry data Tsunami propagation and Inundation in Tacna	DHN, BRI, Tohoku Univ., Tohoku Gakuin Univ.

Tsunami Damage/Loss Estimation

Date	Topic	Organization
2014	Damage/loss estimation for Callao	CISMID, Tohoku Univ. , Tsukuba Univ.

Tsunami Damage Mitigation Technology

Date	Topic	Organization
2013-2014	Complete hazard map for Callao	INDECI, DHN, Tohoku Univ.
2013-2014	Strategic planning for tsunami (Evacuation plan)	INDECI, DHN, Tohoku Univ.

Muchas gracias
ありがとうございます
Thank you