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„Local-scale awareness for a global-scale phenomenon: how students at Chilean schools get prepared for tsunami risks“

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Marlene Eller

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Wien, am 23. Mai 2018

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Abstract

This diploma thesis discusses the generation and occurrence of tsunamis, as well as the management and awareness of them. It is important to know how tsunamis work and how they are generated before thinking about the handling of them. Therefore, the generation mechanisms and the occurrence of tsunamis are examined first.

Overall, four generation mechanisms are presented: earthquakes, landslides and volcanic eruptions, as well as comets and asteroids. It is a fact that seismic activity is the main cause of tsunamis and most tsunamis are generated as a result of earthquakes. The reason for that is that a permanent displacement of the sea bottom takes place and then water waves are set in motion. The main cause of tsunamigenic earthquakes are ruptures along active fault lines. Relating to that, the types of faults are explicated.

Moreover, the occurrence of tsunamis is discussed, especially in the Pacific Ring of Fire. Referring to that, the focus will lie on the Nankai Trough and the Cascadia Subduction Zone.

In addition to this, the management and the awareness of tsunami risks are an important aspect of the thesis. First the Disaster Management Cycle is explained and then the risk assessment and management are discussed in more detail. In addition, tsunami awareness is represented exemplarily with three different countries. Indonesia, Japan and Chile are compared relating to the multi-layer safety concept.

Moreover, a research in form of interviews and visits has been done in Chile. The region of Valdivia was visited to find out if there are any safety measures such as warning signs or evacuation routes. Moreover, interviews took place at the Universidad Austral de Chile and the Escuela Juan Bosch de Niebla. One interview was held with the expert of the university, namely Dr. Bruno Mazzorana, and the other ones were conducted with the headmaster of the school and two teachers. In order to be able to analyse the interviews, they were transcribed and then categorised and encoded using the software MAXQDA.

The results of the research show that there are several protective measures relating to tsunami risks in Chile. However, these measures have to be improved

as well as maintained. For instance, it is important that the evacuation routes are renewed regularly. In addition, a relocation of some routes would be of high importance, since, for example, most evacuation routes of Mehuín are on private grounds, thus they are not available immediately for all inhabitants in case of an emergency.

Relating to the preparation at school it can be said that, for instance in Niebla, great importance is attached to tsunami awareness. At the Juan Bosch School several evacuation trainings are implemented each year to prepare the students in the best possible way. Furthermore, all interview partners agreed that the children have a very high tsunami awareness – in contrast to the adults.

Zusammenfassung

Diese Diplomarbeit beschäftigt sich mit der Entstehung, dem Vorkommen sowie dem Management und dem Bewusstsein von Tsunamis. Bevor über Strategien bezüglich des Umgangs mit Tsunamis diskutiert wird, ist es zunächst wichtig zu wissen, wie Tsunamis entstehen und wodurch sie ausgelöst werden. Daher werden zuerst die Entstehungsmechanismen und das Vorkommen von Tsunamis untersucht.

Insgesamt werden vier Generationsmechanismen vorgestellt: Erdbeben, Erdrutsche, Vulkanausbrüche sowie Kometen und Asteroiden. Fakt ist, dass seismische Aktivität die Hauptursache von Tsunamis ist und die meisten Tsunamis durch Erdbeben ausgelöst werden. Der Grund dafür ist, dass eine Verschiebung des Meeresbodens stattfindet und daher Wellen in Bewegung gesetzt werden. Erdbeben werden vor allem durch Störungen entlang von aktiven Verwerfungszonen erzeugt.

Des Weiteren wird in Bezug auf das Vorkommen von Tsunamis der Pazifische Feuerring, insbesondere Nankai Trough und die Cascadia Subduction Zone, näher betrachtet.

Außerdem sind das Tsunamimanagement sowie das Tsunamibewusstsein wichtige Aspekte der Arbeit. In diesem Zusammenhang werden der Disaster Management Cycle erklärt und der Umgang mit den Risiken näher erläutert. Danach wird das Tsunamibewusstsein mithilfe dreier Länder exemplarisch dargestellt. Hierfür werden die verschiedenen Schutzmaßnahmen, einschließlich präventiver Maßnahmen, von Indonesien, Japan und Chile verglichen. Des Weiteren wurde eine Forschungsarbeit in Form von Interviews und Vor-Ort-Besuchen in Chile durchgeführt. Die Region von Valdivia wurde besucht, um herauszufinden, ob Sicherheitsmaßnahmen wie Warnschilder oder Evakuierungswege vorhanden sind. Außerdem fanden Interviews an der Universidad Austral de Chile und der Escuela Juan Bosch de Niebla statt. Ein Interview wurde mit dem Experten Dr. Bruno Mazzorana geführt, die anderen Interviews fanden mit dem Schuldirektor sowie zwei Lehrerinnen statt. Zur Analyse der Interviews wurden diese transkribiert und anschließend mit der Software MAXQDA kategorisiert und kodiert.

Die Ergebnisse der Forschung ergaben, dass Chile mehrere Schutzmaßnahmen bezüglich Tsunamirisiken vorweisen kann. Allerdings muss an der Verbesserung sowie der Instandhaltung dieser Maßnahmen gearbeitet werden. Es ist beispielsweise wichtig, dass Evakuierungsrouten regelmäßig erneuert werden. Des Weiteren wäre eine Verlagerung der Routen von hoher Wichtigkeit, da zum Beispiel in Mehuín die meisten Evakuierungsrouten auf privaten Grundstücken liegen, und sie somit in Notsituationen nicht für alle Personen sofort zugänglich sind.

In Bezug auf die schulische Vorbereitung von chilenischen Schülerinnen und Schüler kann man sagen, dass beispielsweise in Niebla großer Wert auf die Bewusstseinsbildung bezüglich Tsunamirisiken gelegt wird. In der Juan-Bosch-Schule werden mehrmals jährlich Evakuierungsübungen durchgeführt, damit die Kinder bestmöglich auf einen Tsunami vorbereitet sind. Außerdem waren alle Interviewpartner der Meinung, dass Kinder ein sehr hohes Bewusstsein aufweisen – im Gegensatz zu den Erwachsenen.

Resumen

Esta tesina discute la generación, la ocurrencia, la gestión y la conciencia de los tsunamis. Es importante saber cómo los tsunamis funcionan y cómo se generan, antes de pensar en su manejo. Por eso, primero se examinan los mecanismos de generación y la ocurrencia de tsunamis. Se presentan cuatro mecanismos de generación: terremotos, deslizamientos de tierra, erupciones volcánicas y cometas y asteroides. La causa principal de los tsunamis es la actividad sísmica y la mayoría de los tsunamis son causados por terremotos. La causa principal de los terremotos tsunamigénicos son las rupturas a lo largo de las líneas de falla activas.

Además, se discute la ocurrencia de tsunamis, especialmente el Cinturón de Fuego del Pacífico. En relación con eso, se enfoca en Nankai Trough y Cascadia Subduction Zone.

Además, la gestión y la conciencia de los riesgos del tsunami es un aspecto importante de la tesina. Primero se explica el Disaster Management Cycle y luego se analiza la gestión y la evaluación de riesgos. Además, la conciencia del tsunami está representada ejemplarmente con tres países diferentes. Se comparan Indonesia, Japón y Chile en relación con el concepto de seguridad multicapa.

Además, se realizó una investigación en forma de entrevistas y visitas en Chile. Se visitó la región de Valdivia para determinar si existen medidas de seguridad, como avisos de peligro o rutas de evacuación. Además, se realizaron entrevistas en la Universidad Austral de Chile y la Escuela Juan Bosch de Niebla, una entrevista con el experto Dr. Bruno Mazzorana de la universidad y las otras con el director de la escuela y dos profesores. Para analizar las entrevistas, fueron transcritas y luego se categorizaron y codificaron utilizando el software MAXQDA.

Los resultados de la investigación muestran que existen varias medidas de protección relacionadas con los riesgos de tsunami en Chile. Sin embargo, estas medidas deben mejorarse y mantenerse. Por ejemplo, es importante que se renueven regularmente las rutas de evacuación. Además, la reubicación de algunas rutas sería de gran importancia, ya que, por ejemplo, la mayoría de las

rutas de evacuación de Mehuín se encuentran en terrenos privados, por lo que no están disponibles de inmediato para todos los habitantes en una situación de emergencia.

En lo que respecta a la preparación en la escuela, se puede decir que, por ejemplo, en Niebla, se concede gran importancia a la conciencia de los tsunamis. En la Escuela Juan Bosch hay varios entrenamientos de evacuación cada año para preparar a los estudiantes de la mejor manera. Además, todos los entrevistados coincidieron en que los niños tienen una conciencia de tsunami muy alta, al contrario de los adultos.

1. Introduction

Tsunamis are a very fascinating, but also terrifying natural phenomenon. They can be generated in many places around the world, even though they are rather infrequent events. However, both this rarity and irregularity are responsible for the complexity of the research and forecast, even nowadays.
The main problems in this sector are the lack of spatial planning and the missing tsunami education and awareness of the inhabitants living in hazardous areas.

The thesis is divided into two main parts: a theoretical part to understand the topic and the practical one to get an insight into 'real life' and the way residents and schools in Chile tackle the problem.

Before the thesis discusses the generation mechanisms, the research questions and the using methods are presented. Literature research, as well as qualitative research in form of qualitative interviews, was done. The interviews took place in Chile, whereby one was held at the *Universidad Austral de Chile* and the other ones at the *Escuela Juan Bosch de Niebla*. To analyse the interviews the *Qualitative content analysis* according to Mayring is used. Therefore, the contents of the interviews were encoded and categorised.

In my opinion, it is important to know how tsunamis work and how they are generated, before thinking about the handling of them. Therefore, the first chapter examines the generation mechanisms and the occurrence of tsunamis. But first, the fundamental question "What is a tsunami?" is answered. In this context, important terms, such as refraction and shoaling, are explained, but also information about wavelength, wave period, wave height and the velocity of waves is given.
Then, four types of generation mechanisms are described: earthquakes, landslides, volcanic eruptions and comets and asteroids.
Since seismic activity is the most common cause of tsunamis, earthquakes are the most important generation mechanism. A permanent displacement of the sea bottom happens, which in turn leads to a displacement of the seawater and then

water waves are set in motion. Usually, the size of the tsunami depends on the earthquake's magnitude, but there is one exception, namely tsunami earthquakes. This phenomenon, which entails large and devastating tsunamis, is specified in chapter 2.1.2. Moreover, thrust faults are the most important fault type, because they are characteristic of subduction zones – the prime source of tsunamis. There are three types, but the primary reason why tsunamis are generated is that large sections of the seafloor are abruptly displaced.

Such a rapid movement of a large volume of material also occurs at landslides and is described in the next chapter. Due to the fact that there is a considerable amount of types of landslides, a classification by their volume, predominant material or their movement type can be helpful. In order for a tsunami to be generated there must be a juxtaposition of causes and a final trigger, which means that causes prepare a slope for failure.
The major problem of the next generation mechanism, the volcanic eruptions, is their irregularity, but it can be said that tsunamis generated by volcanoes are rather rare. Because of volcanoes' distribution being controlled by plate tectonics, they are often linked with seismicity.
Meteoritic tsunamis, so tsunamis generated by comets or asteroids, are very rare, because they only occur when the entire water column is disturbed.

The following chapter deals with the occurrence of tsunamis, whereby the focus lies on the Pacific Ring of Fire because it is the main region with a high seismic activity. In addition to this, two subduction zones, namely the Nankai Trough near Japan and the Cascadia Subduction Zone, which stretches from Vancouver Island down to Northern California, are amplified. These two regions were chosen as examples because subduction zones play an important role in relation to the generation and the occurrence of tsunamis.

In the next chapter the proper research and the most important part of the diploma thesis are developed: the management and the awareness of tsunami risks, thus the handling with the natural hazard. After an introduction into the context of how tsunamis work and where they occur, the chapter which discusses the management as well as the awareness follows.

First, the Disaster Management Cycle, which consists of four phases (reduction, readiness, response and recovery) and is therefore a four-phased planning system, is described. Afterwards, the different steps of risk assessment and management are amplified, however, it is a fact that the different impacts of environmental hazards are problematic. In relation to that, pre-disaster protection and post-disaster recovery play an important role. In a final step, the social system including the people, public authorities, media and the experts relating to cooperation and communication problems, is illustrated.
Then the multi-layer safety concept is presented, though it depends on the different countries, whether the concept works or not. Thus, there are three examples, namely the earthquakes in Chile in 2010, in Indonesia in 2010 too and the one in Japan in 2011. By means of these countries the big differences in context of tsunami awareness and management can be shown.

After this chapter, the practical part of the diploma thesis follows.
The research took place in Chile and discusses the tsunami management and awareness in ‘real life’ and how schools manage their students’ preparation for and awareness of tsunami risks.
During the initial planning of the thesis it was not clear that research would take place in Chile. However, Dr. Mergili enabled me to do research abroad and then the journey to Chile began. The main motivation for doing this research abroad was that the thesis should not only consist of a theoretical, but also of a practical part. Furthermore, I was very interested in seeing what the contents that I read about in the literature look like in reality. Moreover, I wanted to find out in what way Chilean schools differ from Austrian schools, how the school system works in Chile, if students get prepared for tsunami risks and if they do, what this preparation looks like in class.
Chapter 4 starts with a description of the study area Valdivia. General information as well as my personal impression regarding tsunami awareness are given. This chapter also includes photos of tsunami measures, such as warning signs.

The subsequent chapter describes the cooperation with the *Universidad Austral de Chile*. The content of the meeting with the student Karla Figueroa is reflected and then the interview with Dr. Bruno Mazzorana follows. Karla told me about her research respective the regions of Valparaíso, Mehuín, Puerto Saavedra, Queule and Toltén and provided an insight into her work. Dr. Bruno Mazzorana was interviewed as an expert and talked about current tsunami measures in Chile and explained suggested improvements relating to tsunami management.

To analyse the interviews, also including the three school interviews, the *Qualitative content analysis* according to Mayring was used. Therefore, the interviews were transcribed in a first step and then they were encoded and categorised. Both for the coding and the categorisation, the software called MAXQDA was used. Afterwards, the contents of the conversations were summarised and reflected. The transcriptions, as well as the coding of the interviews, can be found in the Appendix.

Furthermore, there was a second cooperation with the *Escuela Juan Bosch de Niebla*. At the school, overall three interviews took place, one with the headmaster of the school and two with teachers from there. The interview partners explained how they prepare their students for tsunami risks and what the evacuation trainings look like at school and in Niebla. In addition, they told me/us about the tsunami awareness of the children and the way they see it.

The last two chapters are composed of the discussion and the conclusions. The discussion summarises the results of the research and gives a specific overview.

The conclusions include a summary of the whole thesis, whereby the answers of the research questions and the solutions are discussed in more detail.

1.1 Research questions

The research questions the diploma thesis deals with are the following ones:

- How do people deal with the tsunami risks in affected areas?
- How are Chilean children prepared for tsunami risks?
- How does the preparation look like in class at Chilean schools?

1.2 Methods

Since the diploma thesis is divided into a theoretical and a practical part, different methods are used. The theoretical chapters will be developed by means of literature research and the ensuing practical chapters will be compiled using qualitative interviews.

1.2.1 Literature research

For the literature research, books, as well as scientific articles, were used, whereby the books were mainly consulted for the chapter "Generation mechanisms". Especially in the chapter "Management and awareness of tsunami risks" scientific articles were used to be up to date and because of the high practical relevance. Thus, books were rather used for basic principles and to explain the appearance of tsunamis.

1.2.2 Qualitative research

A qualitative research was conducted in form of qualitative interviews at the *Universidad Austral de Chile* and the *Escuela Juan Bosch de Niebla*, which took place in Chile.

<u>Qualitative interviews</u>

The interviews that were used are semi-structured, because it proved to be the most efficient way when there is only one opportunity to interview the interview partner. For the interviews a so called 'interview guide' was used, which "is a list of questions and topics that need to be covered during the conversation" (Cohen & Crabtree 2006: online). Hence, research questions were prepared before the interview, it leads to a more confident and competent appearance. Moreover, this method included open-ended questions, thus providing the participants the opportunity to express their views. With these kinds of questions and possible discussions, the interviews were recorded and transliterated later on. (Refer to Cohen & Crabtree 2006: online)

The interviews did not contain closed-ended questions, since it is very likely that only a one-word response will follow. Multiple questions as a single prompt were also avoided, because this can overwhelm the interviewee. Moreover, either/or questions would not have been very helpful, because then there are limited choices to answer and this can falsify the interviewee's answer. (Refer to Saldana 2011: 36-37)

It was also important to "let the participant know the backstage operations of interview mechanics, and the purpose of your study" (Saldana 2011: 41).

The interview was transcribed as soon as possible. By doing so, one gets the chance to analyse it and to become familiar with every word of the interview. However, it is not always necessary to transcribe the whole interview. It is also possible to use only the highlights or the parts which directly address the research. (Refer to Saldana 2011: 45) The transcriptions can be found in the Appendix.

Analysis according to Philipp Mayring

To analyse the interviews the *Qualitative content analysis* according to Philipp Mayring was used and thus the focus lies on the content. The analysis represents an abstract and shows the most important aspects of what the interviewee said in the interview.

The aim of the *Qualitative content analysis* is to save the strengths of the quantitative analysis and develop techniques of the systematic, qualitative orientated text analysis. (Refer to Mayring 2010: 48)

The first step of the analysis was to determine the raw material. This included the definition of the material, the analysis of the developing situation and the formal characteristics of the material. (Refer to Mayring 2010: 52-53)
For this research, only the main parts of the interviews were transcribed and used. This means that, for instance, the presentation of the topic and the aim of the research are not included.

Then the problem of the analysis followed. The direction of the analysis, which included to describe the content of the text, the emotional state of the interview partner or the text's effect on the target group, and the theory-based differentiation of the problem was discussed. (Refer to Mayring 2010: 56-57)
According to Mayring (2010: 59-60) the last step was the formation of the process model, whereby the technique of the analysis was defined first. Then, the summary and interpretation of the results and the content followed.

To analyse the results, the software called MAXQDA was used. Categories like "preparation", "tsunami awareness" and "additional information" were generated and afterwards, the contents of the interviews were encoded. The coding was converted into a table, which can be found in the Appendix, and then a concise summary of the interview's content was given.

2. Tsunami generation and their occurrence

2.1 Generation mechanisms

2.1.1 What is a tsunami?

A tsunami can be generated by an earthquake, landslides, volcanic eruptions or because of comets and asteroids. It is a wave or a series of waves which is generated by the vertical displacement of a column of water. (Refer to Bryant 2008: 3)
However, in order to acquire a better understanding of the matter, some terms have to be explained first. Although they are extremely different, tsunami waves have almost the same terminology as wind waves. Both types of waves have a wavelength, a period and a deep-water or an open-ocean height. Moreover, the terms shoaling and refraction are of high importance. (Refer to Bryant 2008: 27)

The wavelength is the distance between successive wave crests and the tsunamis' wavelengths lie between 10 km and 500 km. This fact shows the extreme difference between swell or storm waves and tsunami waves, because the tsunami's wavelength is much longer. (Refer to Bryant 2008: 29)
The wave period can be determined by the time a pair of wave crests needs to pass a point. Tsunamis usually have periods from 100 seconds to 2000 seconds, which are approximately between one and a half to 33 minutes. These kinds of waves can reach a speed of 600 to 900 km per hour in the deepest parts of the ocean. Across the continental shelf, the waves travel at speeds of 100 to 300 km per hour and the average speed at shore lies by 36 km per hour. (Refer to Bryant 2008: 28-29) This means that tsunamis can also rapidly cross large oceans like the Pacific Ocean. (Refer to Haslett 2000: 29)
The wave height is defined as the vertical distance between the through and the crest. (Refer to Haslett 2000: 20) In the open ocean, tsunami waves are like wind waves. They are often very small and generally the waves are not higher than 1 m. Therefore, ships would not notice that there is a tsunami passing beneath them. (Refer to Haslett 2000: 29)

When the tsunami reaches the coast, the wave height can be between only a few metres and 50 metres. (Refer to Koldau 2013: 14) In this context, the terms shoaling and refraction need to be explained.
Shoaling means that the sea bed interferes with the oscillatory motion of the deep-water wave and the deep-water wave turns into a shallow water wave. As a result, the wavelength and the wave velocity decrease, but because of the energy of these reductions, the wave height increases, and this leads to a steepening of the wave front. (Refer to Haslett 2000: 22)
“Refraction is an important wave modification process because it affects the distribution of wave-energy along the shore.” (Haslett 2000: 23) Some parts of a wave‒reach shallow water earlier than other parts. If these parts reach shallow water, the wave gets slower. However, the sections of the wave which are still in deep water will maintain their celerity. This means that the wave will either bend or refract. As a result of this process, waves always come parallel to the shore. (Refer to Haslett 2000: 23)

The next question that arises is how tsunamis are generated. The chapters 2.1.2, 2.1.3, 2.1.4 and 2.1.5 will examine four different generation mechanisms: earthquakes, landslides, volcanic eruptions, as well as comets and asteroids.

2.1.2 Earthquakes

Seismic activity is the most common cause of tsunamis. In the Pacific Ocean, 82.3% of all tsunamis were produced by earthquakes over the past two millennia. However, 15.000 earthquakes generated only a total of 124 tsunamis during a period of 100 years. Moreover, it is a fact that around 90% of earthquakes occur in subduction zones. (Refer to Bryant 2008: 127, 135)

Earthquakes that generate tsunamis are mainly in the upper 100 km of the oceanic crust, but it is also possible that earthquakes centred over adjacent landmass produce tsunami waves. “Earthquakes produce seismic waves transmitted through the Earth from an epicenter that can lie as deep as 700 km beneath the Earth’s surface.” (Bryant 2008: 127)

“The earthquake produces a permanent displacement of the sea bottom thereby displacing the seawater and setting in motion water waves.” (Tinti et al. 2004: 200) The displacement of the sea bottom takes place during the earthquake and therefore it is called co-seismic. It is “called co-seismic to distinguish it from the very slow adjustment preceding and following the earthquake that can only be detected by geodetic measurements […]” (Tinti et al. 2004: 200). Tinti, Armigliato and Bortolucci (2004: 200) say that only co-seismic displacements can generate tsunamis and that the vertical displacements of the sea bottom are much more important than the horizontal ones.
To measure earthquakes, the so-called Richter scale, also called local magnitude scale or M_L scale, is originally used. It is “defined as the logarithm to base ten of the maximum seismic wave amplitude recorded on a seismograph at a distance of 100 kilometres from an earthquake’s epicentre” (Bryant 2008: 129). The surface wave magnitude or M_S scale, which is more useful, “measures the largest magnitude of seismic waves at the surface at a period of 20 seconds” (Bryant 2008: 129). For the generation of a tsunami, the surface wave magnitude of the earthquake has to be 7.0 or greater on the surface wave magnitude scale; otherwise, a tsunami wave cannot be created. Teleseismic tsunamis impact across an ocean basin and are only generated by large earthquakes with a moment magnitude greater than 8.6. In this juncture, it is important to distinguish the moment magnitude from the surface wave magnitude, which has already been described above. (Refer to Bryant 2008: 129-130) In contrast, the moment magnitude (M_W) has “become the most commonly used method of describing the size of a microseism” (ESG Solutions n.d.: online). It measures the earthquake’s size as well as the amount of energy released and therefore it is more accurate in terms of describing the event’s size. (Refer to ESG Solutions n.d.: online) Edward Bryant (2008: 130) describes that “the moment magnitude does not saturate and gives a consistent measure across the complete span of earthquake sizes.”

Usually, the size of a tsunami depends on the magnitude of the earthquake. This means that the higher the earthquake’s magnitude is, the bigger the tsunami wave will be. For most teleseismic tsunamis in the Pacific Ocean, this assumption is true. However, scientists found out that also earthquakes with small and moderate seismic moments are able to create large and devastating tsunamis. These kinds of events are called tsunami earthquakes. (Refer to Bryant 2008: 130)

The following figure demonstrates the difference between an ordinary earthquake and a tsunami one.

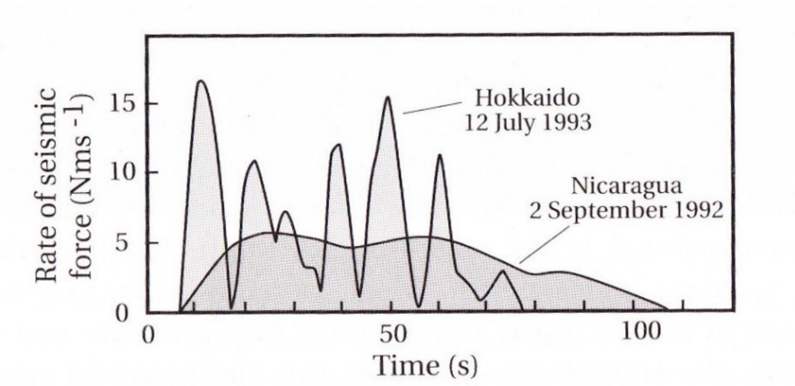

Figure 1. Comparison tsunami earthquake and ordinary earthquake. Source: Bryant 2008: 130.

The Hokkaido tsunami in 1993 was an ordinary one. The earthquake which generated the tsunami lasted for about 80 seconds and there were five large and two minor shock waves. (Refer to Bryant 2008: 131)

"In contrast, the Nicaragua tsunami of 1992 had no distinct peak in seismic wave activity." (Bryant 2008: 131) The movement along the fault line arose as a moderate disturbance, which lasted for at least 80 seconds. A tsunami earthquake is a rare type of earthquake and generates a tsunami which is much larger than the seismic magnitude would suggest. (Refer to Esteban et al. 2013: 88) The result of this earthquake was a killer tsunami.

One reason for these unusual events can be submarine landslides, "but this explanation has not been proven conclusively" (Bryant 2008: 130). Another actual assumption is "that slow rupturing along fault lines causes tsunami earthquakes" (Bryant 2008: 130). The problem with slow and silent earthquakes as a result of slow rupturing is that at first they can hardly be felt, but then produce a killer tsunami.

Another important term that must be explained is the seismic gaps.
Usually, tectonic plates are moving at rates which are consistent, which means that continual earthquake activity has been generated “over the past 150 years as stresses build up to crucial limits and are periodically released at various points along the plate margin” (Bryant 2008: 134). Moreover, some plates, like the Pacific and North American Plates in the Alaskan region, have generated continual earthquake activity. This activity has lasted over the past 150 years, because stress is first built up and then periodically released sat various points along the plate margin. However, at some points stresses are not released and these are the so-called seismic gaps. These are abnormal aseismic zones and are surrounded by seismically active regions. (Refer to Bryant 2008: 134)
Scientists believe that these gaps are prime sites for future earthquake activity. The seismic gap theory says that these gaps have a higher potential to rupture in earthquakes than regions that have recently undergone large earthquakes. (Refer to Johnson 1999: 3)
For instance, “the Alaskan earthquake of 1964 filled in one of these gaps, and a major gap now exists in the Los Angeles area” (Bryant 2008: 135). However, one should be careful when uttering statements like these, because the seismic gap concept is flawed.

Earthquakes and accrued tsunamis are chaotic geophysical phenomena. Thus, they should “be generated by a spectrum of seismic waves with varying amplitudes and periods” (Bryant 2008: 135).
Subduction zone earthquakes normally recur at the same location. Moreover, a casual glance will show that most tsunamis arise repetitively within a 100 km radius of the same location in lots of regions. (Refer to Bryant 2008: 135)

<u>How earthquakes generate tsunamis</u>

The main causes of tsunamigenic earthquakes are ruptures along active fault lines. At these fault lines “two sections of the Earth’s crust are moving opposite each other” (Bryant 2008: 135). However, there are only three types of faults that are able to generate a tsunami:

- a strike-slip earthquake on a vertical fault

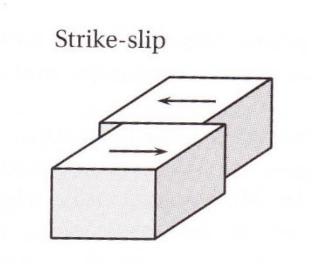

Figure 2. Strike-slip fault. Source: Bryant 2008: 136.

- a dip-slip earthquake on a vertical fault

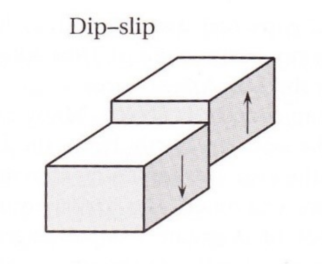

Figure 3. Dip-slip fault. Source: Bryant 2008: 136.

- a thrusting earthquake on a dipping plane

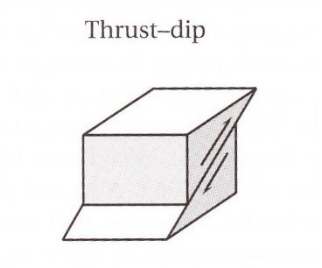

Figure 4. Thrust-dip fault. Source: Bryant 2008: 136.

Rupturing is possible at any point along a fault line and this point is known as the focal depth of the epicentre. Although all three types of faults can produce tsunamis, the configurations of the dip-slip and the thrust fault line have the best preconditions. In all three cases, large sections of the sea floor are abruptly displaced, but the most logical displacement is the one of the dip-slip mechanism, because it displaces vertically – typical for a tsunami. (Refer to Bryant 2008: 135)

Furthermore, the thrust fault is characteristic of subduction zones, which are the prime source for tsunamis, and thus this kind of fault is the preferred one for tsunami generations. Another interesting discovery is that the amplitude's size of the tsunami depends on the size of the vertical displacement – the greater the vertical displacement, the greater the amplitude of the tsunami. (Refer to Bryant 2008: 135)
However, "the length and orientation of a rupture are also important in the generation of a tsunami" (Bryant 2008: 136). It seems obvious that the rupture's length correlates with the amount of seafloor displacement. This leads to the result that long ruptures are able to create the largest tsunamis. For instance, "rupturing over a 1,000 km length of fault line caused the exceptional 1960 Chilean tsunami" (Bryant 2008: 137).

In subduction zones it is common that tsunamis, especially in the Pacific Ocean, are directed toward the centre of the ocean. (Refer to Bryant 2008: 137) However, in this case, the beaming effect has to be mentioned. The beaming effect occurs if the wave length is less than the fault length. An example which exemplifies this effect is the Alaskan earthquake tsunami in 1964. The tsunami's energy was beamed toward California and Chile, rather than having been distributed throughout the Pacific basin. (Refer to Geist 1999: 129)

2.1.3 Landslides

"The word landslide is used to describe a range of processes that result in downward and outward movement of slopeforming material composed of rock, soil and artificial materials." (Petley 2010: 63) One can also call it "mass movement", but in this context mainly the term "landslide" is used. There is a wide range of landslide types and thus it is both important and helpful to classify them by their volume, their predominant material or their movement type. (Refer to Petley 2010: 63) The actual type of movement mainly depends on the nature of the geological environment. There are three factors that count to the geological environment, namely material strength, slope configuration and pore-water pressure. (Refer to Smith 2004: 124)

Furthermore, it can be said that rapid movement types are more likely to cause death than slow ones, but slow movements can cause severe damage to buildings and infrastructure.

Causes and triggers

First, the terms cause and trigger have to be distinguished. For the occurrence of a landslide, there has to be a juxtaposition of a number of causes and a final trigger. The final failure of a slope often occurs because of a clear trigger, whereupon the most common is precipitation. Other triggers can be seismicity or the action of humans. In any case, other processes, which have prepared the slope for failure, must have been there first. These processes are called causes and among them, four types can be distinguished: geological, morphological, physical and human causes. (Refer to Petley 2010: 64-65)

Geological causes

Geological causes are responsible for making materials, which form a slope, prone to failure. This includes weak or weathered materials, materials with strong joint sets and material combinations which allow water to be retained. (Refer to Petley 2010: 64)

Morphological causes

The most typical morphological cause is the slope angle, mostly in comparison with the strength of the material. Consequently, this does not mean that steeper slopes are less stable. An example from Norway shows that “slopes formed from unweathered gneiss are able to form cliffs that can stand vertically to elevations of many hundreds of metres” (Petley 2010: 64). On the other hand, quick clays can fail at angles of 10°.

Another morphological factor is the concavity or the convexity of the slope that can lead to the concentration of water. Moreover, the loss of glacial ice and the under-cutting of cliffs can reduce the stability and thus make slopes susceptible to failure. (Refer to Petley 2010: 64)

Physical causes

Physical processes which are related to these types of causes are, for instance, the elevation of the groundwater level because of previous prolonged rainfall or snowmelt, or the loss of tree cover. These processes make a slope even more prone to shallow landslides. (Refer to Petley 2010: 64)

Human causes

“The final group of factors is centred around human activities that can destabilise a slope.” (Petley 2010: 65) Examples are the deforestation through logging or the collection of firewood and the leakage of pipes or swimming pools. Another factor of human causes is the construction of roads, whereby the problems lie in the inadequate levels of slope stabilisation and water management. Because of the building of roads, slopes have been destabilised and therefore they fail during intense precipitation events. (Refer to Petley 2010: 65)

Thus, the next question is “How can landslides generate tsunamis?”.

Landslides cause a “rapid movement of large volumes of surface materials” (Smith 2004: 123). The characteristics of tsunamis which are generated by landslides differ from tsunamis which are developed by earthquakes, because of the displacement of the seabed.

One important difference is that the direction of propagation is more focused. “The slide moves in a downslope direction, and the wave propagates both upslope and parallel to the slide.” (Bryant 2008: 184) This leads to a tsunami wave that is best characterized as an N-wave, as shown in *Figure 5.*

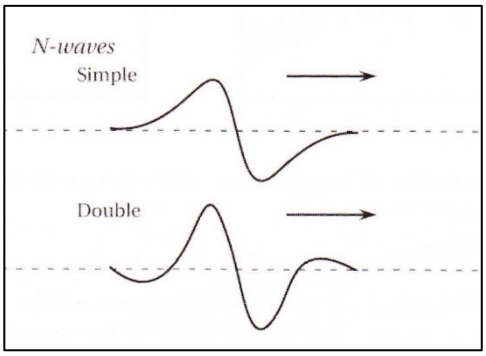

Figure 5. Simple and double N-wave. Source: Bryant 2008: 30.

The first wave is very low-crested and then a through with an amplitude that is up to three times greater follows. The second wave resembles the through because it has the same amplitude, but a decay into three or four waves with decreasing wave periods takes place. Because of the initial inequality between the first wave's crest and the succeeding through, landslide-generated tsunamis allow greater run-up heights than earthquake-generated ones. (Refer to Bryant 2008: 184-185)

There are three factors that wave generation by landslides depends on: the volume of material moved, the depth of submergence and the landslide's speed. When one knows the height of the slide, its horizontal length and the initial slope, the volume of material can be determined. *Figure 6* shows a schematic representation of such a submarine slide. (Refer to Bryant 2008: 185)

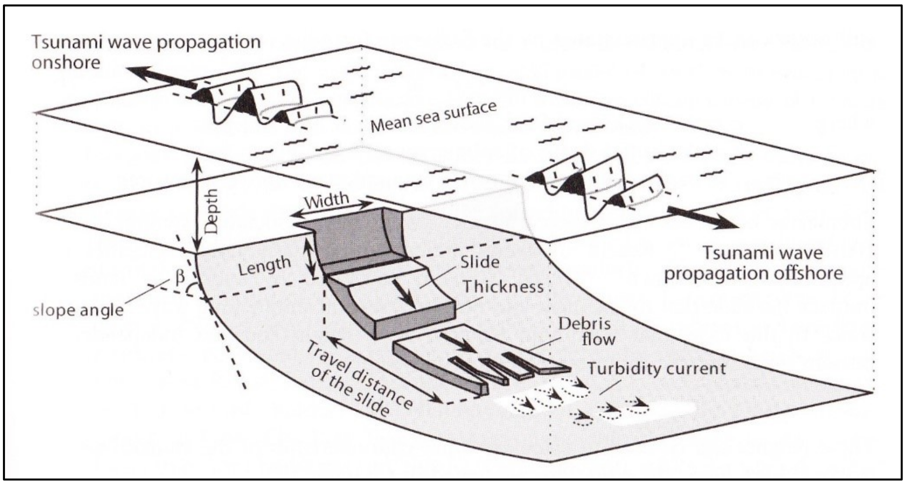

Figure 6. Schematic representation of a submarine slide. Source: Bryant 2008: 185.

"[…] a submarine landslide takes time to develop and generate any tsunami." (Bryant 2008: 185) Lots of slides decay into a debris avalanche and finally a turbidity current. However, turbidity currents are irrelevant in the tsunami's generation "because by the time sediment has become mixed with water and begun to stratify in the water column, the tsunami has been generated and is moving away from its source area" (Bryant 2008: 185).

The final speed of a slide depends on the slide's mass and density and the angle of the slope. Moreover, it can be said that the wave period of a tsunami generated by a landslide increases as the slide's size increases and the slope decreases. (Refer to Bryant 2008: 185)

2.1.4 Volcanic eruptions

The following chapter examines the third type of generation mechanisms: volcanic eruptions.

Around the world, there are about 500 active volcanoes and on average a total of 50 volcanoes erupt each year. This kind of hazard creates fewer disasters than, for example, earthquakes or severe storms. However, the most dangerous feature of volcanoes is their infrequency of eruptive events. (Refer to Smith 2004: 104)

Volcanoes can traditionally be classified as active, dormant or extinct. The result of this classification is that, for instance, Mount Lamington, a volcano considered extinct in Papua New Guinea, erupted in 1951 and killed 5000 people. Therefore, “all volcanoes that have erupted within the last 25,000 years should be regarded as at least potentially active” (Smith 2004: 104).

In the past, the causes of death, such as famine due to the destruction of crops by ashfall, were indirect rather than direct like nowadays. These days, deaths are associated with violent eruptions and volcanic mudflows, by way of example. (Refer to Smith 2004: 104)

“The distribution of volcanoes is controlled by the global geometry of plate tectonics.” (Smith 2004: 105) Thus, volcanic eruptions are often linked with seismic activity, but most volcanic earthquakes are small. Volcanoes can be found in three tectonic settings (Refer to Smith 2004: 105-106):

- subduction volcanoes
- rift volcanoes
- hot spot volcanoes

Subduction volcanoes are located where one tectonic plate is consumed and trusts beneath another one. They are the most explosive volcanoes and cover around 80 per cent of the world’s active volcanoes. (Refer to Smith 2004: 105)

Rift volcanoes, on the contrary, can be found where tectonic plates diverge. Usually this type is more effusive and less explosive. (Refer to Smith 2004: 105)

Hot spot volcanoes appear, for instance, on the Hawaiian Islands in the middle of the Pacific plate. These kinds of volcanoes exist in the middle of tectonic plates. In this area "a crustal weakness allows molten material to penetrate from the earth's interior" (Smith 2004: 106). Therefore, the Hawaiian Islands are the most common place for hot spot volcanoes.

Volcanic eruptions are a rather rare generation mechanism for tsunamis. (Refer to Smith 2004: 110) However, it is interesting how volcanic eruptions are able to trigger tsunamis.
Volcanoes cause only 4.6% of all tsunamis. (Refer to Bryant 2008: 217) The following table (*Table 1*) shows ten generation mechanisms whereby volcanic eruptions can generate tsunamis.

Table 1. Volcanic generation mechanisms for generating tsunamis. Source: Adapted from Bryant 2008: 219.

Mechanism	Percentage of events	Examples	Height (m)
Volcanic earthquakes	22.0	New Hebrides (1878)	17
Pyroclastic flows	20.0	Ruang, Indonesia (1871) Krakatau, Indonesia (1883)	25 >10
Submarine explosions	19.0	Krakatau, Indonesia (1883) Sakurajima, Japan (1780)	42 6
Caldera formation	9.0	Ritter Island (1888) Krakatau, Indonesia (1883)	12-15 2-10
Landslides	7.0	Unzen Volcano, Japan (1792)	6-9
Basal surges	7.0	Taal Volcano, Philippines	?
Avalanches of hot rock	6.0	Stromboli, Italy	?
Lahars	4.5	Mt. Pelée, Martinique (1902)	4.5
Atmospheric pressure wave	4.5	Krakatau, Indonesia (1883)	<0.5
Lava	1.0	Matavanu Volcano, Samoa (1906-1907)	3.0-3.6

Due to the fact that volcanic-generated tsunamis occur rather rarely, they will not be examined in more detail.

2.1.5 Comets and asteroids

The following chapter deals with the last generation mechanism of tsunamis: comets and asteroids. The first questions that must be answered are “What are comets and asteroids and how can they be defined?” and “What is the difference between these two terms?”.
Asteroids and comets are the two main classes of near earth objects (NEOS). NEOS “can cross the Earth’s orbit and eventually impact with the Earth” (Bryant 2008: 231).
The NASA defines a comet as “a ball of frozen gases, rock and dust that is about the size of a small town. Comets orbit the sun. Jets of gas and dust from comets form long tails that can be seen from Earth.” (May 2015: online).

In addition to this, according to Sandra May (2015: online) an asteroid is “a rocky object in space that can be a few feet wide to several hundred miles wide. Most asteroids in the solar system orbit in a belt between Mars and Jupiter.”. This belt is called asteroid belt.

It becomes evident that the biggest difference between asteroids and comets is what they are made of. Asteroids are made of rocky material and metals, while comets consist of dust, ice, organic compounds and rocky materials. Hence, asteroids are very solid, but comets lose material when they get closer to the sun because the ice melts and vaporizes. (Refer to Atkinson 2014: online)
Another difference is the “tail” of comets. The tail arises as a result of the melting ice when comets approach the sun. According to Atkinson (2014: online) the tail is “a glowing halo that extends outward from the comet as it sails through space”.

There are already some asteroids with sprouted tails named “active asteroids” which is a rather new and very rare phenomenon. When asteroids are hit or pummeled by other asteroids, the consequence is that gas or dust are ejected from their surfaces and then a sporadic tail effect occurs. (Refer to Atkinson 2014: online)

Moreover, the orbital patterns of comets and asteroids are different. Comets have very elongated and extended orbits, while asteroids tend to have more circular and short ones. (Refer to Atkinson 2014: online)

Extraterrestrial objects can be classified further by their densities: comets, carbonaceous bodies, stony asteroids and iron asteroids. Moreover, these four types have different yield strengths, which is an important factor for generating a tsunami. “The yield strength determines how easily the objects will fragment when they hit the atmosphere.” (Bryant 2008: 236) However, even when the explosion takes place in the atmosphere before the objects hit the earth’s surface, a tsunami can still be generated. Usually, objects with a diameter greater than 1 km intersect the earth’s atmosphere without exploding or fragmenting. In contrast, comets with a diameter less than 580 m and asteroids less than 320 m (stony asteroids) and 100 m (iron asteroids) in diameter tend to begin fragmenting and distorting while travelling through the atmosphere. When an object enters the atmosphere at a shallow angle, it is more likely to reach the ocean without breaking up, but this doesn’t necessarily mean that this fact leads to bigger tsunamis. (Refer to Bryant 2008)

For example, a fragmented asteroid is able to create a cavity that is ten times greater than the radius of the original asteroid because the fragments can hit the ocean as a hollow shell. However, the initial waves that are formed in this case are technically not a tsunami, because they are the result of the air blast. “The real tsunami comes about 5 seconds later when the cavity in the water collapses.” (Bryant 2008: 238)
However, it does not mean that every asteroid and comet triggers tsunamis. For instance, if an asteroid hits the ocean in the middle it would produce waves and splashes which go up tens of kilometres, but this does not necessarily mean that a tsunami will occur. Furthermore, these kinds of waves are very dispersive, which means that the waves lose their energy very quickly, in contrast to a tsunami wave. Moreover, an asteroid impact only affects the immediate region because it is a point source. Therefore, such an impact is not very dangerous unless it is close to shore. (Refer to O’Neill 2016: online)

Meteoritic tsunamis can be compared with tsunamis generated by rockfalls, but they appear very rarely. Only when the comet or asteroid disturbs the entire water column, a tsunami can be generated. (Refer to O’Neill 2016: online)

2.2 Occurrence of tsunamis

Because of the important question “Where do tsunamis arise?”, the following chapter deals with the occurrence of tsunamis. The main region with a high seismic activity is the Pacific Ring of Fire. In this context, two subduction zones will be amplified, namely the Nankai Trough near Japan and the Cascadia Subduction Zone that is located from Vancouver Island to Northern California, more precisely to Cape Mendocino.

<u>Pacific Ring of Fire</u>

The Pacific Ring of Fire “is one of the most geologically active regions of the planet” (Rinard Hinga 2015: xv). It is a string of volcanoes and because of its plate tectonics there is a lot of seismic activity. According to Evers (2015: online) there are about 90% of all earthquakes along the ring and 75% of all active volcanoes can be found there. The Ring of Fire also includes some other geologic features such as ocean trenches, hydrothermal vents and mountain trenches. (Refer to Evers 2015: online)

It is a fact that the specific tectonic setting, namely the subduction zone, is responsible for most events on the ring. Moreover, the most violent earthquakes are generated in subduction zones, as for instance the earthquake of Chile in 1960 with a magnitude of 9.5, which is thus the biggest historical event. (Refer to Rinard Hinga 2015: xviii)

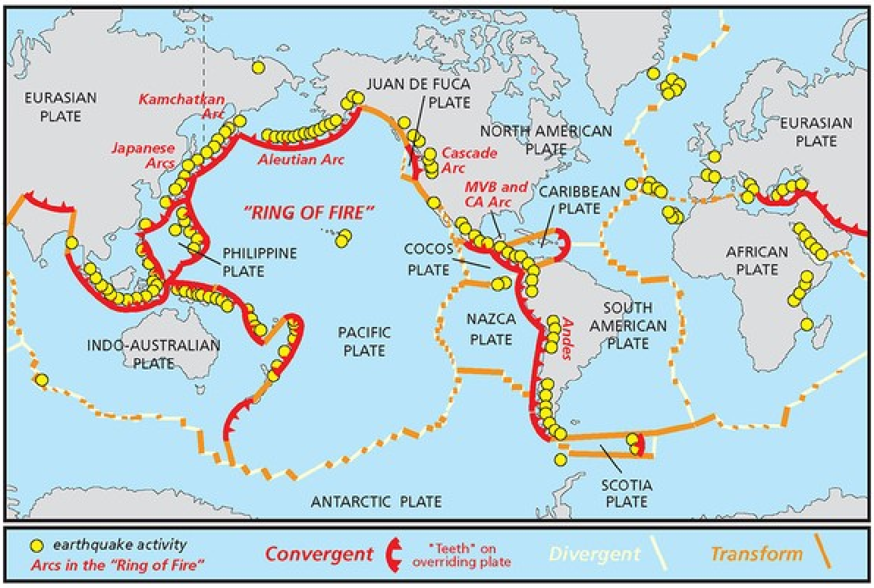

Figure 7. Pacific Ring of Fire. Source: https://www.quora.com/How-was-the-Pacific-ring-of-fire-formed-Why-is-it-so-unstable [18.01.2018].

As *Figure 7* shows, the Pacific Ring of Fire is not a circular ring but resembles a horseshoe.
Referring to Evers (2015: online), there are three different plate boundaries:

- convergent boundaries
- divergent boundaries
- transform boundaries

Convergent plate boundaries are formed because of two tectonic plates crashing into each other. Usually these boundaries are subduction zones, where one plate slips beneath the other, and, as a result, a deep trench is created. For example, South America's Andes Mountains "run parallel to the Peru-Chile Trench, created as the Nazca Plate subducts beneath the South American Plate" (Evers 2015: online).

Divergent plate boundaries occur when tectonic plates are pulling apart from each other and the results are seafloor spreading and rift valleys. An example is the East Pacific Rise, which is situated on the divergent boundary of the Cocos Plate and the Pacific Plate, the Antarctic Plate and the Nazca Plate. On this boundary, between the coasts of southern Peru and northern Chile, there is the largest group of volcanoes. (Refer to Evers 2015: online)

The last type of boundaries that can be found on the Pacific Ring of Fire is the transform boundary, which is the main reason for earthquakes. Tectonic plates slide opposite each other, but some plates' parts get stuck and stress is built. When the rock slips or breaks, the plates suddenly lurch forward and an earthquake occurs. (Refer to Evers 2015: online)
On the Pacific Ring of Fire, one of the most active faults is the San Andreas Fault, which stretches along North America's west coast and lies on the transform boundary between the Pacific Plate and the North American Plate. (Refer to Evers 2015: online)

The most active parts can be found in the North and in the West.

On the western edge of the Ring of Fire there is the island nation of Japan, which "is one of the most tectonically active places" (Evers 2015: online) worldwide.

2.2.1 Nankai Trough

Nankai Trough is a subduction zone because the Philippine Plate sub-ducts beneath southwest Japan. Every 100 to 200 years great earthquakes are generated on this site. The most recent earthquakes were the Tonankai earthquake in 1944 and the Nankaido earthquake in 1946. (Refer to Linde & Selwyn Sacks 2002: 265-266)

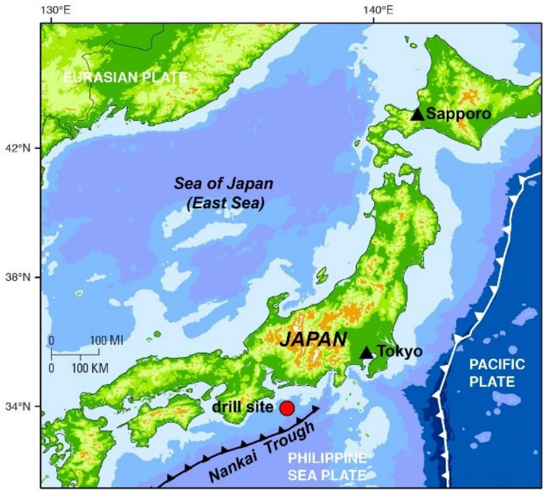

Figure 8. Nankai Trough. Source: https://soundwaves.usgs.gov/2014/08/meetings.html [19.01.2018].

There are reports that show that a slow deformation occurred before these two earthquakes. "The standard survey procedure is to measure the level difference between the endpoints twice, […]" (Linde & Selwyn Sacks 2002: 266). If there is a discrepancy between the measured level differences, it is called 'closure error'. Before the earthquake in 1944, two north-south line segments were measured, and the closure errors were larger than normally. On December 6, 1944, hence one day before the Tonankai earthquake occurred, measurements were conducted again, also including an east-west segment. The next day, scientists found large differences on north-south segments, even though there was no closure error on the east-west segment. Thus, it has been determined that the closure errors were not actual errors, but there was a slow ground tilt previous to the earthquake. (Refer to Linde & Selwyn Sacks 2002: 266)

According to Linde & Selwyn Sacks (2002: 265), this phenomenon has also occurred on the San Andreas fault and on the Cascadia Subduction Zone.

Moreover, observations also showed that there were slow changes before the occurrence of the Nankaido earthquake in 1946. It seems as if there was a slow slip on the deeper part of the subduction zone, which "increased the stress on the upper (seismogenic) section of the interface" (Linde & Selwyn Sacks 2002: 271) and thus was like a precursor for both the Tonankai and the Nankaido earthquake.

Since sections of the Nankai Trough are stressed near to failure points, there are implications for future seismic activity. (Refer to Linde & Selwyn Sacks 2002: 272)

2.2.2 Cascadia Subduction Zone

"Subduction zone megathrust faults generate the largest earthquakes in the world" (Beittel & Margesson 2012: 18). Therefore, the odds are that very large earthquakes are generated on the Cascadia Subduction Zone. Moreover, because of the proximity to the north-western coastline of the United States, the fault also represents a significant tsunami hazard. The waves of a large earthquake could reach the coast of Washington and Oregon in an hour or even less. (Refer to Beittel & Margesson 2012: 18)

Figure 9. Cascadia Subduction Zone. Source: https://de.sott.net/article/21850-Cascadia-Die-gefahrliche-Ruhe-vor-einem-Megabeben-mit-Tsunami-in-Amerikas-Nordwesten [18.01.2018].

The fault of the subduction zone is "the boundary between the subducting Juan de Fuca tectonic plate and the overriding North American plate" (Beittel & Margesson 2012: 18).

There were two recent earthquakes on the Cascadia Subduction Zone, namely the Nisqually earthquake with a magnitude of 6.8 in 2001 and the Masset earthquake with the magnitude of 7.7 in 2012. However, in both cases the damages were minor, although the Masset earthquake generated a small tsunami and triggered a tsunami warning for the Hawaiian Islands. But the measured waves were only 2.5 meters above average sea level. (Refer to Rinard Hinga 2015: 33-34)

According to Bethany Rinard Hinga (2015: 35), although there was no great earthquake, which means a magnitude greater than 8.0, in 300 years on the Cascadia Subduction Zone, it is not unlikely that there will be one in the future.

3. Management and awareness of tsunami risks

This chapter is about the management and the awareness of tsunami risks. First, there will be an introduction and a general description which includes, for instance, the Disaster Management Cycle and risk assessment and management. Furthermore, three examples of natural hazards and the risk management in three different countries will follow. In this context, the question, whether there is a difference between rich and poorer countries will be answered.

3.1 Disaster Management Cycle

The Disaster Management Cycle is a four-phase planning system whereby a variation of this cycle is used by many nations. The four phases are reduction, readiness, response and recovery. (Refer to Joyce et al. 2009: 318-319)

Figure 10. Disaster Management Cycle.
Source: Adapted from Joyce et al 2009: 319.

“Although the cycle can be considered as a continuum, traditionally the first phase of the cycle is considered to be reduction, followed by readiness, response, and recovery.” (Joyce et al. 2009: 318-319)
The reduction phase includes “all measures and planning that reduce the likelihood of a disaster occurring” (Joyce et al. 2009: 319). According to Joyce et al. (2009: 319) “the process of risk identification and reduction” is done by using

two types of modification: modifying the hazard process or modifying behaviours and the assets at risk. For the modification of the hazard process, traditional structural methods like stopbanks or seawalls are used. For the behaviour modification, land use planning plays an important role. This includes the prevention of development in hazardous areas, the incorporation of good access for evacuation and response and the facilitation of resilient and interconnected communities. Modifying assets at risk means methods such as strengthening the infrastructure and buildings and raising the heights of the floors to reduce impacts. (Refer to Joyce et al. 2009: 319)

Readiness planning is the acceptance “that some residual risk is present for communities” (Joyce et al. 2009: 319) and this means that measures have to be put in place to guarantee hazard response and the reduction of impacts. This phase includes, for example, training of emergency planners and responders, public education on hazards and their consequences, the installation of monitoring and warning systems for hazards and home preparedness, like having an evacuation plan or learning how to administer first aid. (Refer to Joyce et al. 2009: 319-320)

Although the best and most important “option for reducing the chance of a disaster is through reducing risk” (Joyce et al. 200: 320), response is also necessary because it involves the coordination processes to manage life essentials and personnel resources for various activities such as relief, evacuation, search and rescue. Furthermore, assessment is needed. (Refer to Joyce et al. 2009: 320)

The first and last phase of the cycle is recovery, which means to restore lifeline utilities and to reconstruct buildings. During this phase, measures which will reduce the risk of future disasters are often included. (Refer to Joyce et al. 2009: 320)

3.2 Risk assessment and management

Risk must be assessed and managed to reduce disaster because it cannot be eliminated. Risk assessment includes the evaluation of the significance of a risk which can either be quantitively or qualitatively. (Refer to Smith 2004: 36)

Commonly, two main categories of risks are classified: involuntary and voluntary risks. As the name suggests, involuntary risks are not knowingly or willingly undertaken. This means that the risk could possibly be unknown to the exposed person when it relates to rare events with catastrophic potential. An example would be meteorite impacts. Moreover, a risk is involuntary when it seems to be uncontrollable or inevitable, like earthquakes. (Refer to Smith 2004: 37)
In contrast, “voluntary risks are more willingly accepted. Such risks are likely to be more common, have less catastrophe potential and be capable of control.” (Smith 2004: 37). This control can happen through the modification of individual behaviour or by government action. This risk category includes manmade hazards such as risks from technology. (Refer to Smith 2004: 37)

According to Smith (2004: 38) risk assessment has the following three distinct steps:

- “[…] identification of hazards likely to result in disasters
- estimation of the risks of such events
- evaluation of the social consequences of the derived risk […]”

The problem is that environmental hazards have impacts that are variable and so some assessment of consequences is also required. “If every event resulted in the same consequences, it would be necessary only to calculate the frequency of occurrence.” (Smith 2004: 38)

“Effective risk management depends on the implementation of a sequential series of actions.” (Smith 2004: 48) There are individual stages that often overlap, however, they act as a closed loop to learn from feedback and experience. (Refer to Smith 2004: 49)
The stages can be divided in pre-disaster protection and post-disaster recovery and are evocative of the Disaster Management Cycle. Moreover, the timescales which are needed for the different activities may range from hours, like emergency evacuation, to decades, such as rebuilding damaged infrastructure.

Figure 11 shows this closed loop of risk management which is similar to the Disaster Management Cycle.

Pre-disaster protection includes the stages risk assessment, mitigation, preparedness and emergency plans. Risk assessment involves hazard identification, database assembly and the preparation of loss estimates. The aims of mitigation are the decrease or elimination of loss. These measures, which are mainly long-term ones, are taken in advance and include insurance and land planning. Preparedness means, on the one hand, forecast systems and warning schemes and on the other hand, safe refuges and stockpile aid. The last stage of pre-disaster protection is named emergency plans and includes evacuation routes, practice drills and first aid supplies. (Refer Smith 2004: 49)

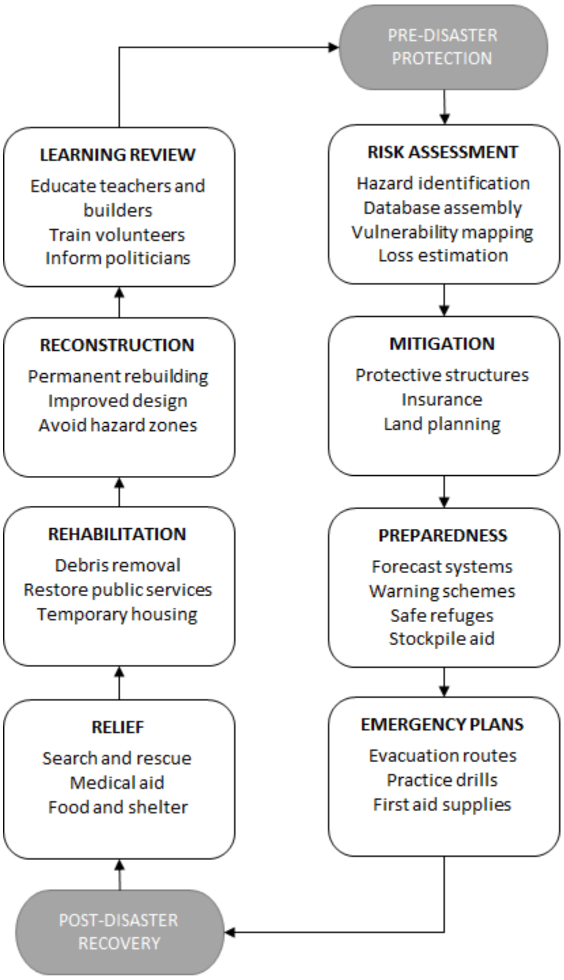

Figure 11. Pre-disaster protection and post-disaster recovery. Source: Adapted from Smith 2004: 49.

Post-disaster recovery consists of the stages relief, rehabilitation, reconstruction and learning review. The first stage is very important because it "includes the first 'golden' hours or days following the disaster impact" (Smith 2004: 49). Besides the rescue of survivors, the focus of the relief period is also on the distribution of basic supplies, such as medical aid, food, water or clothing. The following weeks or months cover the phase of rehabilitation. This stage concentrates on the removal of debris, restoration of public services and temporary housing. "[…] the priority is to enable the area to start to function again." (Smith 2004: 49) The function of reconstruction is to guide an area back to 'normality' and to improve disaster planning, like constructing hazard resistant building. The last stage, called learning review, involves the education of teachers and builders, the information of politicians and the training of volunteers. (Refer to Smith 2004: 49)

As this cycle shows, adequate feedback and learning play an important role, because the education of people enables the closure of the cycle. Moreover, communication and public information are essential. (Refer to Smith 2004: 49)
The community at risk is like a system that consists of four categories of factors, as *Figure 12* shows. (Refer to Mauro 2004: 240)

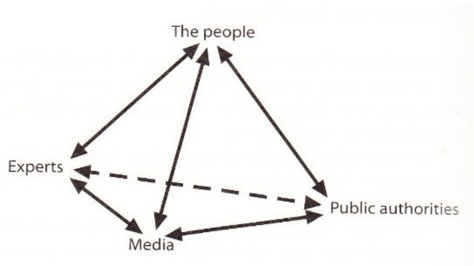

Figure 12. Social system before, during and after an emergency. Source: Mauro 2004: 240.

The people includes individuals and social groups which are either directly or indirectly exposed to the risk. The public authorities can be both local and national. The experts are scientists, researchers and practitioners. The media means the public information system, such as radio, the press or TV broadcasts. (Refer to Mauro 2004: 240)

They are like subsystems and the behaviour of each system is based on individual and common activities and interests. As mentioned before, an emergency itself consists of different phases (before, during and after). During the different phases there is an interaction of the actors of each category with the others, which takes place in different ways. These ways are based on their own interests and needs. However, these interactions among the people, public authorities, media and experts are very complex, because different levels of commitment, contents and expectations are implied. The actions and requests each actor makes influence the behaviour of the others, thus the communication appears to be bi-directional. (Refer to Mauro 2004: 240-241)
Because of the different contents of the actors' messages, the communication system is not easily assessable. Furthermore, "the distance between the people and the experts is currently wide" (Mauro 2004: 241), which means that the dialogue between the people and the media or the public authorities is significally

easier than with the scientists. A reason for “that is that the scientific system is an auto-referential one: it is only available to be judged by the same scientific environment” (Mauro 2004: 241). The main problem is the language the experts speak which is hardly spoken by common people. This fact allows the experts to place themselves at a higher level and creates the great distance. (Refer to Mauro 2004: 241) Thus, the communication between scientists and the population is usually executed through the media system. Not only the people need the communication through the media, but also the scientists because they need to recognise their interlocutors background, values, needs, commitment and expectations. (Refer to Mauro 2004: 244)

Before an event, the aim of giving information is to improve prevention and preparedness “to achieve a cultural progress of the social actors and targeted categories in the community” (Mauro 2004: 241). This kind of information takes place in normal routine conditions. “Disaster preparedness is necessary to ensure an effective response to disaster.” (Smith 2004: 67) This means that temporary evacuation plans have to be activated, medical aid must be provided, and emergency food and shelter must be prepared. In this process, various groups of people are involved. It can still be said that good preparedness is suboptimal in Least Developed Countries, but progress is happening. (Refer to Smith 2004: 67-68)

Furthermore, forecasting and warning systems (FWS) play an important role. Because of associated improvements in information and communications technology and scientific advances in weather forecasting these systems are sophisticated. “Most warnings of environmental hazard are based on forecasts but some threats (like earthquakes and droughts) are insufficiently understood and warning has to be based on predictions instead.” (Smith 2004: 70) Therefore, it is of high importance to be able to distinguish the terms predictions, forecasts and warnings.

In context of historical record of past events and statistical theory the term prediction is used. The results are expressed in terms of average probability. This means that they are long-term and have no precise indication of the moment when an event may occur. Relating to earthquakes, it is usually not possible to give precise information about the magnitude or the location of the event. (Refer to Smith 2004: 70)

In contrast, forecasts often enable the specification of time, likely magnitude and location. They depend on the evaluation and the detection “of a potentially hazardous event as it evolves” (Smith 2004: 71). As/Since forecasts tend to be short-term, they have a limited lead-time for the issue and thus the effectiveness of warnings is often restricted. (Refer to Smith 2004: 71)

Warnings are messages, which advise the people at risk about an upcoming hazard. In addition, they give instructions about what should be done to minimise losses. Warnings are based on forecasts or predictions, but “very few of the routine forecasts are followed by warnings” (Smith 2004: 71).

In case of an emergency different phases can be distinguished.

The first phase of the emergency is the (early) warning phase. During this phase, information has an enormous potential and a large influence on the reaction of the community to the upcoming threat. Therefore, it is important that the information is effective to reach a positive effect. An effective warning message must, by way of example, contain clarity and a clear description relating to the different possibilities of survival and the protection of goods. Moreover, the nature of the danger has to be described clearly and a clear indication of solutions that were chosen, as well as their benefits and problems, has to take place. (Refer to Mauro 2004: 242)

During the central phase of the emergency, hence “in the moment of crisis, the community is more or less blocked in its functions” (Mauro 2004: 242). Then the physical event turns into a social one, namely the disaster. During this phase, two official channels of information appear very quickly. On the one hand, there is the institutional channel, which is responsible for the management of the information. This includes the ways, finalities and problems which relate to the intervention that is needed. On the other hand, there is the media system as the second channel, which shows two different purposes. It provides practical service information about the activities, which the authorities need in order to manage the emergency at its best. However, the media also serves spectacular news, sometimes in the form of creating additional sub-events, just to provide

sensationalised information to get a wider audience and to endure the competition against other information channels. (Refer to Mauro 2004: 243)
During the last phase, the recovering phase, the aim of the information system is to receive its “normal” characteristics and to go back to its routine. This also means that the different actors of the social system lose their emergency characteristics and obtain a normal functioning. (Refer to Mauro 2004: 244)

Another very important term relating to tsunami risk management is resilience. First, the term itself has to be explained.
“Resilience is the ability of a system to experience unexpected and extreme changes without crossing the threshold into a different system regime.” (Villagra et al. 2016: 64) This means that a system can absorb disturbance and reorganises itself after a change to retain the same structure, identity, function and feedback capability. However, it is important to know that resilience does not mean the ability to eliminate or avoid disturbance. In the resilience thinking approach, which was introduced by Walker and Salt in 2006, it is more important to learn planning for and adapting to disturbances, because in this approach disturbances like tsunamis and earthquakes are part of systems. (Refer to Villagra et al. 2016: 64)
“The concept of resilience has been included in urban planning with the aim to address the challenges cities face from natural disasters.” (Villagra et al. 2016: 64) Therefore, the resilience thinking approach has become the framework to improve the three important steps preparation, response and recovery after a disaster on the community level. Thus, resilience has a great influence on the organisation of planning for innovative transformations, but “resilience planning requires the ability to think and prepare for successfully adapting to existing or potential adverse events” (Villagra et al. 2016: 64).

For the regulation of human communities there are seven resilience attributes that should be included in urban planning: diversity, redundancy, multi-functionality, modularity, multi-scale network and connectivity, overlap in governance and adaptability with innovation. (Refer to Villagra et al. 2016: 64)
According to Villagra et al. (2016: 64) these attributes can be defined as follows:

- Diversity means to have different options to adapt a wide range of circumstances.
- The ability to have multiple elements with similar functions that can be used if others fail is called redundancy.
- After a disaster, response diversity is required, and this is also called multi-functionality.
- In case loosely linked modules fail, modularity is needed to keep individual modules functioning.
- Multi-scale network and connectivity means “building resilient networks through redundant circuitry” (Villagra et al. 2016: 64).
- Overlap in governance is the redundancy in governance structures.
- The adaptability with innovation includes the learning and experimentation processes to develop rules and appreciate local-scale changes.

In the context of urban planning, three dimensions of resilience can be distinguished: the physical, the environmental and the social dimension. (Refer to Villagra et al. 2016: 64)

“The physical dimension refers to the characteristics of urban morphology that affect the adaptive capacity of cities […].” (Villagra et al. 2016: 64) This includes aspects such as population density, the amount of open space and evacuation routes, the distance to evacuation routes and built infrastructure that is useful for shelter. Moreover, it can be said that urban areas with more open space, public infrastructure in safe areas and more evacuation routes are more resilient than areas with long distances to evacuation routes and high population densities. (Refer to Villagra et al. 2016: 65)

The environmental dimension relates “to the characteristics or natural systems that provide advantages for survival after disaster” (Villagra et al. 2016: 65). For instance, mitigation, provisions and regulation count to these characteristics. Wide coastal forests lead to a reduction of the intensity of a tsunami and therefore, improve resilience. On the contrary, increased distance to important resources like food, wood and water decrease resilience. (Refer to Villagra et al. 2016: 65)

The last dimension is the social one, which “refers to the characteristics of communities including the percentage of people living in poverty, the amount of the population with special needs, and participation in and the number of civic and emergency organizations” (Villagra et al. 2016: 65). This means, on the one hand, that if a community has a high percentage of people living in poverty and a big amount of people with special needs it is less resilient. On the other hand, many emergency and community organisations and an increased participation in community groups lead to a higher resilience. (Refer to Villagra et al. 2016: 65)

However, there is often a problem of misleading understanding of the resilience thinking approach relating to urban planning. The main problem is the wrong “translation” of urban resilience into urban planning policies. This “leads to its incorrect conceptualization and/or implementation” (Villagra et al. 2016: 64).

However, not only risk assessment and management, but also awareness plays an important role relating to this natural hazard.

3.3 Tsunami awareness

Since the tsunami in the Indian Ocean in 2004, there has been a growing awareness of tsunami risks in many countries of the world. Because of “the frequent reoccurrence of major tsunamis in recent years” (Esteban et al. 2013: 84), the state of tsunami awareness has ameliorated. This appears through an increased disaster preparedness, knowledge and willingness of local people to evacuate quickly when the tsunami arises. However, the lack of awareness and transmission of knowledge from prior events can still be noticed. (Refer to Esteban et al. 2013: 84)
To determine the level of tsunami awareness, the existence of multiple layers of safety, which were developed by previous generations, can be analysed. According to Esteban et al. (2013: 85), this concept was not actually created to mitigate tsunami disasters, but to mitigate hurricanes since it “was developed by the Dutch after Hurricane Katrina”. Therefore, tsunami awareness should take place in a much wider scale because it is different to storm surge mitigation.

When a tsunami occurs, there is very little time to evacuate and it produces “higher inundation heights than storm surges” (Esteban et al. 2013: 85).
“Multi-layer safety is a concept in flood risk management that introduces the integration of flood risk probability-reducing measures and loss-mitigating measures in a flood protection system.” (Esteban et al. 2013: 85) It distinguishes three safety layers:

- Layer 1 – Prevention
- Layer 2 – Spatial Solutions
- Layer 3 – Emergency Management

Layer 1 means to prevent areas which are normally dry from being inundated by seawater. This safety layer takes place in form of the building of flood defences like dykes or breakwaters. (Refer to Esteban et al. 2013: 85)
Layer 2 includes the usage of spatial planning and the adaptation of buildings. The aim is to decrease the loss in case of a flood. (Refer to Esteban et al. 2013: 85)
The focus of layer 3 is the organisational preparation that includes disaster plans, early-warning systems, medical help and evacuation and risk maps. If a tsunami occurred, a rapid evacuation plan would be of primary importance. (Refer to Esteban et al. 2013: 85)

Whether the multi-layer safety concept is present depends on the different countries and regions. There are many parameters, which are mostly time-dependent, such as the degree of public awareness of tsunami risk, the value of the area and the severity and occurrence of tsunamis in the past. Moreover, the economic resources play an important role because they finance disaster management projects. Therefore, developing countries’ resources are limited and thus they often just use loss-mitigating measures, because they are much cheaper than prevention structures. However, this also means that “richer countries such as Japan have more financial resources for flood protection hard measures, such as tsunami breakwaters and dykes.” (Esteban et al. 2013: 85)

The following chapters describe different events in three countries, namely Indonesia, Japan and Chile. Firstly, there will be a description of the emergency event itself and then the level of preparedness and the risk management will follow.

3.3.1 Indonesia 2010

A large earthquake with a magnitude of 7.7 hit the west coast of the Mentawai Islands in Indonesia on October 25, 2010. Badan Meteorologi Klimatologi dan Geofisika (BMKG) of Indonesia issued a tsunami warning just 5 minutes after the earthquake. (Refer to Satake et al. 2012: 1567) However, because of a missing communication infrastructure, the tsunami warning reached the Mentawai regency office, but not the coastal communities. Nonetheless, there was a running text of a tsunami warning on TV a few minutes after the earthquake. (Refer to Satake et al. 2012: 1581)

Because of the subduction of the Indian Ocean Plate off the West coast of Sumatra, several great earthquakes, like the Sumatra-Andaman earthquake of December 26, 2004, were generated. However, no great earthquake has hit the region of the Mentawai Islands between 1797 and 1833. Hence, this area is called a seismic gap. However, in October 2010 a tsunami earthquake occurred and because of this type of earthquake, the tsunami became much larger than the seismic magnitude would have suggested. Moreover, “as with other tsunami earthquakes, the magnitude was larger at longer periods for the Mentawai earthquake” (Satake et al. 2012: 1568) and the duration was rather long with about 100 to 120 seconds. (Refer to Satake et al. 2012: 1568)

According to the Indonesian National Disaster Management Agency the official loss of life was 431 and about 90 missing people. (Refer to Lay et al. 2011: 1)

Lots of houses, which were located near the sea and commonly wooden constructions, were washed away. Moreover, there are little elements of modern infrastructure in these areas which can be seen by means of narrow motorbike paths and the transport by small boats. These are indications for no adequate tsunami multiple layer protection system on the Mentawai Islands. There was just one exception: the coastal forests in front of the villages, but they did not provide much protection. (Refer to Esteban et al. 2013: 88)

Mostly "due to the relative lack of socio-economic resources of local villagers" (Esteban et al. 2013: 88) layer 2 measures did not exist either. A clear lack of spatial planning could be noted because settlements were located too close to the sea. However, this could be expected due to the fact that Mentawai is an impoverished and remote area. Furthermore, the constructions of the houses were a serious problem. As stated above, many of them were constructed from wood and concrete bricks were only used in the walls' foundation. Especially houses with several stories would be important because in case of a tsunami, inhabitants could move to the upper stories. This is called vertical evacuation and counts to layer 3 protection. For vertical evacuation, the construction quality is very important, because poorly constructed buildings cannot be used as evacuation buildings since they would not survive the tsunami. (Refer to Esteban et al. 2013: 88)

According to layer 3 measures there was a tsunami warning system, but it did not work correctly at the time of the event. (Refer to Esteban et al. 2013: 88) The problem was that there was a new warning system placed in Indonesia, "but there were no tsunami sirens located along the most exposed shorelines near the Sumatra trench" (Løvholt et al. 2014: 128). Moreover, there were many earlier tremors and false warnings, hence many people did not take the situation seriously enough. (Refer to Løvholt et al. 2014: 128)

However, a positive aspect was that the residents had a reasonably good awareness of the threat of tsunamis and thus evacuated quickly when they were prompted. The evacuation was triggered by the inhabitants' own initiative or by the distribution of information on the radio and through aid organisations. In this context, own initiative means that people evacuated after they had felt the earthquake. (Refer to Esteban et al. 2013: 88-89)

In some areas there were tsunami drills, which could explain the evacuation preparedness of the residents. Another reason for the successful evacuations was that some regions had enough time to evacuate. This shows the existence of tsunami awareness "which appeared to be the consequence of education (tsunami drills) rather than the knowledge transmitted by previous generations"

(Esteban et al. 2013: 89). However, there should be a stronger awareness because the Mentawai Islands are located in a high tsunami risk area. But due to the fact that there has not been a tsunami for a long time and some villages are relatively new, which means that they are formed by people from other parts of the islands that are not normally affected by tsunamis, the awareness is weaker than it should be. (Refer to Esteban et al. 2013: 89) This was shown “specifically as many people ran to the beach to watch the setback of the sea” (Løvholt et al. 2014: 134) instead of running away and respectively moving to higher grounds.
Nevertheless, after the event the residents’ tsunami awareness grew stronger, which can be seen through some villages moved further inland. (Refer to Esteban et al. 2013: 89)

3.3.2 Japan 2011

The 2011 tsunami, which was a near-source tsunami, occurred on March 11, whereby the initiating earthquake had a magnitude of 9.0. Thus, it was much greater than previous ones. The tsunami run-up height reached nearly 40 meters and it affected more than 1.000 km of the Japanese coastline, which is characteristic for tsunamis with run-up heights of more than 5 meters. (Refer to Yeh et al. 2012: 1019) The earthquake arose 380 km from Tokyo and 125 km east the coast of Honshu, and shocked large parts of Japan and some parts of East China and Russia. It lasted about 3 minutes and the result was a 130 km long and 159 km wide rupture zone on the Pacific Plate at the subduction zone. (Refer to Zaré & Ghaychi Afrouz 2012: 12)
The disaster had an enormous impact on Japan’s socioeconomic situation, such as the increase of the unemployment rate in tsunami-affected areas from 5% to 8% and the decrease of the income by 10%. (Refer to Nakamura et al. 2017: 352) Moreover, the aftermaths of the natural disaster did not only concern Japan, but also the whole world because of the damages due to nuclear power plants. The Fukushima I Nuclear Power Plant exploded and was demolished and thus damaged its environment irreversibly by generating radioactive contamination. Usually, the nuclear power plants automatically shut down after an earthquake, but due to tsunami debris and high waves, the cooling system of the reactor was

damaged. A few hours before the disaster happened, authorities supposed that the cooling system could break down and ordered the evacuation of neighbouring inhabitants. Furthermore, they tried the drop of the vapours' pressure, but the hydrogen explosion could not be prevented. More than 140.000 people were evacuated, and radiation got into food and drinking water 30 km around the Fukushima plant. According to the U.S. Department of Energy, any area with a radius beyond 80 km is affected by radiation. In Japan, there are 54 reactors in total and primarily no reactors have been restarted since the tsunami. (Refer to Zaré & Ghaychi Afrouz 2012: 12-13, 15-16) However, in 2015 the nuclear power plant Sendai was the first one that was restarted after the catastrophe. Another 23 nuclear power plants have made a request for a safety inspection or are waiting for a permission to restart the reactors. (Refer to Zeit Online 2015: online)
The Japanese National Police Agency reported on nearly 16.000 dead, about 27.000 injured and over 3.000 missing people. Moreover, 125.000 buildings were destroyed by the devastating tsunami and earthquake and 1.5 million edifices had no water for a few days. It can be said that not the tsunami, but the earthquake was mostly responsible for damaging the buildings. (Refer to Zaré & Ghaychi Afrouz 2012: 12-13) In Japan, there are lots of reinforced concrete buildings, which are strong against tsunamis. The buildings' structures were able to withstand, however "the buildings were overturned by tsunami waves" (Yeh et al. 2012: 1021). Thus, the reinforced concrete buildings did not break up, but tipped over. Such a rotation failure of these kinds of buildings had never happened before. (Refer to Yeh et al. 2012: 1021)

Due to the fact that Japan had had a high tsunami awareness already prior to the event, it illustrates all 3 layers of multiple layer safety. However, it can be said that the tsunami countermeasures were not homogenous along the affected coast. (Refer to Esteban et al. 2013: 90)
Measures that count to layer 1 included tsunami walls and breakwaters along the northern coastline and sandy frontages and coastal levees in the South, which were mainly built for the protection against storm surges. However, most layer 1 measures and the regions behind them were damaged considerably. (Refer to Esteban et al. 2013: 90)

Layer 2 measures, like spatial arrangements, also existed. Important social infrastructure buildings were placed on higher grounds and the most important functions of high buildings were on higher floors. For instance, Tohokus' hospitals and schools were located on higher grounds and at the hospital of Onagawa, only the ground floor was inundated. However, on the other hand, the Disaster Prevention Centre of Minamisanriku, which was an important administration building, was destroyed because of its close location to the waterfront. (Refer to Esteban et al. 2013: 90-91)

Layer 3 measures, such as evacuation schemes and early warning systems, are well developed in Tohoku. Local residents and children frequently participate in evacuation exercises and in addition to this, the "Disaster Preparedness Day" takes place in Japan once per year on September 1. (Refer to Esteban et al. 2013: 91)

As Japan is a pioneer in crisis management, the country "has a comprehensive plan for preparing against disaster" (Zaré & Ghaychi Afrouz 2012: 14). This disaster plan consists of an advanced research system, the extensive public disaster education and cohesive rules to respond immediately to all unexpected incidents. Therefore, in case of a disaster, government officials, the people and rescue departments "know exactly what to do while the alarm is sounded, without chaos" (Zaré & Ghaychi Afrouz 2012: 14).

Furthermore, Japan installed the most advanced tsunami and earthquake warning system worldwide, "which is one of the main parts of this crisis management system" (Zaré & Ghaychi Afrouz 2012: 14). This system played an important role at the earthquake in 2011. A tsunami warning was issued just 3 minutes after the initiating earthquake. (Refer to Esteban et al. 2013: 91) Japanese media and mobile phone networks are, among other things, responsible for the broadcast of the news of early warning systems. However, one of the most important aspects was the proper behaviour of the people themselves, because they followed the commands strictly and carefully. (Refer to Zaré & Ghaychi Afrouz 2012: 14)

Nevertheless, in some regions the time to evacuate was too short and many people died, for example while trying to move to higher grounds. Moreover, although people were instructed not to use vehicles, some residents tried to escape by car and this action created “serious traffic jams which increased mortality during the evacuation” (Esteban et al. 2013: 91).

Nonetheless, Tohoku is one of the most prepared coastal areas worldwide for a tsunami emergency, including a very high level of tsunami awareness. (Refer to Esteban et al. 2013: 91) The Government of Japan acted immediately after the event and declared an emergency situation in affected areas. The Japan Self Defense Forces were dispatched for rescue operations and all ministries and departments like Ministry of Transport, Foreign Ministry and Ministry of Health were involved in the response. For example, the Ministry of Health was responsible for the preparation of vehicles to supply water and to assign hospitals to medicate people. The Ministry of Agriculture, Forestry and Fisheries as well as the Ministry of Finance were ordered to provide and distribute essential things like blankets, food, water and gas oil. The Japanese Red Crescent Society played an important role and was deployed promptly. It was responsible for the accommodation of evacuees and refugees in shelters, schools and public buildings. (Refer to Zaré & Ghaychi Afrouz 2012: 14-15)

Japan was very well prepared and educated for tsunamis, and there was just one major problem, namely that the “tsunami was more severe than the tsunami barriers were designed for” (Løvholt et al. 2014: 128). Nearly half of the disaster prevention was destroyed and even the breakwater in Kamaishi, which is the deepest one worldwide, was damaged heavily. However, though these measures were flooded and damaged, seawalls and dikes avoided greater damage, because they reduced the wave height. (Refer to Løvholt et al. 2014: 128)

3.3.3 Chile 2010

Chile is a country which has suffered from tsunamis regularly. In 1960, the last major one occurred and then, on February 27, 2010, the next large earthquake generated a tsunami. The earthquake was centred 113 km northeast of the second-largest city of Chile, which is Concepción. The earthquake had a magnitude of 8.8 and was thus the second-largest one to ever be recorded in

Chile. Over 100 aftershocks followed the initial earthquake, whereupon they reached a magnitude of 5.0 or greater. The tsunami struck the coast about 20 minutes later and in some places it moved over 600 m onto shore. (Refer to Beittel & Margesson 2012: 2-3) Thus, the following tsunami heavily damaged the coastal area. The inundation height that was measured was 4 to 10 metres throughout the Chilean coast and the tsunami reached a maximum run-up height of over 20 metres. (Refer to Esteban et al. 2013: 85)

The earthquake and the following tsunami affected about 2 million people, whereupon more than 500 people died, and 200.000 homes were destroyed or badly damaged. Lots of roads were destroyed, bridges and power lines were down, and some ports had to be closed. (Refer to Beittel & Margesson 2012: 3) However, impoverished population groups living in rural areas had the biggest problems because in some smaller cities food prices were increased and thus food was unattainable for poor people. Moreover, the loss of electricity and water lasted much longer than in the capital city Santiago, where the restoration was quick. (Refer to Beittel & Margesson 2012: 6)

The economic damage was estimated between 15 and 30 billion U.S. dollars. This means that the damage of the infrastructure could also curb Chile's recovery from the global financial crisis. (Refer to Beittel & Margesson 2012: 3)

The Chilean government tried to provide relief to the victims and launched search and rescue teams. Furthermore, the government worked on the restoration of basic services and therefore it distributed food, medical equipment and blankets in affected areas. The Chilean National Emergency Office (ONEMI) is responsible for the coordination of the relief effort. In addition, "the Chilean government appealed to the international community for aid" (Beittel & Margesson 2012: 5). It requested electric generators, water purification systems, field hospitals, satellite communications equipment and mobile bridges. Chilean officials and the United Nations agencies established a clear plan for international support and then the United States and more than 20 nations began to help Chile and provided the aid needed. Furthermore, many aid agencies offered help and waited for further instructions from the government. (Refer to Beittel & Margesson 2012: 5)

However, two major problems were the lack of prevention and absent tsunami countermeasures, and an element “of the Chilean government‘s initial response” (Beittel & Margesson 2012: 5) that has been criticized in Chile was the missing timely tsunami warning for coastal and island communities. (Refer to Beittel & Margesson 2012: 5)

Generally, it can be said that there were no adequate tsunami countermeasures developed in Chile and prevention measures did not exist. Even though they existed, it did not look like they have been there to avert the damage inflicted by natural disasters, but as a random feature of the terrain. (Refer to Esteban et al. 2013: 84-85)

Furthermore, according to Esteban et al. (2013: 86) there was only one indication of layer 2 measures, namely the houses which were built on stilts and thus survived. The mitigation of potential damage to infrastructure and buildings took place because of the enforcement and the adoption of advanced building codes that include requirements for damage reduction from earthquakes’ shaking. (Refer to Beittel & Margesson 2012: 19) This kind of protection measure was tried by citizens themselves and was not dictated at the institutional level. (Refer to Esteban et al. 2013: 86)

The assessment of the damage will give information, whether Chile’s building codes have to be changed. Various engineering teams are supported by or participated from the National Science Foundation and U.S. federal agencies with the collection and analysation of data from the hazardous event to improve domestic and international building codes. These building codes make structures more resistant to damage and collapse, but they are never completely earthquake proof and an increased structural resiliency means higher construction costs. (Refer to Beittel & Margesson 2012: 19)

This shows that people have learnt from prior tsunami events and that tsunami awareness is remained. However, it also points out that awareness did not exist on an institutional level, because it is not acceptable that a settlement exists in a possibly hazardous area. Above all, if there are not any other countermeasures and no warning system. In essence, layer 2 measures did not exist in most of the country, and when some could be found, they did not appear as part of a modern risk management, but as a consequence of historical events. (Refer to Esteban et al. 2013: 86)

Layer 3 measures existed in form of evacuation buildings or other evacuation plans. Furthermore, there was a tsunami warning system, but the authorities failed to act correctly and hence, a tsunami alert was not fired. (Refer to Esteban et al. 2013: 87) The coastal city of Valparaíso, which is located 330 km northeast of the earthquake's epicentre, was hit by the first tsunami waves 34 minutes after the initial earthquake. However, "the tsunami warnings in coastal areas were not clearly transmitted" (Beittel & Margesson 2012: 6), despite "the Chilean Navy received word of the imminent tsunami threatening the cost just 11 minutes after the initial earthquake" (Beittel & Margesson 2012: 6).

"Despite this failure, residents evacuated most coastal areas, and especially fishermen (and in some cases local policemen) instructed residents to leave due to the danger of an incoming tsunami […]." (Esteban et al. 2013: 87) Because most people followed the warnings of some local authorities and local fishermen, the number of victims was rather low. However, there was a main exception, namely an island off the coast of Constitución. On this island, dozens of people were camping and all of them died, because usually local fishermen brought people to the island and so the camping people could not evacuate. (Refer to Esteban et al. 2013: 87) Nonetheless, the low number of casualties and the evacuation speed of residents to nearby mountains because of fishermen and local authorities show "a strong tsunami awareness at the citizen level" (Esteban et al. 2013: 87). Because of that, important efforts were made at the institutional level too and various studies and research centres accepted the bid to improve disaster preparedness throughout Chile. (Refer to Esteban et al. 2013: 87)

Despite lots of criticism of the initial government response, there were also some positive aspects mentioned from disaster managers. For example, major roads like the North-South highway were restored quickly and "a careful assessment to target foreign assistance" (Beittel & Margesson 2012: 6-7) to support Chile's relief and rescue efforts. Military helicopters, tractor trailers and navy ships distributed relief and ten days after the earthquake, "90% of homes in the disaster area had regular power and water" (Beittel & Margesson 2012: 7).

Overall, it can be said that the tsunami preparedness and awareness greatly depend on whether it concerns a richer country like Japan or less developed countries like Chile or Indonesia. Japan has much more resources to finance and improve warning systems, disaster plans and the people's education for tsunami disasters. Therefore, the country itself, the inhabitants and the local authorities are better trained to handle such hazardous events. Nonetheless, Chile and Indonesia have learnt from prior events and try to improve their safety measures with resources that are available.

In a final step, the following flow chart (*Figure 13*) gives an overview of the multiple layer measures that are used in Indonesia, Japan and Chile.

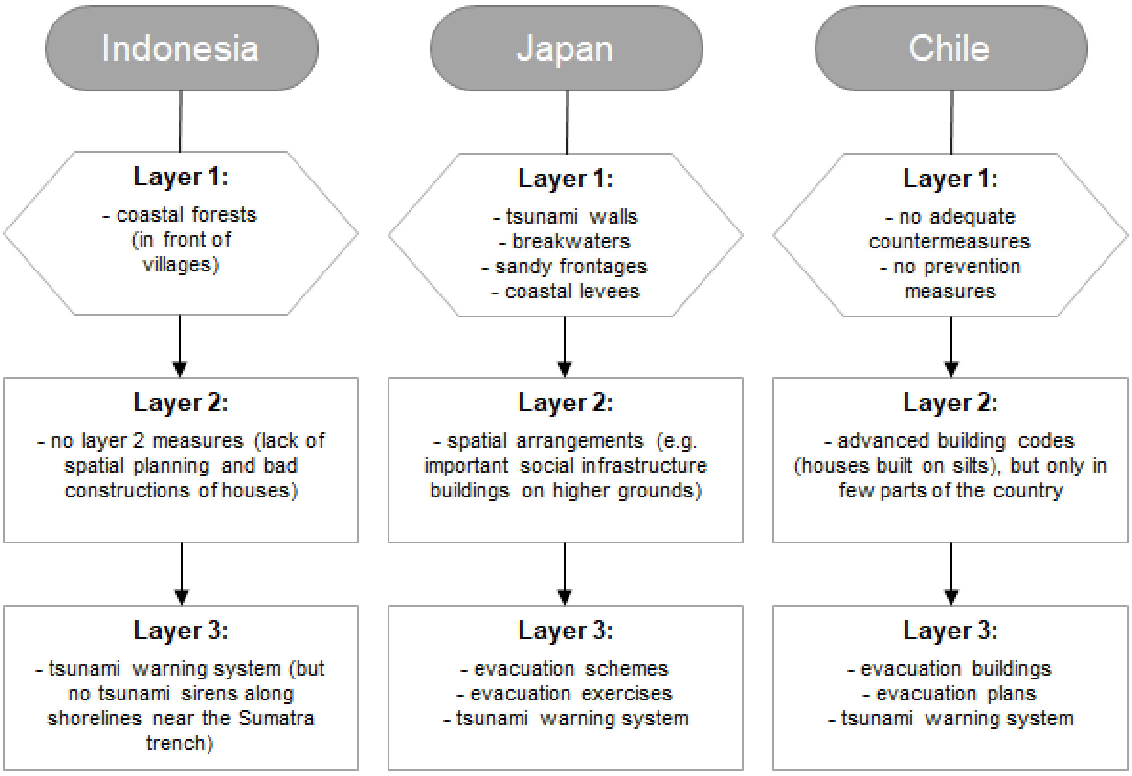

Figure 13. Overview of multiple layer measures 2018.

4. Research in Valdivia and Valparaíso, Chile

The following chapters include the practical part of the thesis and discuss the tsunami management in Chile, especially in Valdivia and Valparaíso. The first chapter describes the study area in more detail.

Moreover, there were two cooperations in Chile, one with the *Universidad Austral de Chile* and the one with the *Escuela Juan Bosch de Niebla*. The first cooperation includes a conversation with a geography student who works and does research in the tsunami sector as well as an interview with the expert Dr. Bruno Mazzorana. The second cooperation consists of three interviews with the headmaster and two teachers from a school in Niebla.

The transcriptions and the coding of the interviews, as well as the interview guidelines, can be found in the Appendix. It has to be said that the transcriptions solely include the main parts of the interviews, thus they do not include the introduction of the interviewer or the presentation of the topic.

The aim of all Chilean interviews was to determine the people's views towards life and to see how different aspects, which have been discussed in the previous theoretical chapters, are seen on-site.

4.1 Study area

The main study area was the region of Valdivia, but the interviews also include other places like Valparaíso and Mehuín.

First, it has to be said that Chile is divided into fifteen regions, whereupon the first region starts in the North and the last one ends in the South. These regions are consecutively numbered with Roman numerals.

<u>Valdivia</u>

The 14^{th} region is Los Rios and with its capital Valdivia. In Valdivia, four rivers, namely the Calle-Calle, the Valdivia River, the Cruces River and the Cau-Cau River, coalesce and divide Valdivia into some parts. Moreover, the west of

Valdivia borders on the Pacific Ocean, which means that parts of Valdivia are located at the sea. (Refer to Visit Chile n.d.: online)

In Valdivia the climate is oceanic and there is an exuberant vegetation and abundant rainfalls, especially during May, June and July, which are the winter months. (Refer to Visit Chile n.d.: online) However, there was also some heavy rain in March.

Generally, it can be said that Valdivia shows several typical characteristics of a university town. There are a lot of young people, most of them being students or pupils since Valdivia has many universities, like the *Universidad Austral de Chile* or the Universidad San Sebastián. The *Universidad Austral de Chile* is located on an island called Isla Teja, which was generated because of the confluence of the rivers.

The Chilean tsunami in 1960 was the result "of over four dozen earthquakes occurring along 1,000 km of fault line parallel to the Chilean coastline" (Bryant 2008: 144). The largest earthquake occurred with a moment magnitude of 9.5 and, respectively, a surface wave magnitude of 8.9. Within 10 to 15 minutes, a wave which was between four and five meters above normal tide level rushed in "and just as quickly raced back out to sea taking with it boats and flotsam" (Bryant 2008: 144). About an hour later "the sea returned as a thunderous 8 m wall of green water racing at 200 km h^{-1}" (Bryant 2008: 144).
As a consequence, between 5000 and 1000 people died in Chile and the property damage due to both the earthquake and the tsunami was 417 million US dollars. (Refer to Bryant 2008: 145)

Relating to tsunami management, several warning signs and evacuation routes can especially be found in Niebla which is located directly by the sea. *Figure 14* and *15* show the signs of the evacuation route. *Figure 16* shows the safe area that can be reached when one follows the signs.

Figure 14. Evacuation route 2018.

Figure 15. Evacuation route 2018.

Figure 16. Safe area 2018.

4.2 Cooperation: Universidad Austral de Chile

This chapter describes the cooperation with the *Universidad Austral de Chile*. The first conversation that took place was with the geography student Karla Figueroa, who is working in the same field of studies focusing on Mehuín and Puerto Saavedra.
This was followed by an interview with Dr. Bruno Mazzorana, who works at the *Universidad Austral de Chile.*

4.2.1 Meeting with Karla Figueroa

Karla and I got in contact through Dr. Carla Marchant. The meeting with Karla took place at the university and she talked about her research, which was very helpful. In this chapter the content of the conversation will be reflected.
Karla spoke about different regions including Valparaíso, Mehuín, Puerto Saavedra, Queule and Toltén.

Generally, it can be said that in coastal areas the raising of awareness is higher than in other areas. In many of these regions there are evacuation signs and routes, but it is unusual for tsunami education to take place in every school in such regions. Nonetheless, there are often courses during the year to train the inhabitants, but the problem is that these courses are not compulsory, which is why several people do not participate.

In every region there are different management problems, but sometimes some tsunami measures can be found too. Therefore, the five earlier mentioned regions will be examined.

Let’s start with Valparaíso. The major problem in Valparaíso is the land planning. Many houses are located under the flood line, which means that they are strongly affected by tsunamis. Thus, a lack of land planning can be noticed. Another problem, which has already been mentioned before, are the missing evacuation signs. Although Valparaíso is located directly by the sea and is an affected area, there is just one warning sign located near the port.

In Mehuín, evacuation routes and security zones can be found. However, the problem with these routes and safety zones is that they are often located on private grounds and therefore it is possible that they are closed when they are needed. Thus, the question is if it would be possible to create evacuation routes and safety zones on public properties, so that the inhabitants can use them in case of a tsunami. Moreover, these measures are often in a bad condition and thus they need a renewal.

Puerto Saavedra has several measures for the various effects of tsunamis. These measures include a recovery plan, dunes and a wall, which is very low. Moreover, this region has the only equipped refuge in Chile, which is located in a safe area called Stella Maris. This refuge offers, for example, water, an infrastructure and bathroom facilities. However, this refuge is not sufficient for all inhabitants in case of a tsunami impact.

In Queule some facilities are in safe areas. For instance, the Rayen Lafquen School is located 30 m above sea level and thus, according to ONEMI (Oficina Nacional de Emergencia del Ministerio del Interior y Seguridad Pública), it is a safe area and serves as a refuge in case of a tsunami. However, the main problem is that the location of the mentioned school is an exception. Most other facilities lie under the flood line and hence they are in hazard zones.

In the region of Toltén, Nueva Toltén, Toltén Viejo and La Barra can be found. Nueva Toltén was relocated after the earthquake in 1960, but the new location is also in a tsunami hazard zone. Thus, a lack of spatial planning can be noticed again. La Barra is a fishermen's cove with about 100 inhabitants. The major problem is that there is only one evacuation route for all people, which is a little bit ambitious and thus represents a problem for elderly people with illnesses. Moreover, the inhabitants of La Barra usually only have 15 minutes to evacuate, which depends on the magnitude of the tsunami of course.

In essence, it can be said that a lack of spatial planning exists in four of five regions. This means that the houses would have to be relocated in order for them not to be under the flood line. Moreover, some evacuation routes and measures would have to be renewed and, if possible, also relocated.

4.2.2 Interview with Dr. Bruno Mazzorana

The interview with Dr. Bruno Mazzorana took place in the interviewee's office at the *Universidad Austral de Chile*. Because of the help of Dr. Carla Marchant, I got in contact with the expert and arranged an appointment with him.
Dr. Bruno Mazzorana is originally from South Tyrol, which is the reason why the interview could have been held in German, but currently he works at the *Universidad Austral de Chile* at the Instituto de Ciencias de la Tierra.

The interview partner was informed about the topic and the aim of the research in Chile. In addition, he was asked for permission to record the interview.

One aim of the research was to find out whether the theoretical aspects read in the literature matched the statements of both the inhabitants and the experts.
The technique of the analysis is the content's summary. First, the following categories were defined:

- last tsunami
- handling
- effects

- responsible for instant and further measures
- warning systems and evacuation routes
- suggested improvements (tsunami handling and awareness)
- preparation of habitants
- preparation of children at school

In addition, information which was given but is not associated with the guideline was marked as “additional information”. Using these categories, the interview was encoded using the software MAXQDA. The coding can be found in the Appendix.

<u>last tsunami</u>
Dr. Mazzorana said that it is correct that the last meaningful tsunami hit Valdivia in 1960.

<u>handling</u>
Relating to the handling of the tsunami, the interviewee did not know it in detail and suggested literature from Wolfgang Weischet, who is an Austrian geographer, who lived in Valdivia and also reconstructed the earthquake of 1960.

<u>effects</u>
Dr. Mazzorana told me about the important Valdivian phenomenon called Riñihuazo, which was related to the earthquake and the tsunami in 1960. He mentioned this specific phenomenon because the tsunami itself did not affect Valdivia as city, but only the coastal areas of Valdivia. The city itself was affected by the consequences of the earthquake and the following tsunami, especially by the Riñihuazo. The Riñihuazo phenomenon was the high increase of the water level of the Riñihue Lake as a result of a landslide which was generated by the earthquake in 1960. This landslide blocked the lake’s outflow and therefore, the water level increased within a very short time and Valdivia was flooded. (Refer to Vergara 2015: online)

responsible for instant and further measures

The interview partner explained that the ONEMI is responsible for the inhabitants' evacuation and the preparation of the evacuation.

warning systems and evacuation routes

Dr. Mazzorana said that there are evacuation routes but that there is one major problem relating to evacuation routes. Most of the routes are not on public ground, but on a private one, which means that the access to them is not ensured. Furthermore, the routes are often in bad condition, for example a bad quality of the road surface and therefore they are not appropriate for everyone, especially not for handicapped or elderly inhabitants. Thus, it is not possible that all people come to the safe area in a safe way.

Nonetheless, there is an acoustic warning system for earthquakes and tsunamis. In addition, the warning message is distributed on mobile phones.

suggested improvements (tsunami handling and awareness)

Dr. Bruno Mazzorana also mentioned some solution opportunities. One possibility is to relocate houses to safe areas or, as a preventative measure, to avoid settlements in so-called “red zones”. The latter requires good land planning and would entail that no building of houses in hazardous zones. Another option could be the decrease of vulnerability, which can be reached by changing the construction method of houses. For example, houses could be built on stayers as thereby they are not destroyed by the first tsunami. However, it has to be considered that this measure does not work in case of a tsunami and an earthquake with a magnitude of 9 or higher.

However, the main problem is the lack of funds and therefore, it is often difficult to realise the mentioned solution opportunities. In contrast to other countries, such as Austria or South Tyrol, in Chile there are no institutions which are responsible for active protective measures. Furthermore, there is no set budget for them according to the law. Therefore, a big problem relating to these measures is that they are very punctual, because of the missing budget.

According to Dr. Mazzorana it is very important to offer incentives so that the residents see that something positive is happening. For example, several walls to divert the tsunami were built in coastal areas, especially in touristic regions.

A suggestion to make structural measures more attractive could be connecting the construction of walls with the road network. Thus, the environmental damage due to the wall constructions would have an additional function. Moreover, according to Dr. Mazzorana, the road construction would be the perfect partner to implement preventive measures. Through the road construction the needed resources such as machines, which are also needed for the construction of walls, are provided. As a result, two structural measures could be connected.

<u>preparation of inhabitants</u>
The interviewee said that evacuation trainings take place, especially in coastal areas. They are aimed at the inhabitants' preparation for emergency situations and are offered on given days.

<u>preparation of children at school</u>
With regard to the preparation of children at school he told me that there are some initiatives that try to include natural hazards and their risks in the curriculum. However, this also depends on the teachers. Dr. Mazzorana does not know if it is an inherent part of the content students must learn.
However, in his opinion it would be very important because especially in Chile all kinds of natural hazards such as earthquakes, tsunamis, landslides, flooding and avalanches can occur.

<u>additional information</u>
Dr. Bruno Mazzorana also gave some information which did not relate directly to the interview guideline. These aspects are summarised in this category.

At the beginning of the interview he gave an introduction relating to the generation of earthquakes as a result of subduction zones. In this region the

Nazca Plate subducts beneath the continental plate, which creates a lot of pressure.

Moreover, he gave an example for the problem with evacuation routes, namely Mehuín. Due to the fact that evacuation routes are on private grounds, it is also possible that gates must be opened before the people can pass them.
Furthermore, safe areas have to be examined carefully, because it must be checked if the safe area is only safe in case of a tsunami or if it is also safe in case of a landslide too. Thus, it is important to know which characteristics such a safe area has. For instance, it is important that there is an infrastructure like traversable roads to bring the people essential things like food and medicine. If this is available in a safe area it is called “equipped safe area” and Mehuín has one.

In addition, the important term resilience, which has already been discussed in a previous chapter, was mentioned. Dr. Mazzorana emphasised that resilience needs good planning. This is of high importance because without planning, resilience can fail. Moreover, resilience needs different levels, the institutional, the financial, the technical and the planning one. The problem that arises when the resilience is not planned is that it is not possible to determine which things have to be changed for a better resilience function.

Another problem in Chile is that the development of infrastructure and the planned colonisation of sparsely populated regions will lead to a higher risk because more houses and people will be located in exposed zones. As a result, the vulnerability will increase.

Here is a short excursion for better understanding:

Because Mehuín is mentioned several times during the conversation with Karla and also in the interview with Dr. Mazzorana, it will be described in more detail to see what happened and why it is used as an example so often.

“Mehuín is a small coastal city located in the Los Rios Region, in the South of Chile.” (Tumini et al. 2017: 1370) In 1960, all of Mehuín’s buildings under 10 metres above sea level were destroyed after the earthquake and the following tsunami. Moreover, because of drastic geomorphological changes, the Lingue River, which forms Mehuín’s border to the South, was modified. As a further consequence of the natural disaster, 112 fishermen’s houses, 10 commercial premises, 77 summer houses and 4 hotels were destroyed by the waves that reached 8 km inland. (Refer to Tumini et al. 2017: 1370)
After the earthquake and the tsunami, Mehuín was rebuilt “through an international cooperation programme” (Tumini et al. 2017: 1370) by the Government of Chile, which was supported by the USA. The focus of the reconstruction lay “on an area across the river called the Mississippi” (Tumini et al. 2017: 1370). This area is located on higher ground above the tsunami inundation level. It can be said that a form of land planning took place, because between 1960 and 1965 several houses were built in the elevated area so that future tsunami waves could not reach the settlement. Furthermore, new fishermen arrived to improve the techniques of traditional fishing and the water, health and school facilities were created in this period. In a following step the Maiquilahue road was built to offer a second access to the area and in 2014, the construction of a bridge that connects the old town with the area of Mississippi started. Moreover, the original neighbourhood of Mehuín was rebuilt as well and has already reached 1135 inhabitants. (Refer to Tumini et al. 2017: 1370)

4.3 Cooperation: Escuela Juan Bosch de Niebla

All three interviews took place in the *Escuela Juan Bosch de Niebla*. Thanks to the help of Carolina Quintana, who arranged an appointment with the school, three people of the school agreed to help me with the interviews.

Both the interviews with the headmaster of the school, named Pablo David Coronado Farías, and the ones with two teachers of the school were held in Spanish.

Just as at the interview with Dr. Mazzorana the interview partners were informed about the topic and the aim of the research and were asked for permission to record the interviews.

The main aim of the interview was to see how the preparation of children looks like at Chilean schools. Moreover, the focus lay on whether the students have a tsunami awareness.
Once again, the summary of the content is the analysis' technique. The following categories were used:

- preparation
- evacuation training
- tsunami awareness
- suggested improvements relating to preparation
- former event
- additional information

4.3.1 Interview with Headmaster

The interview with the headmaster of the school Pablo David Coronado Farías took place in his office in Niebla. As mentioned before, I explained the aims of the research and gave some information about the topic and the content of my thesis.

preparation

The first question was if there is a preparation for tsunamis at his school. He said that there are yearly preparation programs and at least two or three evacuations take place each year. Moreover, there is an evacuation plan, which is shown to the students, and there are also alerts. When an evacuation training takes place, the teachers and the headmaster go to the safe area with the children, which is in striking distance.

Thus, the teachers and the headmaster evacuate the children and give them instructions. It is important that the students take this training seriously and follow the instructions.

evacuation training

In the headmaster's opinion the most important using method is the evacuation training. However, there are many statutory provisions, for example: the residents of Niebla must get written information that a simulation will take place.

Since the school is located directly at the street, the cooperation with the police and partially also with the fire brigade, is important. They manage the traffic and block some streets, so that it is possible to go to the safe area with the students. As mentioned above, alerts and also megaphones are used. The headmaster said that the children are very disciplined, and that the evacuation works very well.

tsunami awareness

The interview partner told me that, in his opinion, the students have a high awareness relating to tsunamis, especially a higher one than adults.

In Niebla evacuation trainings took place three years running, and although it was organised for the whole community, most adults did not participate. Only children, all public organisations, the kindergartens and the *Escuela Juan Bosch* with all its employees participated. Thus, the headmaster said that he thinks that his school is very well prepared and passes this education and preparation on to its students. However, the problem is that the community does not take it seriously.

The headmaster answered the interview questions precisely and thus he gave no additional information.

4.3.2 Interview with Teacher 1

The second interview took place with a teacher of the school in a classroom.

<u>preparation</u>

The teacher said that the preparation surely happens in class. However, what should be taught in detail is not standardised in the curriculum and neither is at which level of education the education and preparation of natural hazards should take place. Therefore, the level of the children's knowledge differs greatly and is not standardised.

However, the teachers usually begin with volcanoes and the sea, then they go on to earthquakes and tectonic plates and relating to this they explain the possible consequences such as tsunamis.

The teacher said that at Niebla it is a little bit different because the city, as well as the school, are located in a hazardous zone. Therefore, tsunamis, the generation mechanisms and especially the consequences and risks of them are discussed in more detail.

<u>evacuation training</u>

As the headmaster has already mentioned before, there are tsunami evacuation trainings at least two times a year. The teacher said that it is very important that the students know what they have to do in case of a tsunami. Moreover, they visit the safe area regularly to be well prepared in an emergency situation.

The teacher agreed with the statement of Pablo David Coronado Farías and also said that the evacuation trainings are the most important method used. There are school internal trainings too with the aim that the students know which way is the fastest one to go outside.

The younger children are very attentive, but sometimes there are little problems with older students, because it is more difficult to encourage them to take the trainings seriously and follow the instructions of the teachers and the headmaster.

former event

The teacher told about a scenario during an evacuation simulation. The evacuation was very chaotic. The students reacted badly and did not use the right ways and then it became a very chaotic situation.

As a result, the teacher thinks that they have to work even more with the students, because this must not happen in an emergency situation.

tsunami awareness

Relating to the last question the teacher said, “Yo creo que sí […]” (Interview 3 2018: 93) Since they live in a hazardous zone, teachers as well as the parents talk a lot about the risks of tsunamis with the children. Because many fathers are fishermen, it is always a much-discussed topic.

Thus, the children have a high awareness, not only because of the preparation and education at school, but also because of the education at home.

However, the teacher said that it is of high importance that the children can distinguish between school and their homes. This means that they may have to go to two different safe areas depending on whether they are at school or at home. This is an important point that has to be explained to the children.

additional information

The teacher also gave some additional information, which was not associated with the guideline. For instance, she told that the parents are informed that the school and all employees know what they have to do in case of a tsunami and that the teachers as well as the children are well prepared and educated. This information is very important for the parents to feel a little bit safer.

4.3.3 Interview with Teacher 2

The last interview took place in the school’s library with a direct view of the sea.

preparation

The teacher said that even the youngest students know what they have to do in an emergency situation.

Furthermore, the teacher went to the sea with some pupils to understand the mechanisms of the waves in more detail. Thus, they know how a tsunami is generated and its consequences and risks.

evacuation training

She said that the students know that they have to sit under the tables when a microseism can be felt. If the tremor does not stop, they have the knowledge that they have to leave the classroom as well as the school and need to go to the safe area. Of course, the children know the way to this area and also the way out of school. The teacher explained that they have practiced the evacuation already and that they have accomplished it at record speed.

Moreover, she said that the students behave very well and that they know what they have to do. Thus there are no problems relating to the evacuation.

suggested improvements relating to preparation

However, the teacher said that the preparation could be a little bit more. The teachers need more information, more practice and more videos. Furthermore, she thinks that it would be a good possibility to teach the younger students the consequences, risks and awareness of tsunamis in form of games.

In addition, in her opinion the teachers should have more knowledge because they only have basic knowledge and they need more to educate and prepare the students even better.

tsunami awareness

Related to the question if the students are aware of the risks of tsunamis she said, “Tienen conciencia, sobre todo en esta zona.” (Interview 4 2018: 95) In her opinion, all inhabitants of the Valdivian region know what happened in 1960. The knowledge of this event is passed on to the children. Thus, they know that an earthquake has consequences and are aware of the risks of an earthquake and a tsunami.

additional information

The teacher also mentioned that it is very important that the employees of the school keep calm during an emergency situation. The students watch the teachers' reactions and if they seem nervous, the children become anxious too.

5. Discussion

The aim of the research in Chile, especially in respect of the interviews, was to compare the aspects mentioned in the literature with the people's views of life on-site. Therefore, the different aspects are discussed and compared in the following chapter. However, it has to be considered that some parts of the literature relate to the whole of Chile, whereas the research only took place in the region of Valdivia and Valparaíso.

Both in the literature and in the interviews the lack of land planning and the missing awareness on an institutional level were mentioned. It is defined as the main problem because it must not happen that settlements are built in hazardous zones, which means that the zone is under the flood line. Both the literature and the interviewees are of the opinion that this has to be changed urgently. (Refer to Interview 1 2018: 89-90, Esteban et al. 2013: 86)
Moreover, the literature would suggest that the inhabitants have a good tsunami awareness, but in the interviews, it was said that the adults are not very aware of these kinds of risks. The reason for this assumption is the fact that most habitants do not take the risk seriously enough and therefore they do not participate in evacuation trainings which are offered to the community. (Refer to Interview 2 2018: 94-95)

Relating to the prevention and tsunami countermeasures, the literature says that there is also a big lack. This statement is identical with what Dr. Mazzorana said. Even though some walls were built in touristic areas, there are no active measures in the region of Valdivia. However, in few parts of Chile advanced building codes are already used, which means that, for instance, houses are built on stilts. Nonetheless, this measure has to be improved and extended. (Refer to Esteban et al. 2013: 86, Beittel & Margesson 2012: 19, Interview 1 2018: 90)

Although evacuation buildings and plans can be found, it is not specifically mentioned in the literature whether these are on private ground or not. Thus, they might (possibly) not be (easily) accessible for all the inhabitants. Furthermore,

they could be in bad condition, thus rendering their use very difficult for elderly and handicapped people. Moreover, there is a warning system, but in some parts of Chile it did not work correctly in 2010. (Refer to Interview 1 2018: 88,92, Esteban et al. 2013: 87, Beittel & Margesson 2012: 6)
Warning signs can be found in some parts of Chile. For instance, there are several warning signs which show the evacuation route and finally the safe area in Niebla.

The biggest problem relating to active protective measures are the missing funds. There is no fixed budget for measures like these and therefore they are just punctual. Moreover, there are no specific institutions which are responsible for protective measures in Chile. In contrast, other countries do have such responsible institutions. For instance, in Austria the *Wildbach- und Lawinenverbauung (WLV)* is responsible for specific protective measures. (Refer to Interview 1 2018: 91)

However, it would be very important that the land planning is improved, and that there is a fixed budget and institutions which are responsible for fixing the problem regarding active protective measures. (Refer to Interview 1 2018: 91)
In addition, it would be of high importance that the evacuation routes are renewed and that they are no longer on private ground. So, if it is possible, they should be relocated in order for them to be usable for everyone.
Furthermore, more warning signs are needed in many regions so that the people know where they have to go in case of a tsunami. Moreover, they should know where the safe areas are located and how they can get to them.

Referring to the evacuation training, an incentive should be offered, as the habitants will be more interested and will take it more seriously. It is very important that the people know what they have to do in case of an emergency situation. Therefore, evacuation trainings are of high importance. (Refer to Interview 2 2018: 94-95)

In contrast, children take the evacuation trainings much more seriously. For example, the *Escuela Juan Bosch de Niebla* organises at least two evacuation trainings each year. The students know exactly what they have to do in case of a tsunami. They know the fastest way to get out of school, as well as the location of the safe area. (Refer to Interview 3 2018: 98, Interview 4 2018: 100)

Although neither the level of education at which the preparation and education of natural hazards should take place, nor what should be taught in detail is specified in the curriculum the children have a very high awareness – at least in Niebla. At the *Escuela Juan Bosch de Niebla* they learn about the generation mechanisms and the consequences, as well as the risks of tsunamis. Furthermore, the evacuation training is an important part of the school program, as mentioned before. (Refer to Interview 3 2018: 96)

However, there is no information about the education and preparation at other schools. Nevertheless, the interview partner said that because of the school being located in a hazardous zone, natural hazards play an important role in class and are treated in more detail. (Refer to Interview 3 2018: 96)

6. Conclusions

The aim of this chapter is to give a comprehensive overview of the thesis and to amplify and answer the research questions. At the beginning, three research questions were presented:

- How do people deal with the tsunami risks in affected areas?
- How are children prepared for tsunami risks?
- How does the preparation look like in class at Chilean schools?

Of course, the primary objective of the thesis was being able to answer these questions at the end.

However, first it was important to understand the phenomenon tsunami. This means knowing how it is generated and where it occurs. In this context four generation mechanisms, namely earthquakes, landslides, volcanic eruptions as well as comets and asteroids were described. As a result, it can be said that earthquakes are the most important generation mechanism because seismic activity is the most common cause of tsunamis. (Refer to Bryant 2008: 127)

Afterwards, the occurrence of tsunamis was highlighted, whereby the focus was on the Pacific Ring of Fire because it is the main region with a high seismic activity. In essence, subduction zones play an important role and therefore, the Nankai Trough and the Cascadia Subduction Zone were described in more detail.

How do people deal with the tsunami risks in affected areas?

To answer the research questions, the management and awareness chapter is of high importance. Indonesia, Japan and Chile were defined as affected areas and were examined in more detail. For analysing the differences relating to protective measures, the multi-layer safety concept was used. Layer 1 defines the prevention, layer 2 discusses the spatial solutions and layer 3 relates to the emergency management. There are different aspects on which the implementation of different measures depends on. (Refer to Esteban et al. 2013: 85)

Generally, it can be said that Indonesia and Chile are less prepared and educated than Japan. Referring to layer 1, Indonesia has some coastal forests in front of villages, but there are no adequate countermeasures or prevention measures in Chile. Moreover, there are no layer 2 measures in Indonesia because there is a lack of spatial planning as well as bad constructions of houses. (Refer to Esteban et al. 2013: 88) In contrast, Chile can manifest advanced building codes like houses built on silts, but only in few parts of the country. (Refer to Beittel & Margesson 2012: 19) Relating to layer 3 measures, there are tsunami warning systems in both countries. However, there were some problems with the alert in Indonesia as well as in Chile. (Refer to Esteban et al. 2013: 87) For example, there are no tsunami sirens along the shorelines near the Sumatra trench in Indonesia. (Refer to Løvholt et al. 2014: 128) In addition, there are evacuation buildings and plans in Chile. (Refer to Esteban et al. 2013: 87) For instance, the habitants of Niebla can follow the warning signs on the evacuation route which show them the way to the next safe area.

In contrast to these two countries, Japan fulfills the whole multiple layer concept. Relating to layer 1, there are tsunami walls, breakwaters, sandy frontages, as well as coastal levees. Moreover, it manifests spatial arrangements, such as important social infrastructure buildings which are located on higher grounds. In addition, Japan has evacuation schemes, evacuation exercises take place, as well as in Chile, and it has the most advanced tsunami and earthquake warning system worldwide. (Refer to Esteban et al. 2013: 90-91) Since Japan is the pioneer in crisis management, it has a comprehensive disaster plan and is very well prepared. (Refer to Zaré & Ghaychi Afrouz 2012: 14)

To answer the first research question, it can be said that different measures are used in different countries. However, it is a fact that the tsunami preparedness and awareness depends on whether it concerns a richer country or a poorer one. Indonesia and Chile have problems with financing and improving warning systems, preventive measures and the education and preparedness of the habitants for tsunami risks. However, it can be realised that Indonesia, as well as

Chile, have learnt from prior natural hazards and that they try to improve their protective measures, and in some parts a rising awareness can be noticed.

How are children prepared for tsunami risks?

In general, it can be said that there are mostly two places where children are prepared for tsunami risks: at school and at home.

The preparation at school takes up the biggest part of the preparation. In contrast, the preparation at home does not always take place. However, in many families in Niebla the parents talk a lot about tsunamis and their risks with their children. Due to the fact that many fathers are fishermen, it is a very important topic for them. As a result, the children have a very high awareness. (Refer to Interview 3 2018: 98)

However, it is very important that the children can differentiate between their home and school in case of an emergency situation. Relating to the safe areas they must have the knowledge that the safe area depends on the place where they are. This means that they may have to know different safe areas. (Refer to Interview 3 2018: 98)

How does the preparation look like in class at Chilean schools?

As mentioned, evacuation trainings play an important role and take place at least two times each year. The children take it very seriously, follow the instructions given by the teachers and the headmaster and behave very well. The evacuation training includes the evacuation from the classroom to the safe area. In addition, the tsunami alert and megaphones are used. (Refer to Interview 2 2018: 94) The results of the interview analysis show that all interview partners of the school agreed that the children show a very high tsunami awareness. The reason for this is that the children take the evacuation trainings, which are organised both at school as well as within the community, much more seriously than the adults. Consequently, this means that students at the *Escuela Juan Bosch de Niebla* are well prepared and educated for tsunami risks. (Refer to Interview 2 2018: 94-95)

Moreover, even the youngest pupils know that they have to sit under the tables in case of a microseism. When the tremor does not stop, the children know that they must leave the school and go to the safe area with their teacher. (Refer to Interview 4 2018: 100)
Since the *Escuela Juan Bosch de Niebla* is located in the hazardous zone, the generation, consequences and risks of tsunamis are explained in more detail. (Refer to Interview 3 2018: 98)

In essence, the most important method used is the evacuation training. Furthermore, the preparation in class, such as explaining how natural hazards, especially tsunamis, are generated, which consequences can follow and which risks the students have to be aware of, is of high importance for the preparedness and the education of the children.

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Appendix

Guideline for interview with Dr. Bruno Mazzorana

- When did the last tsunami take place?
- Which effects followed?
- How was the tsunami handled?
- Were there any instant measures?
    - Who was responsible for them?
- Was there a tsunami warning? Did evacuations follow?
- What happened after that? (the days afterwards)
    - What did the people do?
- Who is responsible for further measures?
    - Who gives the instructions? The government?
- Are the habitants prepared for tsunamis?
    - If yes, how?
    - Are there training courses or something like that?
- What do children learn about tsunamis at school?
- Is there anything that could be improved relating to tsunami handling and awareness?

Guideline for interviews at school

- ¿Hay una preparación de los estudiantes por riesgos de Tsunami en la clase?
- ¿Cómo se ve esta preparación?
    - ¿Cuáles métodos se usan?
- ¿Tienen los estudiantes una consciencia por los riesgos de Tsunami?

Transcription Interview 1

A – Marlene Eller

B – Dr. Bruno Mazzorana

A: Gut, dann geht es los. Der letzte Tsunami war ja 1960 hier, oder?

B: In Valdivia schon.

A: In Valdivia schon, da war 1960, da war nachher dann keiner mehr soweit ich weiß, oder?

B: Zumindest kein nennenswerter mit sage ich mal, dann, also messbare Auswirkungen.

A: Ok also 1960. Ich habe auch das, das Epizentrum, das ein Restaurant glaube ich ist, gesehen in Valdivia. Ist dort wirklich das Epizentrum?

B: Das ist eine schwierige Frage. Eigentlich, eigentlich sind hier die Erdbeben, also es ist eine Subduktionszone, das bedeutet, dass eigentlich eine Fläche entlang der Subduktionszone bricht und somit das Epizentrum schwer festzustellen ist, also woran erkennt man das Epizentrum? Ist schwierig, man kann sich ja nur vorstellen, dass man irgendwie nach der Mercalliskala, die Intensitäten sieht, aber die Intensitäten sind, wie die Mercalliskala selbst aufgebaut, sind zum Teil subjektiv und das kann ja sein, dass eigentlich das wahre Epizentrum in einer, in einer Zone ist, die gar nicht so richtig aufgenommen worden ist, aber gut, aber wenn es die wissenschaftliche Literatur belegt, dann dürfte, dann müsste man das aufgrund der wissenschaftlichen Literatur prüfen, aber nach dem neuesten Stand, also man muss sich eigentlich einen Erdbebenzyklus vorstellen, also es baut sich innere Energie auf in der Subduktionszone, also zwischen den, den Platten, der subduktierenden Platte und sage ich mal der darüber streifenden Platte, die Nazca-Platte praktisch bewegt sich unterhalb der kontinentalen Platte, dort hat es Reibungspunkte, in diesen Reibungspunkten ist das als ob ein Draht von der oberen Platte in die untere Platte, dort baut sich, sage ich mal, der Druck auf bis dann eben diese Reibungspunkte brechen und die weitere gesamte Fläche sozusagen in binnen kürzester Zeit bewegt und somit, das ist das Hypozentrum im Sinne, die Hypozone. Dann, wo in der Oberfläche die maximale Intensität registriert wurde, das ist dann aber ein anderes paar Schuhe. Es hängt dann zum Teil auch von der Fortpflanzung, der B und S Wellen ab und die hängen ja von der Beschaffenheit des Untergrunds ab, somit ist es eigentlich schwierig, je nach was dann die Magnitude betrifft, wenn man sagt die Magnitude nach der Richterskala, das misst ja die Parameter Fläche, die sich sozusagen, wo sich die Platten bewegt haben und nicht so sehr die Intensität, somit, sage ich mal, die Magnitude des Erdbebens hängt eigentlich von der Größe dieser,

dieser Rutschfläche zwischen den Platten ab und deshalb hat Valdivia diese große Magnitude, was hier effektiv eine große Fläche sozusagen, also Rutschflächen gebildet hat zwischen den Platten.

A: Ok.

B: Somit, die Magnitude hängt von dem ab, das ist nicht unbedingt das gleiche wie die Intensität. Das hängt von der Auswirkung in der Oberfläche, in der Erdoberfläche ab und das hängt von der, von der Fortpflanzung der B und S Wellen und so weiter ab und somit ist die Größe des Erdbebens Valdivia eigentlich dadurch gekennzeichnet, dass sie einfach ein großes Segment, entlang eines großes Segments, eigentlich die Rutschfläche zwischen den Platten gebildet hat.

A: Ok. Wissen Sie vielleicht wie das, wie der Tsunami, was da gemacht worden ist, also 1960 wie der Tsunami passiert ist, die Folgen danach, was haben die Menschen gemacht, wissen Sie das, haben Sie dazu irgendwas?

B: Eigentlich im Detail weiß ich es also nicht, aber was ich halt indirekt, ich habe ein paar Sachen dazu gelesen, also die alten Arbeiten von Wolfgang Weischet, das ist ein Geograph, ein österreichischer Geograph, der hat viel zur Geographie von Chile beigetragen und der hat einige Zeit lang in Valdivia gelebt und der hat das Erdbeben 1960 rekonstruiert, ich habe da ein paar Unterlagen dazu. Mein Interesse liegt vielmehr in der Auswirkung eines anderen gekoppelten Phänomens, also das sogenannte Riñihuazo, ich weiß nicht ob du davon gehört hast?

A: Nein.

B: Also das Erdbeben von Valdivia hatte mehrere Folgen, die Folgen des Erdbebens an sich, der Tsunami der dazu gekoppelt ist was ja einfach ein sage ich mal durch die Bewegung dieser Platten einfach ein großes Volumen an Wasser nach oben bewegt hat und somit sich eine Tsunami-Welle Richtung Küste hervorgerufen wurde, aber auch mehrere große Rutschungen, die den Valdivia Fluss an mehreren Stellen sozusagen blockiert haben, und somit eigentlich mehrere Seen die dahinter lagen sozusagen aufgestaut hat, und da haben dann mehrere Monate lang Einsatztruppen gearbeitet, um einen Kanal in eine dieser Rutschungen zu öffnen, damit sich dieses, dieses Wasser-Volumen langsam entleert und nicht schnell und der Riñihuazo hat sich dann glücklicherweise nicht allzu schnell entleert und sie haben die Leute evakuiert, aber doch hat er viele Schäden im ganzen Tal bis nach Valdivia hervorgerufen, somit hat es mehrere Folgen gegeben vom Erdbeben. Der Tsunami, der Tsunami hat sich eigentlich in den Küstengebieten ausgewirkt, also das Wasser ist zwar ein bisschen bis nach Valdivia aufgestaut worden, aber eigentlich in Valdivia selbst, soweit ich mitbekommen habe ist eigentlich, sind die Effekte des Tsunamis wirklich minimal gewesen, aber zum Beispiel in Corral, nicht nur in Corral, aber im ganzen Küstengebiet von Corral Richtung Valdivia, das ist ein sehr fragmentiertes

Küstengebiet, somit glücklicherweise hat sich dann auch die Tsunami-Welle aufgespalten, da sieht man wirklich, dass sich der Tsunami bis in diese Einbuchtungen hinaus, hinein ausgewirkt hat. Dort hat es größere Schäden gegeben, das heißt die Holzhäuser, die damals gebaut worden sind, die wurden komplett zerstört, die wurden eigentlich komplett zerstört, jetzt was der Tsunami an Menschenleben gekostet hat, muss ich ehrlich sagen, bin ich im Moment überfragt. Jedenfalls in Valdivia selbst hat es der Tsunami nicht geschafft, sage ich mal richtig Schäden anzurichten. Das ist mehr der Riñihuazo der eigentlich, oder das Erdbeben mal grundsätzlich, das praktisch mehrere Meter den ganzen Talboden gesenkt hat und dann darauf folgend im ganzen Tal, also vom Rio Valdivia oder Rio San Pedro, wie er weiter oben heißt, hat sich diese Hochwasser-Welle des Riñihuazo sozusagen ausgebreitet und eigentlich mehrere Dörfer, sage ich mal, stärker in Mitleidenschaft gezogen, aber die Leute wurden bereits evakuiert, weil das war ein paar Monate später. Eigentlich wussten sie den, konnten sie den Moment eigentlich vorhersagen, wann dann die größeren Abflüsse sozusagen aus diesen, aus diesen Seen-Konvolut entleert wurden und zum Beispiel Los Lagos zum Beispiel stand komplett unter Wasser, aber das ganze Tal stand komplett unter Wasser, aber die Intensität mit der sich sozusagen diese Talsohlen gefüllt haben ist natürlich glücklicherweise gering im Vergleich zu, zu einer plötzlichen, zu einem plötzlichen Versagen der Rutschungen, die sozusagen diese Seen abgeschirmt haben oder, oder blockiert haben. Wenn das jetzt einfach von heute auf morgen passiert wäre, dann wäre eigentlich die Hochwasserwelle des Riñihuazo viel gravierender gewesen von den Auswirkungen.

A: Und wer ist für die Evakuierungen zuständig, also wie läuft das ab, wie funktioniert das?

B: Heutzutage ist eigentlich die ONEMI, das wäre sozusagen das Analoge des Zivilschutzes mehr oder weniger zuständig für, für die Evakuierung und auch für die Vorbereitung und für die, sage ich mal, die ganzen Übungen dazu zuständig. Das ist eben das Problem, also sie sind zuständig, aber die Infrastruktur zum Beispiel die Evakuierungsrouten und so weiter, die sind, die sind ja nicht oder zumindest nur in den seltensten Fällen auf öffentlichen Grund, also das heißt, dass zum Teil die Evakuierungsrouten existieren, aber sie führen durch Privateigentum und das kann auch bedeuten, dass jetzt diese Evakuierungsrouten nicht unbedingt für Jedermann geeignet sind. Es kann sein, dass, dass entweder die Qualität des Straßenbelags ganz einfach schlecht ist und somit jetzt nicht unbedingt alle Altersklassen oder, oder keine Ahnung, irgendwelche andere benachteiligte Gruppen, die jetzt nicht unbedingt auf dem sichersten Weg zur sogenannten Sicherheitszone gelangen. Das ist ein Problem das ich zum Teil festgestellt habe. In Mehuín zum Beispiel, dort hat es zum Teil auch aufgrund dieser Strukturierung des Privateigentums, musste man mehrere Tore auch öffnen zum Beispiel, das kann mitunter ein Problem sein. Dann ist die Frage, im Detail muss man halt auch aufpassen, was eigentlich diese Sicherheitszone mit sich bringt, inwiefern sicher vor dem Tsunami also möglicherweise schon, also fast sicher, aber klarerweise, klarerweise, ich spreche jetzt nicht über einen spezifischen Fall, aber es gibt auch wie gesagt andere Naturgefahren, die eventuell auch Folgen haben könnten, wenn jetzt diese Sicherheitszone nur tsunamisicher ist und nicht rutschungssicher, die Tsunamis sind eine Folge des Erdbebens, aber auch die Rutschungen sind eine Folge des Erdbebens oder keine Ahnung, andere Naturgefahren eben auch dort vorkommen können, somit, somit ist das auch zu beachten, aber klar, also und vor allem kommen dann die ganzen Hilfeleistungen, sind das die Zonen wo die Hilfeleistungen einfach zu erbringen sind, das müsste man auch unter die Lupe nehmen. Aber gut, soweit, ich habe jetzt nur Mehuín gesehen, was eine sogenannte ausgestattete Sicherheitszone hat in Puerto Saavedra, was auch eine andere Zone ist, wo der Tsunami, sage ich mal, irgendwelche Einwirkungen gehabt hat, da scheint die Situation besser zu sein, ganz einfach weil schon geographisch Puerto Saavedra schon sicherer ist unter Anführungszeichen und eine Sicherheitszone, also ohne, sage ich mal, Verbindung mit Straßen, mit dem Straßennetz, sodass die ganzen Nahrungsmittel und was auch und Medikamente und so weiter, um den Zugang dieser, dieser Nahrungsmittel und Medikamente zu gewährleisten ist halt auch ein Problem, wenn die Leute länger in dieser Sicherheitszone bleiben müssen, weil, sage ich mal, das Dorf oder die Infrastruktur im Dorf total beschädigt ist und nicht verwendbar ist.

A: Das heißt was könnte man da machen, also weil Sie zum Beispiel die Evakuierungsrouten angesprochen haben, könnte man das irgendwie nicht auf privatem Grund führen, kann man das auf öffentlichen Wegen machen? Geht das irgendwie, dass man das ändern könnte?

B: Also ich denke man könnte mehrere Sachen machen, also man müsste eigentlich den gesamten Risikokreislauf auch ein bisschen sich anschauen und vor allem die präventive Seite einfach besser durchleuchten, also natürlich hängt das dann auch von den verschiedenen, von den Ressourcen, die zu Verfügung stehen ab, was man da konkret machen kann, aber andererseits wieder hängt es auch davon ab wie viele Ressourcen man verschaffen kann, um gewisse Dinge zu machen. Somit könnte man auf zwei Ebenen arbeiten, also effektiv die ganzen Strategien ausloten, die man mit den zur Verfügung stehen Ressourcen, sage ich mal, bewerkstelligen kann und Strategien zu suchen, um die Ressourcen einfach zu vergrößern die zur Verfügung stehen, somit sind zwei Ebenen, die glaube ich wichtig sind. Die eine Ebene ist mehr technisch-sozialer Natur und die andere Ebene ist mehr sozial-institutioneller Natur. Somit die erste Ebene kann man natürlich mehrere Sachen machen, also vorstellen könnte man sich natürlich die ganze Palette von den aktiv-präventiven und passiven Maßnahmen. Wobei die passiven Maßnahmen natürlich eine große Bedeutung hätten. Man muss nicht unbedingt, alle müssen im exponiertesten Teil der Küste leben und es gibt noch potentiell exponierte Teile wo man genug Häuser hinein pflanzen kann. Somit könnte man eigentlich schon das vermeiden, dass man neue, neue Häuser in diesen Zonen überhaupt zulässt, vor allem wo nachgewiesen ist, dass es sich um gefährdete Gebiete handelt oder rote Zonen heißen sie nach europäischen Mustern. Das wäre das erste, das zweite wäre zum Beispiel effektiv zu sehen, ob jetzt, ob es nicht Möglichkeiten gibt auch im längeren Zeitraum hin Anreiz zu schaffen, dass man zumindest die Lebensfunktion, also die Häuser wo die Familien leben einfach versucht in sicherere Zonen zu, zu verlagern sage ich mal und ökonomische Funktion natürlich das, also das Nötige bleibt dann natürlich an der Küste, aber das hieße ja nicht, dass man die, sage ich mal, die wirtschaftliche Seite außer Acht hält, außer Acht lässt, sondern dass man versucht progressive, exponierten Elemente zu entfernen, das wäre, das wäre auch eine, eine Strategie die man befolgen könnten. Es gibt Beispiele wo man natürlich dann auch die Vulnerabilität herabsetzt, da sage ich mal die physische Vulnerabilität, ich spreche jetzt nicht unbedingt von der sozialen Vulnerabilität, also man kann ja die Häuser auch so bauen, dass sie jetzt nicht unbedingt beim ersten Tsunami total einbrechen, man kann zum Beispiel nach, nach alten Muster auch die Häuser, sage ich mal, in der Höhe abheben und, sage ich mal, die Vulnerabilität um einiges herabsetzen, natürlich jetzt bei einem Tsunami mit einem Erdbeben von Magnitude nach der Richterskala neun und so weiter kann sein, dass das nicht ausreicht.

A: Natürlich.

B: Aber die Wahrscheinlichkeit, dass sich diese Erdbeben, sage ich mal, in kurzen Zeitspannen wiederholen ist halt dementsprechend nieder, somit, somit sind das auch Sachen die man mach kann, nicht. Das sind alles Sachen die man, allerdings, die ganzen Veränderungen am Gebäude selbst, soweit ich verstanden habe, hängen natürlich von der finanziellen Verfügbarkeit der, der Eigentümer ab und somit ist das eher fraglich, dass das eine, zumindest auf die schnelle eine allgemein gültige Strategie für ganz Chile sein könnte, ohne Anreizsystem, aber man könnte sich ja doch vorstellen, dass man ein Anreizsystem schafft, dass man beginnt eben einfach die, die Häuser auch anders zu bauen in diesen exponierten Gebieten. Theoretisch gibt es dann auch technische Maßnahmen, zum Teil werden sie ja errichtet, also Dämme und Ablenkmauern, die sozusagen, also die bezwecken sollten, dass sich der Tsunami sozusagen sobald der auf diese Ablenkmauern aufprallt sich eigentlich wieder rückwärts propagiert. Einige sind, sind gemacht worden vor allem in Küsten wo eine Anhäufung, eine Wertanhäufung zu verzeichnen ist, sehr touristische Gebiete nicht notwendigerweise in der Los Rios Region. Also ich habe gesehen, dass, dass man zum Teil, eine mögliche Strategie ist diese Ablenkdämme eigentlich auch mit einer, also mit der sogenannten, das Straßennetz zu verbinden, das heißt dass auch beim Ablenkdamm jetzt nichts dagegenspricht, wenn jetzt dort auch eine Straße ist. Es ist klar, dass während dem Tsunami diese Straße nicht befahrbar ist, aber zumindest hätte sie eine Funktion in der sogenannten Friedenszeit, also wenn kein Tsunami ist, sodass man wenn man schon, wenn man schon die Umwelt stark beeinträchtigt mit dem Bau eines solchen, eines solchen Ablenkdammes, dass zumindest auch eine günstige Zusatzfunktion dazu kommt und ich denke, dass auch der Straßenbau einer der wenigsten, einer der, im Straßenbau eigentlich noch die Ressourcen sind, um solche Dinge zu machen, weil wie baut man eine Straße - man hat die nötigen Maschinen, man verlagert die nötigen Erdmassen und so weiter, somit ist eigentlich der Straßenbau der ideale Partner, um präventiven Tsunami-Schutz auch zu machen. Ob jetzt gewisse Überlegungen jetzt in diese Richtung laufen bin ich überfragt. Ich habe für ein ähnliches Problem mehr im Hochwasser-Bereich eine ähnliche Lösung vorgeschlagen und es ist im Prinzip eine der wenigen Sachen, die man, die man, wo man sozusagen die Straßen auf einem Ablenkdamm kombiniert und somit eigentlich zwei Funktionen auf einmal bewerkstelligt, was sonst eigentlich die Leute nicht oder die anderen Institutionen schwer machen können, weil was kann schon eine Institution für Urbanistik machen, wenn sie nicht die Ressourcen hat, um zu bauen. Somit braucht es eigentlich, sage ich mal, jemanden der baut um zu bauen, also so einfach das klingen mag und das ist im Moment auch Straßenbau, weil in Chile existiert jetzt nicht eine ähnliche Institution wie zum Beispiel in einigen Ländern des Alpenraums, die für gewisse Gefahren spezifisch zuständig sind und die per Gesetz ein Budget haben, um aktive Schutzmaßnahmen zu bauen, also gut im Alpenraum ist das zum Beispiel die Wildbachverbauung, die in Österreich und in Südtirol ein Budget hat, um aktive Schutzmaßnahmen zu bauen. Das ist praktisch der Hauptexistenzgrund dieser, dieser Institutionen, einer der Existenzgründe dieser Institutionen ist, aber das ist hier, existiert hier nicht, somit müssen das notwendigerweise die (...) machen oder die, der Straßenbau also zum Beispiel. Das heißt die aktiven Schutzmaßnahmen sind sehr punktuell im Moment was Tsunami oder auch andere Gefahren betrifft, weil eigentlich das nötige Budget nicht also im Finanzgesetz sozusagen nicht fixiert wird, also einen anderen Eindruck den ich habe ist, dass hier sehr stark die sogenannte Resilienz im Vordergrund steht, was natürlich problematisch ist weil, also ich habe jetzt nichts gegen die Resilienz, ich hoffe ja, dass die Resilienz als Epiphänomen aufscheint, nicht, aber Resilienz ist eigentlich ein Epiphänomen, man muss ja eigentlich das System so verändern, dass die Wahrscheinlichkeit besteht, dass diese Resilienz effektiv aufscheint, dass die Funktionen laufen, damit das System resilient ist und somit Resilienz alleine ohne diese antizipatorische Planung, also kann sein dass das halt eben fehlschlägt, also manchmal sieht man, dass gewisse, dass in gewissen Situationen ein resilientes Verhalten, sage ich mal, aufscheint und manchmal nicht. Eigentlich müsste man die Voraussetzungen schaffen, damit das einfach wahrscheinlicher ist, dass ein resilientes Verhalten zustande kommt. Somit Resilienz ohne, sage ich mal, Rückendeckung durch die ganzen anderen Facetten, sprich institutionelle Seite, sprich finanzielle Seite, sprich technische Seite, sprich Planungsseite und so weiter ist halt nur ein Teil der Strategie und somit und das kann halt fehlschlagen. Auf der anderen Seite die ganzen Aspekte der Resilienz, vor allem der sozialen Resilienz zu vernachlässigen und glauben, dass man einfach durch technische Planung gestützte Strategien, sage ich mal, die maximale Risikoreduktion oder Minimierung schafft ist halt auch nur ein Teil der Strategie. Somit braucht es einfach beides, aber das Problem der nicht geplanten Resilienz ist, dass es, dass eigentlich man nicht nachhaltig feststellen kann, was man eigentlich verändern muss, um die Resilienzfunktionen, also die, wie sich eigentlich das System verhält verbessern kann. Das ist ein bisschen das Problem was ich halt sehe.

A: Genau, ich habe noch eine Frage und zwar, wie oder in welcher Art und Weise sind jetzt die Einwohner darauf, oder wie werden die Einwohner in, vor allem in Küstenregionen, wie werden die auf Tsunamis vorbereitet oder auf ein Erdbeben, gibt es da Schulungen, gibt es da irgendwas anderes, lernen sie in der Schule etwas darüber schon, ist das sehr unterschiedlich, kann man das so pauschal nicht sagen oder woher wissen Leute wie man sich verhalten soll?

B: Also es gibt eine Warnung, es gibt eine Warnung, vor allem für Erdbeben und Tsunami gibt es eine Warnung, die läuft über mehrere Kanäle, akustisch und über Handys und so weiter was eigentlich, ich denke ein wesentlicher Schritt vorwärts ist. Es gibt Übungen, wo an gewissen Tagen, an gewissen Tagen, sage ich mal, in den Küstengebieten die Evakuierung eingeübt wird. Es gibt soweit ich weiß einige Initiativen auch die, sage ich mal, die Naturgefahren und Naturrisiken ein bisschen in den Schulstoff einzubauen, aber das hängt auch noch zum Teil, sage ich mal, von der Initiative der einzelnen Lehrpersonen ab. Somit kann ich nicht, zumindest bin ich mir nicht sicher, was das jetzt fixer Bestandteil des Programms ist, sage ich mal, einer, einer Oberschule zum Beispiel. Hier gibt es, das Schulsystem sind, ist in basico und medio aufgeteilt. Es gibt von der ersten bis zur achten basico und dann von der ersten bis zur vierten medio, somit habe ich auch festgestellt, dass unter anderem die Schüler vor der Universität zwölf Jahre Schule haben und nicht dreizehn wie in Italien, aber gut das ist jetzt ein Detail, aber wie gesagt, ich bin mir jetzt nicht sicher, dass Naturgefahren ein fixer Bestandteil des Unterrichts ist. Wobei in Chile das schon eine gewisse Rechtfertigung finden würde, weil eigentlich alle in, Chile ist vielleicht eines der wenigen Länder, das wirklich alle Naturgefahren hat die man sich so vorstellen kann, also somit wäre das eine angebrachte Neuerung würde ich sagen, also wenn man jetzt von Erdbeben, Tsunami, Überflutung, Murgang, Rutschung, Lawinen, die ganzen Gefahren die vom Klimawandel und vom Gletscherrückgang abhängig sind, also im Prinzip hat Chile diese ganzen Gefahren und auch in einem Maßstab, den man sich zum Teil in Europa kaum vorstellen kann, also zum Beispiel ein Ausbruch eines Gletschersees, also hängt davon ab wie groß jetzt dieser Gletschersee eigentlich ist, also wenn man jetzt die Größe der Gletscherseen in den Alpen und in den Anden vergleicht, dann sind einfach verschiedene Maßstäbe und somit die Gefahren existieren und sind eigentlich relevant, zum einen kann man von Glück reden, dass die Verbauung des Territoriums in einigen Zonen eigentlich noch sehr dünn, also eine sehr dünne Dichte hat, eine geringe Dichte und somit eigentlich die Auswirkungen nicht unbedingt immer katastrophal sind, aber wenn man sich jetzt vorstellt, dass, dass Chile eigentlich plant unter anderem mit dem Programm der (...) an die Einkommenswerte der, sage ich mal, x besten Nationen oder ökonomisch am besten gelagerten Nationen der Welt anzuknüpfen durch Bau von Infrastruktur und auch Besiedlung von, von verschiedensten jetzt noch dünn besiedelten Zonen und Ausbau des Tourismus und so weiter, dann, was natürlich das Problem ist, dass sich einfach die Vulnerabilität stark vergrößert und die Exposition stark vergrößert, weil einfach mehr Leute, mehr Sachen, mehr Häuser in exponierten Zonen, sage ich mal, platziert werden, somit, wenn man jetzt nicht vorausplant, dann hat man halt einfach ein großes Risiko in der Zukunft. Im Prinzip ist ja diese Dynamik ja nicht ganz neu, also auch im Alpenraum hat man das festgestellt im letzten Jahrhundert, dass man durchaus das Risiko stark verschärfen kann indem man einfach ohne Planung exponierte Zonen einfach bebaut und besiedelt.

A: Gut.

Transcription Interview 2

A – Marlene Eller

B – Headmaster

C – Carolina Quintana

B: Nosotros, en nuestro colegio hay una preparación que se hace con los niños anualmente. Tenemos al menos dos o tres evacuaciones masivas de los niños que hay programadas. hay un plan de evacuación, donde salimos con los chicos. Hay alarmas, y en algún momento, cuando se programan, los simulacros, nosotros salimos con todos nuestros niños hacia la zona de seguridad. Los evacuamos y les damos las instrucciones. Los niños toman con alta seriedad esto, porque partiendo de nosotros mismos, los docentes, también lo tomamos con seriedad. Esta es la primera pregunta.

A: Sí. Gracias. ¿Cómo se …?

B: ¡Ah! ¿Qué método uso?

A: ¡Sí!

B: La forma para hacer los primeros simulacros, primero cumplen algunos requisitos legales. Nosotros, antes los simulacros no eran avisados. Ahora tienen que ser comunicados a la comunidad por escrito. Pensamos que el día tanto a tal hora se va a hacer un simulacro por el riesgo de accidente. Nosotros estamos aquí en una zona que es muchos vehículos que pasan. Entonces participan carabineros y, a veces, nos colaboran bomberos. Entonces, ellos cortan el tránsito y, podemos salir con nuestros niños seguros de la zona de seguridad. En este momento, una vez comunicado a la comunicad, a las autoridades este aspecto, nosotros evacuamos con otros niños. ¿De qué manera? Hay una alarma, que es una campaña. Y con un megáfono nosotros tenemos ya registradas nuestras zonas de evacuación. Los niños salen de forma ordenada y se van a la plaza que está aquí cerca del puerto que alcanza … ¿Se llama cota u cuota?

C: Cota.

B: La cota 25 parece. Y allí tenemos nuestra zona de seguridad.

A: ¿Y tienen los estudiantes una consciencia por los riesgos?

B: A mí me sorprende que en los estudiantes haya una consciencia. Ellos están mucho más conscientes que los adultos en cuanto a su propia seguridad. Y eso siempre me ha llamado la atención, porque tres años seguidos se han hecho evacuaciones con toda la comunidad. Y los únicos que participamos son los niños, el consultorio, todas las organizaciones de tipo público. El jardín infantil, las salas cuna, pero la gente adulta no tiene la consciencia. No participa en esto. Porque estos simulacros son con toda la comunidad, pero toda la comunidad no participa. La escuela sí en su totalidad. Nosotros participamos con los decentes, con los asistentes de educación, las cocineras, toda la gente que en este momento está en la escuela tiene que hacer en público el protocolo de evacuación. Nosotros como escuela, considero que estamos bien preparados para actuar ante una emergencia. Pero siento que la comunidad no lo ha asumido en forma más seria. Pero sí los niños. Los niños tienen más consciencia.

A: ¡Muchas gracias!

Transcription Interview 3

A – Marlene Eller

B – Teacher

C – Carolina Quintana

A: ¿Hay una preparación de los estudiantes por riesgos de tsunami en la clase? (risa)

B: Sí, a ver, no es tan propia nuestra tal vez del (...) porque está incluido en el programa estudio de los estudiantes. Esto comienza desde los 4 años, que es en NT1, empezamos a hablar sobre los volcanes, sobre el mar. No es tan precioso o direccionado, pero en el tercero básico se habla directamente sobre las capas tectónicas, cómo se produce un terremoto, todo relacionado. Esto está en el plan de estudios y se trabaja una unidad completa. Luego hay que calificar, ya. Entonces nosotros no podemos optar a eso, porque ya viene así, desde tercero a octavo en distintos tiempos. Unos comienzan en la unidad uno, otros en la tres o en la cuatro, pero esto se trabaja. Y el grado de información y de conocimiento que se les da, va a depender de la edad que ellos tengan. Esto, por una parte. Ya estamos nosotros como establecimiento, porque estamos insertos y estamos en riesgo en el fondo. En los cursos más pequeños, nosotros les mostramos las zonas de peligro y les mostramos las zonas donde podemos refugiarnos. Felizmente, acá es cerquita. Una forma de prevención. Se hacen simulacros de tsunami, al menos dos veces al año desde que sucedió el 27F hemos hecho dos simulacros de tsunami, pero aquí a nivel de comunidad. Con todas las inclusiones de (...) está la cuna, nos reunimos allá en nuestra zona segura que es en la plaza. Nosotros como establecimiento reforzamos periódicamente qué pasa cuando hay un temblor, un movimiento telúrico por decirlo así. Que se meten bajo la puerta, hay un niño que es el encargado de abrir la puerta a los profesores y, luego, bueno allí se da la conversación de manera espontánea de si hay un movimiento telúrico como estamos al lado del mar, lo más seguro es que vaya a haber un tsunami de acuerdo a la intensidad que tenga el movimiento telúrico. Entonces si la pregunta dice si hay una evaluación de los estudiantes por los riesgos del tsunami en la clase, se va para más allá. Explicamos cómo se produce un tsunami, cuáles son los riesgos, dónde están las zonas seguras y qué debemos hacer y qué no debemos hacer. También nosotros vamos un poquito más allá, porque nosotros vivimos esto como colegio con los apoderados. Porque la primera vez cundo sucedió en febrero, se … ¿Cuánto es? 4 años atrás, 5 años atrás. ¿Tanto?

C: Fue el 2010.

B: Ah sí, tienes razón. Lo que pasa es que el año 2014 hubo también un movimiento telúrico grande. Yo me acuerdo porque estaba recién llegada a este colegio.

C: Esto fue (...).

B: Si, y se dio alerta, todo lo que estaba al alrededor de … Hubo un movimiento telúrico y, entonces el año anterior, no me acuerdo bien. La cosa es que nosotros porque fue fuerte, se sintió porque normalmente que hay, pero no se sintió. Yo acá, todavía no llegábamos a la puerta con el primer grupo de estudiantes y, afuera estaba colapsado con vehículos, colapsados de papás que estaban al borde de histeria. Nosotros queríamos salir, los papás querían entrar. Fue realmente un colapso. Fue espantoso. Fue un movimiento telúrico que nosotros lo sentimos acá. Estoy perdida en los años. ¿Puede ser el 2013?

C: Réplicas tal vez.

B: Sí, sí, pero fue alto porque nosotros lo sentimos. Fue horrible, nos íbamos con los niños. Me acuerdo yo como una de las que salí última, como la zona de refugio estaba allí, yo estaba esperando que salieran todos. Y miro hacia allá y, unas mamás tomando chicos y metiéndolos en la camioneta, porque no solo me llevé a mis hijos, sino al amigo de mi hijo, al vecino, al esto, … Los papás llegaban allá, no veían a sus hijos, nos pedían explicaciones, no sabíamos si estaban acá. ¡Horrible! Entonces que hicimos fueron las reuniones de apoderado a explicarle cómo funcionaba esto y explicarle el rol que nosotros teníamos. Y fundamentalmente tenían que confiar en nosotros y en su hijo. Lo que había sucedido era el mayor riesgo, porque nosotros llegó un comento no podíamos dar explicaciones de dónde estaban los niños. Si se los había llevado la tía, la abuelita o qué pasó. Nosotros tenemos (...) con un profesor y una asistente. Entonces fuimos más allá a mostrarle a los papás los riesgos, pero de su conducta frente a cómo ello se enfrentaba a una situación telúrica. No hemos tenido la oportunidad de comprobarlo. ¡Gracias a Dios! Sí que da resultado, pero nosotros en todas las reuniones de padres al menos una vez al año explicamos que nosotros estamos preparados, que nosotros tenemos conciencia, que, si quieren ver a sus hijos, saber de ellos que vayan allá. No que vengan acá. Y vamos más allá. No solamente el riesgo telúrico que te puedas caer, de no bajar la escalera si se está cayendo, meterte debajo de la mesa. Todo esto lo puedes explicar y allá hay que tener mucho cuidado. Tenemos muchos alumnos que se van caminando a su casa solitos. Ellos conocen la zona de prevención y saben si mueven, se marean y se caen, ellos tienen que ir a la plaza y quedarse allí. Que va a ir un bombero, un carabinero, alguien va a ir a buscarlos allí. Esto es lo que nosotros aportamos.

A: ¿Cómo se ve?

B: Ya lo contestó.

C: She answered this question.

A: Sí.

B: ¿Cuáles métodos?

A: Sí.

B: Allí nosotros también vemos la inducción que nos hace el ministerio y ellos nos dicen que hay que buscar un alumno que se encargue de abrir la puerta, despreocúpense del libro de clase, cómo saberlo … ¿A ello se refiere?

C: Sí. Cómo lo hacen, cómo se prepara …

B: Cómo tienen que salir los estudiantes. Nosotros tenemos nuestra propia, … ¡Ay, no te lo dije! Aparte de eso, nosotros también hacemos nuestros propios simulacros, pero solamente del colegio, del establecimiento. Así hacemos el simulacro de incendio, (...) Pero también tenemos que hacer un simulacro de incendio y de eso, de tsunami y lo hacemos los cursos que están en el segundo piso. Tenemos tres accesos al segundo piso y a ver los cursos, tales bajan por esta escalera, el otro por la otra y por la otra. Acá se da la suerte de que no siempre tienen la misma sala, porque si van a talle ro a una asignatura en otra sala y, ellos saben que están en tal sala y, para bajar de esta forma. Por esta escalera y no por otra. Es una forma también de … y esto lo reforzamos mucho. Especialmente en los niños chicos. Y curiosamente como más chicos son, más ordenados. Como más grande, nos cuesta que se pongan un poco serios. Un año se asustaron mucho, porque no dijimos nada, se asustaron mucho y también reaccionaron mal, corrieron desesperados por ser los primeros en llegar allá. Esto nos indicó también que tenemos que trabajar un poquito más con ellos.

A: ¿Tienen los estudiantes una conciencia por los riesgos de un tsunami?

B: Yo creo que sí, porque nosotros conversamos sobre esto, porque estamos en una zona acá que estamos en riesgo porque sus papás son pescadores y se habla mucho de eso. Tú le hablas de tsunami y decía una vez un alumno cuando yo hacía clase de segundo básico: “Mi papá dijo que, si se movía el mar, que el rema rápido y se viene, porque la hora tarda tanto en llegar.” Son cosas que por lo que ellos conversan, son conversaciones familiares también. Para tranquilizarlos y si te preguntan:” No, mi mamá dice que nos tenemos que ir al (...).” Sí, pero digo que más cerca es acá, no que hasta que llegue la hora, nosotros sabemos que nos tenemos que ir al (...). Yo que sé. Yo creo que ellos tienen consciencia. Ellos saben no solo por la parte de pedagógica, porque nosotros estamos obligados de explicarles. Y ellos manejen un tema de concepto y relacionado con eso. En las casas igual se habla, dentro de la familia por medio de creencias o no de lo que tiene que ser, pero es un tema latente. Y ellos tienen consciencia de los riesgos de un tsunami.

A: ¡Muchas gracias!

Transcription Interview 4

A – Marlene Eller

B - Teacher

A: Es la primera pregunta: ¿Hay una preparación de los estudiantes por riesgos de tsunami en la clase? (risa)

B: Sí, hay una preparación. La escuela está preparada en todo esto porque hemos tenido charlas, tenemos personas encargadas de este tipo de evento y, hemos hecho simulacros y los niños están preparados. Incluso desde pre-kinder porque ellos conocen lo que tienen que hacer si se presenta un evento de este tipo. Si es un temblor simple, saben que deben ponerse bajo las mesas unos minutos. Si sigue y nos podemos mantener en pie, ellos saben que debemos salir que yo debo tomar el libro, salir por la puerta que está establecida para que nosotros salgamos en un caso de este tipo y concluir inmediatamente a la zona - de cómo es - zona de seguridad que está allí en la plaza. Y ya lo hemos hecho, y hemos llegado en tiempo récord. Y los niños se portan maravillosamente bien. Y no hay problema. Están muy preparados y tienen consciencia de lo que están haciendo. Así que en esto no hay problema.

A: Ah, sí. ¿Cómo se ve esta preparación y cuáles métodos se usan?

B: Mira, cómo la veo yo o cómo se ve. La preparación si bien está, pienso que podría ser mayor. Podríamos tener más información, podría ser más (...) para los niños pequeños. Más práctica, vídeos más tal vez en este aspecto de hacerlo como juego, más práctica. Tenemos conocimiento, claro, pero es el básico y es el mínimo. Por lo tanto, yo siento que deberíamos tener más. ¿Está, pero podríamos avanzar?

A: ¿Tienen los estudiantes una consciencia por el tsunami?

B: Tienen conciencia, sobre todo en esta zona. Nosotros estamos al lado (...). Entonces consciencia hay. Ellos lo tienen clarito, aunque ellos nunca lo vivieron lo del terremoto de 1960. Están bien documentados por eso. Entonces saben que es un terremoto a través de la conversación de los padres, porque se lo han ido transmitiendo. Yo creo que no hay ningún (¿Valeriano?) que no tenga conocimiento de lo que ocurrió en el terremoto del 60 y lo haya transmitido a sus sucesores. Los chicos están super claros con eso. Y saben que después de un terremoto va a venir más, puede devolver y nos va a ocasionar problemas. Está muy claro. Los riesgos también los saben. Pero como te insisto, tal vez los niños mayores pueden entender unas charlas que han venido, ellos la entienden. Pero los menores no, y no han tenido esta (...). ¿Entonces qué tienen los menores? Lo que nosotros como profesores podemos esperar. Que tampoco es gran conocimiento. Sí, le entregamos eso y, tú sabes que un niño escucha, te entiende y te sigue. Eso es la gran garantía que tenemos nosotros. Otros niños quizás son más dispersos, pero los pequeños, sí, nos siguen, nos creen todo. Entonces cuando nosotros hacemos un simulacro y avanzamos a la zona de seguridad, incluso ellos van cantando, van tranquilos, van relajados porque la seguridad tiene que (...). Si yo estoy alterado o estoy aterrada, obviamente que ellos van a hacer lo mismo. Entonces ellos la seguridad y, esto nace desde nosotros como persona más y nada más. Porque conocimiento, lo básico, lo que escuchamos por los medios y lo que nos dice nuestra consciencia. ¿Qué debemos hacer en momentos, así como madre, como profesora, uno toma ciertos recuadros? Ya sabemos más o menos lo que tenemos. Entonces como te digo, sí, lo básico lo tienen. Saben lo que es un tsunami, los riesgos y las consecuencias que puede provocar, también porque lo hemos dado como materia, como materia de clase. Entonces este conocimiento lo tienen. Ya han dibujado, han hecho maquetas, saben lo que puede pasar. Hemos ido directamente al mar, ya que lo tenemos al lado, saben el movimiento y que esas olas se reproducen diez veces más con un tsunami. Pueden predecir lo que puede pasar en sus casas, si no tomamos las debidas precauciones. ¿Qué más te puedo decir? Esta es la mirada de profesora, porque la de los directivos ya la tienen.

Coding Interview 1

Farbe	Dokumentname	Code	Segment	Anfang	Ende
●	Interview 1	last tsunami	Der letzte Tsunami war ja 1960 hier, oder? B: In Valdivia schon. A: In Valdivia schon, da war 1960, da war nachher dann keiner mehr soweit ich weiß, oder? B: Zumindest kein nennenswerter mit sage ich mal, dann, also messbare Auswirkungen.	4	7
●	Interview 1	additional information	B: Das ist eine schwierige Frage. Eigentlich, eigentlich sind hier die Erdbeben, also es ist eine Subduktionszone, das bedeutet, dass eigentlich eine Fläche entlang der Subduktionszone bricht und somit das Epizentrum schwer festzustellen ist, also woran erkennt man das Epizentrum? Ist schwierig, man kann sich ja nur vorstellen, dass man irgendwie nach der Mercalliskala, die Intensitäten sieht, aber die Intensitäten sind, wie die Mercalliskala selbst aufgebaut, sind zum Teil subjektiv und das kann ja sein, dass eigentlich das wahre Epizentrum in einer, in einer Zone ist, die gar nicht so richtig aufgenommen worden ist, aber gut, aber wenn es die wissenschaftliche Literatur belegt, dann dürfte, dann müsste man das aufgrund der wissenschaftlichen Literatur prüfen, aber nach dem neuesten Stand, also man muss sich eigentlich einen Erdbebenzyklus vorstellen, also es baut sich innere Energie auf in der Subduktionszone, also zwischen den, den Platten, der subduktierenden Platte und sage ich mal der darüber streifenden Platte, die Nazca-Platte praktisch bewegt sich unterhalb der kontinentalen Platte, dort hat es Reibungspunkte, in diesen Reibungspunkten ist das als ob ein Draht von der oberen Platte in die untere Platte, dort baut sich, sage ich mal, der Druck auf bis dann eben diese Reibungspunkte brechen und die weitere gesamte Fläche sozusagen in binnen kürzester Zeit bewegt und somit, das ist das Hypozentrum im Sinne, die Hypozone. Dann, wo in der Oberfläche die maximale Intensität registriert wurde, das ist dann aber ein anderes paar Schuhe. Es hängt dann zum Teil auch von der Fortpflanzung, der B und S Wellen ab und die hängen ja von der Beschaffenheit des Untergrunds ab, somit ist es eigentlich schwierig, je nach was dann die Magnitude betrifft, wenn man sagt die Magnitude nach der Richterskala, das misst ja die Parameter Fläche, die sich sozusagen, wo sich die Platten bewegt haben und nicht so sehr die Intensität, somit, sage ich mal, die Magnitude des Erdbebens hängt eigentlich von der Größe dieser, dieser Rutschfläche zwischen den Platten ab und deshalb hat Valdivia diese große Magnitude, was hier effektiv eine große Fläche sozusagen, also Rutschflächen gebildet hat zwischen den Platten.	9	9
●	Interview 1	additional information	B: Somit, die Magnitude hängt von dem ab, das ist nicht unbedingt das gleiche wie die Intensität. Das hängt von der Auswirkung in der Oberfläche, in der Erdoberfläche ab und das hängt von der, von der Fortpflanzung der B und S Wellen und so weiter ab und somit ist die Größe des Erdbebens Valdivia eigentlich dadurch gekennzeichnet, dass sie einfach ein großes Segment, entlang eines großes Segments, eigentlich die Rutschfläche zwischen den Platten gebildet hat.	11	11
●	Interview 1	handling	B: Eigentlich im Detail weiß ich es also nicht, aber was ich halt indirekt, ich habe ein paar Sachen dazu gelesen, also die alten Arbeiten von Wolfgang Weischet, das ist ein Geograph, ein österreichischer Geograph, der hat viel zur Geographie von Chile beigetragen und der hat einige Zeit lang in Valdivia gelebt und der hat das Erdbeben 1960 rekonstruiert, ich habe da ein paar Unterlagen dazu.	13	13
●	Interview 1	effects	Mein Interesse liegt vielmehr in der Auswirkung eines anderen gekoppelten Phänomens, also das sogenannte Riñihuazo, ich weiß nicht ob du davon gehört hast?	13	13
●	Interview 1	effects	B: Also das Erdbeben von Valdivia hatte mehrere Folgen, die Folgen des Erdbebens an sich, der Tsunami der dazu gekoppelt ist was ja einfach ein sage ich mal durch die Bewegung dieser Platten einfach ein großes Volumen an Wasser nach oben bewegt hat und somit sich eine Tsunami-Welle Richtung Küste hervorgerufen wurde, aber auch mehrere große Rutschungen, die den Valdivia Fluss an mehreren Stellen sozusagen blockiert haben, und somit eigentlich mehrere Seen die dahinter lagen sozusagen aufgestaut hat, und da haben dann mehrere Monate lang Einsatztruppen gearbeitet, um einen Kanal in eine dieser Rutschungen zu öffnen, damit sich dieses, dieses Wasser-Volumen langsam entleert und nicht schnell und der Riñihuazo hat sich dann glücklicherweise nicht allzu schnell entleert und sie haben die Leute evakuiert, aber doch hat er viele Schäden im ganzen Tal bis nach Valdivia hervorgerufen, somit hat es mehrere Folgen gegeben vom Erdbeben. Der Tsunami, der Tsunami hat sich eigentlich in den Küstengebieten ausgewirkt, also das Wasser ist zwar ein bisschen bis nach Valdivia aufgestaut worden, aber eigentlich in Valdivia selbst, soweit ich mitbekommen habe ist eigentlich, sind die Effekte des Tsunamis wirklich minimal gewesen, aber zum Beispiel in Corral, nicht nur in Corral, aber im ganzen Küstengebiet von Corral Richtung Valdivia, das ist ein sehr fragmentiertes Küstengebiet, somit glücklicherweise hat sich dann auch die Tsunami-Welle aufgespalten, da sieht man wirklich, dass sich der Tsunami bis in diese Einbuchtungen hinaus, hinein ausgewirkt hat. Dort hat es größere Schäden gegeben, das heißt die Holzhäuser, die damals gebaut worden sind, die wurden komplett zerstört, die wurden eigentlich komplett zerstört, jetzt was der Tsunami an Menschenleben gekostet hat, muss ich ehrlich sagen, bin ich im Moment überfragt. Jedenfalls in Valdivia selbst hat es der Tsunami nicht geschafft, sage ich mal richtig Schäden anzurichten. Das ist mehr der Riñihuazo der eigentlich, oder das Erdbeben mal grundsätzlich, das praktisch mehrere Meter den ganzen Talboden gesenkt hat und dann darauf folgend im ganzen Tal, also vom Rio Valdivia oder Rio San Pedro, wie er weiter oben heißt, hat sich diese Hochwasser-Welle des Riñihuazo sozusagen ausgebreitet und eigentlich mehrere Dörfer, sage ich mal, stärker in Mitleidenschaft gezogen, aber die Leute wurden bereits evakuiert, weil das war ein paar Monate später. Eigentlich wussten sie den, konnten sie den Moment eigentlich vorhersagen, wann dann die größeren Abflüsse sozusagen aus diesen, aus diesen Seen-Konvolut entleert wurden und zum Beispiel Los Lagos zum Beispiel stand komplett unter Wasser, aber das ganze Tal stand komplett unter Wasser, aber die Intensität mit der sich sozusagen diese Talsohlen gefüllt haben ist natürlich glücklicherweise gering im Vergleich zu, zu einer plötzlichen, zu einem plötzlichen Versagen der Rutschungen, die sozusagen diese Seen abgeschirmt haben oder, oder blockiert haben. Wenn das jetzt einfach von heute auf morgen passiert wäre, dann wäre eigentlich die Hochwasserwelle des Riñihuazo viel gravierender gewesen von den Auswirkungen.	15	15

●	Interview 1	responsible for instant and further measures	B: Heutzutage ist eigentlich die ONEMI, das wäre sozusagen das Analoge des Zivilschutzes mehr oder weniger zuständig für, für die Evakuierung und auch für die Vorbereitung und für die, sage ich mal, die ganzen Übungen dazu zuständig.	17	17
●	Interview 1	warning systems and evacuation routes	Das ist eben das Problem, also sie sind zuständig, aber die Infrastruktur zum Beispiel die Evakuierungsrouten und so weiter, die sind, die sind ja nicht oder zumindest nur in den seltensten Fällen auf öffentlichen Grund, also das heißt, dass zum Teil die Evakuierungsrouten existieren, aber sie führen durch Privateigentum und das kann auch bedeuten, dass jetzt diese Evakuierungsrouten nicht unbedingt für Jedermann geeignet sind. Es kann sein, dass, dass entweder die Qualität des Straßenbelags ganz einfach schlecht ist und somit jetzt nicht unbedingt alle Altersklassen oder, oder keine Ahnung, irgendwelche andere benachteiligte Gruppen, die jetzt nicht unbedingt auf dem sichersten Weg zur sogenannten Sicherheitszone gelangen. Das ist ein Problem das ich zum Teil festgestellt habe.	17	17
●	Interview 1	additional information	In Mehuín zum Beispiel, dort hat es zum Teil auch aufgrund dieser Strukturierung des Privateigentums, musste man mehrere Tore auch öffnen zum Beispiel, das kann mitunter ein Problem sein. Dann ist die Frage, im Detail muss man halt auch aufpassen, was eigentlich diese Sicherheitszone mit sich bringt, inwiefern sicher vor dem Tsunami also möglicherweise schon, also fast sicher, aber klarerweise, klarerweise, ich spreche jetzt nicht über einen spezifischen Fall, aber es gibt auch wie gesagt andere Naturgefahren, die eventuell auch Folgen haben könnten, wenn jetzt diese Sicherheitszone nur tsunamisicher ist und nicht rutschungssicher, die Tsunamis sind eine Folge des Erdbebens, aber auch die Rutschungen sind eine Folge des Erdbebens oder keine Ahnung, andere Naturgefahren eben auch dort vorkommen können, somit, somit ist das auch zu beachten, aber klar, also und vor allem kommen dann die ganzen Hilfeleistungen, sind das die Zonen wo die Hilfeleistungen einfach zu erbringen sind, das müsste man auch unter die Lupe nehmen. Aber gut, soweit, ich habe jetzt nur Mehuín gesehen, was eine sogenannte ausgestattete Sicherheitszone hat in Puerto Saavedra, was auch eine andere Zone ist, wo der Tsunami, sage ich mal, irgendwelche Einwirkungen gehabt hat, da scheint die Situation besser zu sein, ganz einfach weil schon geographisch Puerto Saavedra schon sicherer ist unter Anführungszeichen und eine Sicherheitszone, also ohne, sage ich mal, Verbindung mit Straßen, mit dem Straßennetz, sodass die ganzen Nahrungsmittel und was auch und Medikamente und so weiter, um den Zugang dieser, dieser Nahrungsmittel und Medikamente zu gewährleisten ist halt auch ein Problem, wenn die Leute länger in dieser Sicherheitszone bleiben müssen, weil, sage ich mal, das Dorf oder die Infrastruktur im Dorf total beschädigt ist und nicht verwendbar ist.	17	17
●	Interview 1	suggested improvements (tsunami handling and awareness)	B: Also ich denke man könnte mehrere Sachen machen, also man müsste eigentlich den gesamten Risikokreislauf auch ein bisschen sich anschauen und vor allem die präventive Seite einfach besser durchleuchten, also natürlich hängt das dann auch von den verschiedenen, von den Ressourcen, die zu Verfügung stehen ab, was man da konkret machen kann, aber andererseits wieder hängt es auch davon ab wie viele Ressourcen man verschaffen kann, um gewisse Dinge zu machen. Somit könnte man auf zwei Ebenen arbeiten, also effektiv die ganzen Strategien ausloten, die man mit den zur Verfügung stehen Ressourcen, sage ich mal, bewerkstelligen kann und Strategien zu suchen, um die Ressourcen einfach zu vergrößern die zur Verfügung stehen, somit sind zwei Ebenen, die glaube ich wichtig sind. Die eine Ebene ist mehr technisch-sozialer Natur und die andere Ebene ist mehr sozial-institutioneller Natur. Somit die erste Ebene kann man natürlich mehrere Sachen machen, also vorstellen könnte man sich natürlich die ganze Palette von den aktiv-präventiven und passiven Maßnahmen. Wobei die passiven Maßnahmen natürlich eine große Bedeutung hätten. Man muss nicht unbedingt, alle müssen im exponiertesten Teil der Küste leben und es gibt noch potentiell exponierte Teile wo man genug Häuser hinein pflanzen kann. Somit könnte man eigentlich schon das vermeiden, dass man neue, neue Häuser in diesen Zonen überhaupt zulässt, vor allem wo nachgewiesen ist, dass es sich um gefährdete Gebiete handelt oder rote Zonen heißen sie nach europäischen Mustern. Das wäre das erste, das zweite wäre zum Beispiel effektiv zu sehen, ob jetzt, ob es nicht Möglichkeiten gibt auch im längeren Zeitraum hin Anreiz zu schaffen, dass man zumindest die Lebensfunktion, also die Häuser wo die Familien leben einfach versucht in sicherere Zonen zu, zu verlagern sage ich mal und ökonomische Funktion natürlich das, also das Nötige bleibt dann natürlich an der Küste, aber das hieße ja nicht, dass man die, sage ich mal, die wirtschaftliche Seite außer Acht hält, außer Acht lässt, sondern dass man versucht progressive, exponierten Elemente zu entfernen, das wäre, das wäre auch eine, eine Strategie die man befolgen könnten. Es gibt Beispiele wo man natürlich dann auch die Vulnerabilität herabsetzt, da sage ich mal die physische Vulnerabilität, ich spreche jetzt nicht unbedingt von der sozialen Vulnerabilität, also man kann ja die Häuser auch so bauen, dass sie jetzt nicht unbedingt beim ersten Tsunami total einbrechen, man kann zum Beispiel nach, nach alten Muster auch die Häuser, sage ich mal, in der Höhe abheben und, sage ich mal, die Vulnerabilität um einiges herabsetzen, natürlich jetzt bei einem Tsunami mit einem Erdbeben von Magnitude nach der Richterskala neun und so weiter kann sein, dass das nicht ausreicht.	19	19

●	Interview 1	suggested improvements (tsunami handling and awareness)	B: Aber die Wahrscheinlichkeit, dass sich diese Erdbeben, sage ich mal, in kurzen Zeitspannen wiederholen ist halt dementsprechend nieder, somit, somit sind das auch Sachen die man mach kann, nicht. Das sind alles Sachen die man, allerdings, die ganzen Veränderungen am Gebäude selbst, soweit ich verstanden habe, hängen natürlich von der finanziellen Verfügbarkeit der, der Eigentümer ab und somit ist das eher fraglich, dass das eine, zumindest auf die schnelle eine allgemein gültige Strategie für ganz Chile sein könnte, ohne Anreizsystem, aber man könnte sich ja doch vorstellen, dass man ein Anreizsystem schafft, dass man beginnt eben einfach die, die Häuser auch anders zu bauen in diesen exponierten Gebieten. Theoretisch gibt es dann auch technische Maßnahmen, zum Teil werden sie ja errichtet, also Dämme und Ablenkmauern, die sozusagen, also die bezwecken sollten, dass sich der Tsunami sozusagen sobald der auf diese Ablenkmauern aufprallt sich eigentlich wieder rückwärts propagiert. Einige sind, sind gemacht worden vor allem in Küsten wo eine Anhäufung, eine Wertanhäufung zu verzeichnen ist, sehr touristische Gebiete nicht notwendigerweise in der Los Rios Region. Also ich habe gesehen, dass, dass man zum Teil, eine mögliche Strategie ist diese Ablenkdämme eigentlich auch mit einer, also mit der sogenannten, das Straßennetz zu verbinden, das heißt dass auch beim Ablenkdamm jetzt nichts dagegenspricht, wenn jetzt dort auch eine Straße ist. Es ist klar, dass während dem Tsunami diese Straße nicht befahrbar ist, aber zumindest hätte sie eine Funktion in der sogenannten Friedenszeit, also wenn kein Tsunami ist, sodass man wenn man schon, wenn man schon die Umwelt stark beeinträchtigt mit dem Bau eines solchen, eines solchen Ablenkdammes, dass zumindest auch eine günstige Zusatzfunktion dazu kommt und ich denke, dass auch der Straßenbau einer der wenigsten, einer der, im Straßenbau eigentlich noch die Ressourcen sind, um solche Dinge zu machen, weil wie baut man eine Straße - man hat die nötigen Maschinen, man verlagert die nötigen Erdmassen und so weiter, somit ist eigentlich der Straßenbau der ideale Partner, um präventiven Tsunami-Schutz auch zu machen. Ob jetzt gewisse Überlegungen jetzt in diese Richtung laufen bin ich überfragt. Ich habe für ein ähnliches Problem mehr im Hochwasser-Bereich eine ähnliche Lösung vorgeschlagen und es ist im Prinzip eine der wenigen Sachen, die man, die man, wo man sozusagen die Straßen auf einem Ablenkdamm kombiniert und somit eigentlich zwei Funktionen auf einmal bewerkstelligt, was sonst eigentlich die Leute nicht oder die anderen Institutionen schwer machen können, weil was kann schon eine Institution für Urbanistik machen, wenn sie nicht die Ressourcen hat, um zu bauen. Somit braucht es eigentlich, sage ich mal, jemanden der baut um zu bauen, also so einfach das klingen mag und das ist im Moment auch Straßenbau, weil in Chile existiert jetzt nicht eine ähnliche Institution wie zum Beispiel in einigen Ländern des Alpenraums, die für gewisse Gefahren spezifisch zuständig sind und die per Gesetz ein Budget haben, um aktive Schutzmaßnahmen zu bauen, also gut im Alpenraum ist das zum Beispiel die Wildbachverbauung, die in Österreich und in Südtirol ein Budget hat, um aktive Schutzmaßnahmen zu bauen. Das ist praktisch der Hauptexistenzgrund dieser, dieser Institutionen, einer der Existenzgründe dieser Institutionen ist, aber das ist hier, existiert hier nicht, somit müssen das notwendigerweise die (...) machen oder die, der Straßenbau also zum Beispiel. Das heißt die aktiven Schutzmaßnahmen sind sehr punktuell im Moment was Tsunami oder auch andere Gefahren betrifft, weil eigentlich das nötige Budget nicht also im Finanzgesetz sozusagen nicht fixiert wird,	21	21
●	Interview 1	additional information	also einen anderen Eindruck den ich habe ist, dass hier sehr stark die sogenannte Resilienz im Vordergrund steht, was natürlich problematisch ist weil, also ich habe jetzt nichts gegen die Resilienz, ich hoffe ja, dass die Resilienz als Epiphänomen aufscheint, nicht, aber Resilienz ist eigentlich ein Epiphänomen, man muss ja eigentlich das System so verändern, dass die Wahrscheinlichkeit besteht, dass diese Resilienz effektiv aufscheint, dass die Funktionen laufen, damit das System resilient ist und somit Resilienz alleine ohne diese antizipatorische Planung, also kann sein dass das halt eben fehlschlägt, also manchmal sieht man, dass gewisse, dass in gewissen Situationen ein resilientes Verhalten, sage ich mal, aufscheint und manchmal nicht. Eigentlich müsste man die Voraussetzungen schaffen, damit das einfach wahrscheinlicher ist, dass ein resilientes Verhalten zustande kommt. Somit Resilienz ohne, sage ich mal, Rückendeckung durch die ganzen anderen Facetten, sprich institutionelle Seite, sprich finanzielle Seite, sprich technische Seite, sprich Planungsseite und so weiter ist halt nur ein Teil der Strategie und somit und das kann halt fehlschlagen. Auf der anderen Seite die ganzen Aspekte der Resilienz, vor allem der sozialen Resilienz zu vernachlässigen und glauben, dass man einfach durch technische Planung gestützte Strategien, sage ich mal, die maximale Risikoreduktion oder Minimierung schafft ist halt auch nur ein Teil der Strategie. Somit braucht es einfach beides, aber das Problem der nicht geplanten Resilienz ist, dass es, dass eigentlich man nicht nachhaltig feststellen kann, was man eigentlich verändern muss, um die Resilienzfunktionen, also die, wie sich eigentlich das System verhält verbessern kann. Das ist ein bisschen das Problem was ich halt sehe.	21	21
●	Interview 1	warning systems and evacuation routes	B: Also es gibt eine Warnung, es gibt eine Warnung, vor allem für Erdbeben und Tsunami gibt es eine Warnung, die läuft über mehrere Kanäle, akustisch und über Handys und so weiter was eigentlich, ich denke ein wesentlicher Schritt vorwärts ist.	23	23
●	Interview 1	preparation of inhabitants	Es gibt Übungen, wo an gewissen Tagen, an gewissen Tagen, sage ich mal, in den Küstengebieten die Evakuierung eingeübt wird.	23	23

●	Interview 1	preparation of children at school	Es gibt soweit ich weiß einige Initiativen auch die, sage ich mal, die Naturgefahren und Naturrisiken ein bisschen in den Schulstoff einzubauen, aber das hängt auch noch zum Teil, sage ich mal, von der Initiative der einzelnen Lehrpersonen ab. Somit kann ich nicht, zumindest bin ich mir nicht sicher, was das jetzt fixer Bestandteil des Programms ist, sage ich mal, einer, einer Oberschule zum Beispiel. Hier gibt es, das Schulsystem sind, ist in basico und medio aufgeteilt. Es gibt von der ersten bis zur achten basico und dann von der ersten bis zur vierten medio, somit habe ich auch festgestellt, dass unter anderem die Schüler vor der Universität zwölf Jahre Schule haben und nicht dreizehn wie in Italien, aber gut das ist jetzt ein Detail, aber wie gesagt, ich bin mir jetzt nicht sicher, dass Naturgefahren ein fixer Bestandteil des Unterrichts ist. Wobei in Chile das schon eine gewisse Rechtfertigung finden würde, weil eigentlich alle in, Chile ist vielleicht eines der wenigen Länder, das wirklich alle Naturgefahren hat die man sich so vorstellen kann, also somit wäre das eine angebrachte Neuerung würde ich sagen, also wenn man jetzt von Erdbeben, Tsunami, Überflutung, Murgang, Rutschung, Lawinen, die ganzen Gefahren die vom Klimawandel und vom Gletscherrückgang abhängig sind, also im Prinzip hat Chile diese ganzen Gefahren und auch in einem Maßstab, den man sich zum Teil in Europa kaum vorstellen kann,	23	23
●	Interview 1	additional information	also zum Beispiel ein Ausbruch eines Gletschersees, also hängt davon ab wie groß jetzt dieser Gletschersee eigentlich ist, also wenn man jetzt die Größe der Gletscherseen in den Alpen und in den Anden vergleicht, dann sind einfach verschiedene Maßstäbe und somit die Gefahren existieren und sind eigentlich relevant, zum einen kann man von Glück reden, dass die Verbauung des Territoriums in einigen Zonen eigentlich noch sehr dünn, also eine sehr dünne Dichte hat, eine geringe Dichte und somit eigentlich die Auswirkungen nicht unbedingt immer katastrophal sind, aber wenn man sich jetzt vorstellt, dass, dass Chile eigentlich plant unter anderem mit dem Programm der (...) an die Einkommenswerte der, sage ich mal, x besten Nationen oder ökonomisch am besten gelagerten Nationen der Welt anzuknüpfen durch Bau von Infrastruktur und auch Besiedlung von, von verschiedensten jetzt noch dünn besiedelten Zonen und Ausbau des Tourismus und so weiter, dann, was natürlich das Problem ist, dass sich einfach die Vulnerabilität stark vergrößert und die Exposition stark vergrößert, weil einfach mehr Leute, mehr Sachen, mehr Häuser in exponierten Zonen, sage ich mal, platziert werden, somit, wenn man jetzt nicht vorausplant, dann hat man halt einfach ein großes Risiko in der Zukunft. Im Prinzip ist ja diese Dynamik ja nicht ganz neu, also auch im Alpenraum hat man das festgestellt im letzten Jahrhundert, dass man durchaus das Risiko stark verschärfen kann indem man einfach ohne Planung exponierte Zonen einfach bebaut und besiedelt.	23	23

Coding Interview 2

Farbe	Dokumentname	Code	Segment	Anfang	Ende
●	Interview 2	preparation	B: Nosotros, en nuestro colegio hay una preparación que se hace con los niños anualmente. Tenemos al menos dos o tres evacuaciones masivas de los niños que hay programadas. hay un plan de evacuación, donde salimos con los chicos. Hay alarmas, y en algún momento, cuando se programan, los simulacros, nosotros salimos con todos nuestros niños hacia la zona de seguridad. Los evacuamos y les damos las instrucciones. Los niños toman con alta seriedad esto, porque partiendo de nosotros mismos, los docentes, también lo tomamos con seriedad.	5	5
●	Interview 2	evacuation training	B: La forma para hacer los primeros simulacros, primero cumplen algunos requisitos legales. Nosotros, antes los simulacros no eran avisados. Ahora tienen que ser comunicados a la comunidad por escrito. Pensamos que el día tanto a tal hora se va a hacer un simulacro por el riesgo de accidente. Nosotros estamos aquí en una zona que es muchos vehículos que pasan. Entonces participan carabineros y, a veces, nos colaboran bomberos. Entonces, ellos cortan el tránsito y, podemos salir con nuestros niños seguros de la zona de seguridad. En este momento, una vez comunicado a la comunicad, a las autoridades este aspecto, nosotros evacuamos con otros niños. ¿De qué manera? Hay una alarma, que es una campaña. Y con un megáfono nosotros tenemos ya registradas nuestras zonas de evacuación. Los niños salen de forma ordenada y se van a la plaza que está aquí cerca del puerto que alcanza	9	9
●	Interview 2	evacuation training	B: La cota 25 parece. Y allí tenemos nuestra zona de seguridad.	11	11
●	Interview 2	tsunami awareness	B: A mí me sorprende que en los estudiantes haya una consciencia. Ellos están mucho más conscientes que los adultos en cuanto a su propia seguridad. Y eso siempre me ha llamado la atención, porque tres años seguidos se han hecho evacuaciones con toda la comunidad. Y los únicos que participamos son los niños, el consultorio, todas las organizaciones de tipo público. El jardín infantil, las salas cuna, pero la gente adulta no tiene la consciencia. No participa en esto. Porque estos simulacros son con toda la comunidad, pero toda la comunidad no participa. La escuela sí en su totalidad. Nosotros participamos con los decentes, con los asistentes de educación, las cocineras, toda la gente que en este momento está en la escuela tiene que hacer en público el protocolo de evacuación. Nosotros como escuela, considero que estamos bien preparados para actuar ante una emergencia. Pero siento que la comunidad no lo ha asumido en forma más seria. Pero sí los niños. Los niños tienen más consciencia.	13	13

Coding Interview 3

Farbe	Dokumentname	Code	Segment	Anfang	Ende
●	Interview 3	preparation	B: Sí, a ver, no es tan propia nuestra tal vez del (...) porque está incluido en el programa estudio de los estudiantes. Esto comienza desde los 4 años, que es en NT1, empezamos a hablar sobre los volcanes, sobre el mar. No es tan precioso o direccionado, pero en el tercero básico se habla directamente sobre las capas tectónicas, cómo se produce un terremoto, todo relacionado. Esto está en el plan de estudios y se trabaja una unidad completa. Luego hay que calificar, ya. Entonces nosotros no podemos optar a eso, porque ya viene así, desde tercero a octavo en distintos tiempos. Unos comienzan en la unidad uno, otros en la tres o en la cuatro, pero esto se trabaja. Y el grado de información y de conocimiento que se les da, va a depender de la edad que ellos tengan. Esto, por una parte. Ya estamos nosotros como establecimiento, porque estamos insertos y estamos en riesgo en el fondo. En los cursos más pequeños, nosotros les mostramos las zonas de peligro y les mostramos las zonas donde podemos refugiarnos. Felizmente, acá es cerquita. Una forma de prevención.	6	6
●	Interview 3	evacuation training	Se hacen simulacros de tsunami, al menos dos veces al año desde que sucedió el 27F hemos hecho dos simulacros de tsunami, pero aquí a nivel de comunidad. Con todas las inclusiones de (...) está la cuna, nos reunimos allá en nuestra zona segura que es en la plaza. Nosotros como establecimiento reforzamos periódicamente qué pasa cuando hay un temblor, un movimiento telúrico por decirlo así. Que se meten bajo la puerta, hay un niño que es el encargado de abrir la puerta a los profesores y, luego, bueno allí se da la conversación de manera espontánea de si hay un movimiento telúrico como estamos al lado del mar, lo más seguro es que vaya a haber un tsunami de acuerdo a la intensidad que tenga el movimiento telúrico	6	6
●	Interview 3	additional information	Entonces si la pregunta dice si hay una evaluación de los estudiantes por los riesgos del tsunami en la clase, se va para más allá	6	6
●	Interview 3	preparation	Explicamos cómo se produce un tsunami, cuáles son los riesgos, dónde están las zonas seguras y qué debemos hacer y qué no debemos hacer. También nosotros vamos un poquito más allá, porque nosotros vivimos esto como colegio con los apoderados.	6	6
●	Interview 3	additional information	B: Ah sí, tienes razón. Lo que pasa es que el año 2014 hubo también un movimiento telúrico grande. Yo me acuerdo porque estaba recién llegada a este colegio.	8	8
●	Interview 3	former event	B: Si, y se dio alerta, todo lo que estaba al alrededor de ... Hubo un movimiento telúrico y, entonces el año anterior, no me acuerdo bien. La cosa es que nosotros porque fue fuerte, se sintió porque normalmente que hay, pero no se sintió. Yo acá, todavía no llegábamos a la puerta con el primer grupo de estudiantes y, afuera estaba colapsado con vehículos, colapsados de papás que estaban al borde de histeria. Nosotros queríamos salir, los papás querían entrar. Fue realmente un colapso. Fue espantoso	10	10
●	Interview 3	former event	B: Sí, sí, pero fue alto porque nosotros lo sentimos. Fue horrible, nos íbamos con los niños. Me acuerdo yo como una de las que salí última, como la zona de refugio estaba allí, yo estaba esperando que salieran todos. Y miro hacia allá y, unas mamás tomando chicos y metiéndolos en la camioneta, porque no solo me llevé a mis hijos, sino al amigo de mi hijo, al vecino, al esto, ... Los papás llegaban allá, no veían a sus hijos, nos pedían explicaciones, no sabíamos si estaban acá. ¡Horrible! Entonces que hicimos fueron las reuniones de apoderado a explicarle cómo funcionaba esto y explicarle el rol que nosotros teníamos. Y fundamentalmente tenían que confiar en nosotros y en su hijo. Lo que había sucedido era el mayor riesgo, porque nosotros llegó un comento no podíamos dar explicaciones de dónde estaban los niños. Si se los había llevado la tía, la abuelita o qué pasó. Nosotros tenemos (...) con un profesor y una asistente. Entonces fuimos más allá a mostrarle a los papás los riesgos, pero de su conducta frente a cómo ello se enfrentaba a una situación telúrica. No hemos tenido la oportunidad de comprobarlo. ¡Gracias a Dios!	12	12
●	Interview 3	additional information	Sí que da resultado, pero nosotros en todas las reuniones de padres al menos una vez al año explicamos que nosotros estamos preparados, que nosotros tenemos conciencia, que, si quieren ver a sus hijos, saber de ellos que vayan allá. No que vengan acá. Y vamos más allá. No solamente el riesgo telúrico que te puedas caer, de no bajar la escalera si se está cayendo, meterte debajo de la mesa. Todo esto lo puedes explicar y allá hay que tener mucho cuidado	12	12

●	Interview 3	preparation	Tenemos muchos alumnos que se van caminando a su casa solitos. Ellos conocen la zona de prevención y saben si mueven, se marean y se caen, ellos tienen que ir a la plaza y quedarse allí. Que va a ir un bombero, un carabinero, alguien va a ir a buscarlos allí. Esto es lo que nosotros aportamos.	12	12
●	Interview 3	preparation	B: Allí nosotros también vemos la inducción que nos hace el ministerio y ellos nos dicen que hay que buscar un alumno que se encargue de abrir la puerta, despreocúpense del libro de clase, cómo saberlo	19	19
●	Interview 3	evacuation training	B: Cómo tienen que salir los estudiantes. Nosotros tenemos nuestra propia, … ¡Ay, no te lo dije! Aparte de eso, nosotros también hacemos nuestros propios simulacros, pero solamente del colegio, del establecimiento. Así hacemos el simulacro de incendio, (…) Pero también tenemos que hacer un simulacro de incendio y de eso, de tsunami y lo hacemos los cursos que están en el segundo piso. Tenemos tres accesos al segundo piso y a ver los cursos, tales bajan por esta escalera, el otro por la otra y por la otra. Acá se da la suerte de que no siempre tienen la misma sala, porque si van a taller o a una asignatura en otra sala y, ellos saben que están en tal sala y, para bajar de esta forma. Por esta escalera y no por otra. Es una forma también de … y esto lo reforzamos mucho	21	21
●	Interview 3	additional information	Especialmente en los niños chicos. Y curiosamente como más chicos son, más ordenados. Como más grande, nos cuesta que se pongan un poco serios. Un año se asustaron mucho, porque no dijimos nada, se asustaron mucho y también reaccionaron mal, corrieron desesperados por ser los primeros en llegar allá. Esto nos indicó también que tenemos que trabajar un poquito más con ellos.	21	21
●	Interview 3	tsunami awareness	B: Yo creo que sí, porque nosotros conversamos sobre esto, porque estamos en una zona acá que estamos en riesgo porque sus papás son pescadores y se habla mucho de eso. Tú le hablas de tsunami y decía una vez un alumno cuando yo hacía clase de segundo básico: "Mi papá dijo que, si se movía el mar, que el rema rápido y se viene, porque la hora tarda tanto en llegar." Son cosas que por lo que ellos conversan, son conversaciones familiares también.	23	23
●	Interview 3	additional information	Para tranquilizarlos y si te preguntan:" No, mi mamá dice que nos tenemos que ir al (…)." Sí, pero digo que más cerca es acá, no que hasta que llegue la hora, nosotros sabemos que nos tenemos que ir al (…). Yo que sé.	23	23
●	Interview 3	tsunami awareness	Yo creo que ellos tienen consciencia. Ellos saben no solo por la parte de pedagógica, porque nosotros estamos obligados de explicarles. Y ellos manejen un tema de concepto y relacionado con eso. En las casas igual se habla, dentro de la familia por medio de creencias o no de lo que tiene que ser, pero es un tema latente. Y ellos tienen consciencia de los riesgos de un tsunami.	23	23

Coding Interview 4

Farbe	Dokumentname	Code	Segment	Anfang	Ende
●	Interview 4	preparation	B: Sí, hay una preparación. La escuela está preparada en todo esto porque hemos tenido charlas, tenemos personas encargadas de este tipo de evento y, hemos hecho simulacros y los niños están preparados. Incluso desde pre-kinder porque ellos conocen lo que tienen que hacer si se presenta un evento de este tipo	5	5
●	Interview 4	evacuation training	Si es un temblor simple, saben que deben ponerse bajo las mesas unos minutos. Si sigue y nos podemos mantener en pie, ellos saben que debemos salir que yo debo tomar el libro, salir por la puerta que está establecida para que nosotros salgamos en un caso de este tipo y concluir inmediatamente a la zona - de cómo es - zona de seguridad que está allí en la plaza. Y ya lo hemos hecho, y hemos llegado en tiempo récord. Y los niños se portan maravillosamente bien. Y no hay problema. Están muy preparados y tienen consciencia de lo que están haciendo. Así que en esto no hay problema.	5	5
●	Interview 4	suggested improvements relating to preparation	B: Mira, cómo la veo yo o cómo se ve. La preparación si bien está, pienso que podría ser mayor. Podríamos tener más información, podría ser más (...) para los niños pequeños. Más práctica, vídeos más tal vez en este aspecto de hacerlo como juego, más práctica. Tenemos conocimiento, claro, pero es el básico y es el mínimo. Por lo tanto, yo siento que deberíamos tener más	7	7
●	Interview 4	tsunami awareness	B: Tienen conciencia, sobre todo en esta zona. Nosotros estamos al lado (...). Entonces consciencia hay. Ellos lo tienen clarito, aunque ellos nunca lo vivieron lo del terremoto de 1960. Están bien documentados por eso. Entonces saben que es un terremoto a través de la conversación de los padres, porque se lo han ido transmitiendo. Yo creo que no hay ningún (¿Valeriano?) que no tenga conocimiento de lo que ocurrió en el terremoto del 60 y lo haya transmitido a sus sucesores. Los chicos están super claros con eso. Y saben que después de un terremoto va a venir más, puede devolver y nos va a ocasionar problemas. Está muy claro. Los riesgos también los saben.	9	9
●	Interview 4	additional information	Pero como te insisto, tal vez los niños mayores pueden entender unas charlas que han venido, ellos la entienden. Pero los menores no, y no han tenido esta (...). ¿Entonces qué tienen los menores? Lo que nosotros como profesores podemos esperar. Que tampoco es gran conocimiento. Sí, le entregamos eso y, tú sabes que un niño escucha, te entiende y te sigue. Eso es la gran garantía que tenemos nosotros. Otros niños quizás son más dispersos, pero los pequeños, sí, nos siguen, nos creen todo. Entonces cuando nosotros hacemos un simulacro y avanzamos a la zona de seguridad, incluso ellos van cantando, van tranquilos, van relajados porque la seguridad tiene que (...). Si yo estoy alterado o estoy aterrada, obviamente que ellos van a hacer lo mismo. Entonces ellos la seguridad y, esto nace desde nosotros como persona más y nada más. Porque conocimiento, lo básico, lo que escuchamos por los medios y lo que nos dice nuestra consciencia. ¿Qué debemos hacer en momentos, así como madre, como profesora, uno toma ciertos recuadros? Ya sabemos más o menos lo que tenemos.	9	9
●	Interview 4	tsunami awareness	Entonces como te digo, sí, lo básico lo tienen. Saben lo que es un tsunami, los riesgos y las consecuencias que puede provoca	9	9
●	Interview 4	preparation	también porque lo hemos dado como materia, como materia de clase. Entonces este conocimiento lo tienen. Ya han dibujado, han hecho maquetas, saben lo que puede pasar. Hemos ido directamente al mar, ya que lo tenemos al lado, saben el movimiento y que esas olas se reproducen diez veces más con un tsunami.	9	9
●	Interview 4	tsunami awareness	Pueden predecir lo que puede pasar en sus casas, si no tomamos las debidas precauciones.	9	9