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Rising to the Challenge: A Creative Approach to Teaching Climate Change and Sea Level Rise in Japanese CLIL/EFL Contexts

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Abstract

This article addresses the issue about how to educate EFL learners in Japan about rising sea levels and the subsequent potential impact on coastal communities domestically and around the world. Sea level rise is an increasingly important global issue that will directly impact Japan and as such merits attention within Japanese content and language integrated learning/English as a foreign language (CLIL/EFL) contexts. The article presents a useful overview of the causes of sea level rise and its potential impacts on infrastructure, economies, and ecosystems to inform educators. A global perspective is adopted within the paper by not only focusing on Japan and Osaka in particular but also the Netherlands and Bangladesh. The paper also addresses the measures that are being taken to address the issue of sea level rise. An extensive practical step by step component is also presented to be used in the classroom that will help students expand their English vocabulary related to sea level rise. Engaging classroom activities are also presented that will enable them to communicate more effectively about the issue in English.

Introduction

The topic of sea level rise is an increasingly pressing issue that has significant consequences for many coastal communities located around the world. Japan is not beyond the reach of rising sea levels and thus climate change and related topics should not be relegated from CLIL/EFL classroom contexts. As the British Council states, “Language education has a vital role to play in tackling climate change” (British Council, n.d.). Kozak (2019, p. 25) notes in specific reference to educating Japanese students of English about climate issues, “It should be our role as educators to provide them with the information and skills vital to their understanding of the natural world.” By informing and equipping our students with knowledge about the topics and vocabulary relevant to the world’s climate crisis, we empower them to be able to engage in broader debates in international contexts while also enhancing their understanding on a local level. Research (Revis, 2020, p. 3) has shown that teaching climate change to students in English classroom contexts is worthwhile because of the “verifiable impact on their current and future lives.” Additionally, as “climate change can be considered to be one of the greatest challenges of modern times,” (Filho & Manolas, 2012, p. 4) we have an opportunity to embrace this challenge together with our students by focusing on connected topics. Furthermore, teaching and discussing climate related topics in Japanese EFL classrooms is supported by student engagement and interest. As Revis (2020, p. 3) importantly notes, Japanese student perceptions about climate change material in English are “directly related to their personal and learning goals.”

This paper draws together data and activities in a unique way by presenting the topic in a comprehensible manner that covers Japan, the Netherlands, and Bangladesh. The paper also presents a full lesson plan that can be deployed to help educators tackle the topic in a comprehensive manner from a language learning perspective. By utilizing the lesson, the teacher can assist their CLIL/EFL students in comprehending the reasons and consequences of sea level rise by conveying the subject matter with their own teaching approach in combination with the presented resources.

Topic overview

Sea level rise is primarily caused by the warming of Earth’s atmosphere, which leads to the melting of glaciers and ice caps as well as the thermal expansion of seawater (Kulp & Strauss, 2019). This process has already seen a rise in sea levels of over 23 cm (8 inches) since 1880 (Nunez, 2022). While that may not initially sound shocking, the rise needs to be considered from a long-term perspective and from one which empathizes with the generations of humans that are to follow our own and who will need to exist in a much-changed global climate. Globally esteemed organizations focused on tracking climate science data, such as the National Oceanic and Atmospheric Administration (NOAA), have predicted a rapid increase in the rate at which sea levels will rise in the coming decades. This was most recently presented in a NOAA 2022 comprehensive sea level rise technical report (NOAA, 2022). The report highlights that there will be 10 times more damaging coastal flooding by the year 2050. This worrying gain in momentum is due to the warming of the atmosphere which is caused by increased concentrations of greenhouse gases, such as carbon dioxide, which trap heat and cause Earth’s temperature to rise (Kulp & Strauss, 2019).

Figure 1

People living in the Sundarbans region of Bangladesh suffer from water shortages due to rising sea levels.

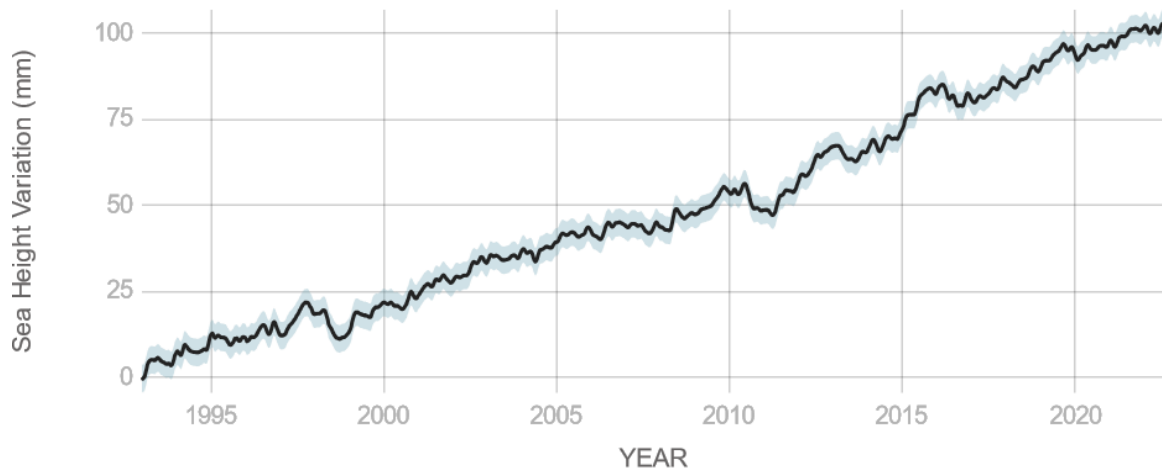


Source: K.M. Asad. Creative Commons License.

Human activity has a significant impact on the climate as we continue to pour harmful elements into the atmosphere from various industrial and domestic sources (Nunez, 2022). One of the primary sources of these greenhouse gases is the burning of fossil fuels upon which humans have been dependent for a considerable period of time to run vehicles, heat our homes, and support industrial activities (IPPC, 2018). These fossil fuels include coal, oil, and natural gas. Each of these release carbon dioxide into Earth's atmosphere. Without radical changes being undertaken, the traditional transportation and industrial sectors in tandem with deforestation will continue to contribute negatively to greenhouse gas emissions (Winkelmann et al, 2015). Additionally, activities such as urbanization and the alteration of wetlands and coastal ecosystems can contribute to sea level rise by reducing the ability of natural systems to absorb water and by altering the natural water balance in coastal areas.

Another cause of sea level rise is the loss of ice from the Antarctic and Greenland ice sheets (Box, 2022). As global climate temperatures continue to steadily rise, the great northern and southern latitude ice sheets are melting at a hastened rate. This in turn increases the amount of liquid water in the ocean. Similarly, the warming of the ocean water also causes the ocean to expand, leading to an increase in sea level (Box, 2022). So, what does this process mean in practical terms for coastal communities? The next section examines the negative impacts connected to sea level rise.

Figure 2
Sea level rise in recent decades as of August 2022.



Source: climate.nasa.gov

Source: NASA. Creative Commons License.

Negative impacts

Sea level rise has wide-reaching negative consequences across the environmental, economic, and social spectra (NOAA, 2022). These costs have started to be increasingly felt as rising sea levels have already caused significant damage in many coastal areas on different continents around the world. One of the most observable impacts has been increased levels of coastal flooding and associated erosion of terrain (Golam, 2005). As the momentum of sea level rise continues to grow, the regularity and severity of coastal flooding events are also increasing. This is putting coastal homes, commercial operations, and public infrastructure all at risk.

From an economic perspective, this flooding can lead to substantial destruction, expensive repairs, and sea defense construction (Hummel et al., 2021). Sea level rise also has the power to disrupt economies that rely on tangible and intangible coastal resources. This can include things such as attracting tourists to beautiful coastal locations or tourist based marine enterprises (Leatherman, 2001; López-Dóriga et al., 2019). Flooding can make beaches disappear and coastal areas much less attractive to tourists, leading to a drop in revenue gained from visiting tourists. Research has proposed for more than two decades now that rising sea levels can also change the stocks and distribution of fish and other marine species in particular areas and this in turn can lead to declines in catches and ensuing incomes for coastal fishing communities (Bigford, 1991). From a social viewpoint, the forced displacement of communities is a real threat which uproots people from their homes and localities.

Coastal flooding can also have an impact on essential services and social life by contaminating freshwater sources and disrupting transportation systems (Leatherman, 2001). From an environmental standpoint, an additional major impact of sea level rise is the loss of coastal ecosystems. This is leading to an interconnected decline in coastal biodiversity. The impacted places include coral reefs, marshes, and especially mangroves (Ward et al, 2016). These sensitive ecosystems provide vital habitat for a wide range of both plant and animal species and also act as natural barriers that protect coastal areas from sudden storm surges and flooding (Ward et al., 2016). As sea levels rise, these ecosystems are being flooded and consequently destroyed. Given this plethora of negative impacts, what can be done to mitigate sea level rise? The next section addresses that question by highlighting some solutions.

Figure 3
Melting iceberg in Greenland.



Source: Peter Prokosch. Creative Commons License.

Stopping sea level rise

To stop the root cause of rising sea levels, the primary step is to reduce greenhouse gas emissions (Moore & Nelson, 2010). Connected to this is the growing need to shift to renewable energy sources such as wave, solar, and wind power (Golam, 2005). This not only decreases the amount of carbon dioxide released into the atmosphere but also lessens each society's dependence on fossil fuels on the whole. Additionally, implementing energy-efficient technologies in homes and offices as well as in private and public transportation can also support further reductions in emissions. Urbanization and deforestation are major emission contributors and so by promoting conservation, reforestation, and sustainable urbanization, further steps can be taken to help decrease overall emissions (Santilli et al., 2005). The driving force behind the aforementioned mitigation factors is proper governance. Governments play a key role in reducing emissions through the development and implementation of regulations and environmental policies (Golam, 2005). Examples of such policies include carbon emissions standards, carbon taxes, and subsidies for renewable energy. Depending on their economic strength, governments also possess the resources to drive investment into the research and development of clean energy technologies.

Japan, the Netherlands, and Bangladesh

By presenting the topic information outlined in the preceding sections in their own style to their CLIL/EFL class, a teacher can help their students to better understand the causes and impacts of sea level rise. Students can gain a broader perspective on the issue, which will enable them to participate in more informed discussions about it in either English or their native language. Yet, in order to make the information feel directly applicable to

Japanese students, it is important to ground the topic in the local context of Japan. Therefore, the following information will pertain to the impact of sea level rise in Japan but also in the Netherlands and Bangladesh. This localization of the topic will allow students to compare and contrast the different ways that sea level rise is affecting countries both domestically and internationally as well as the measures that are being taken to address the issue.

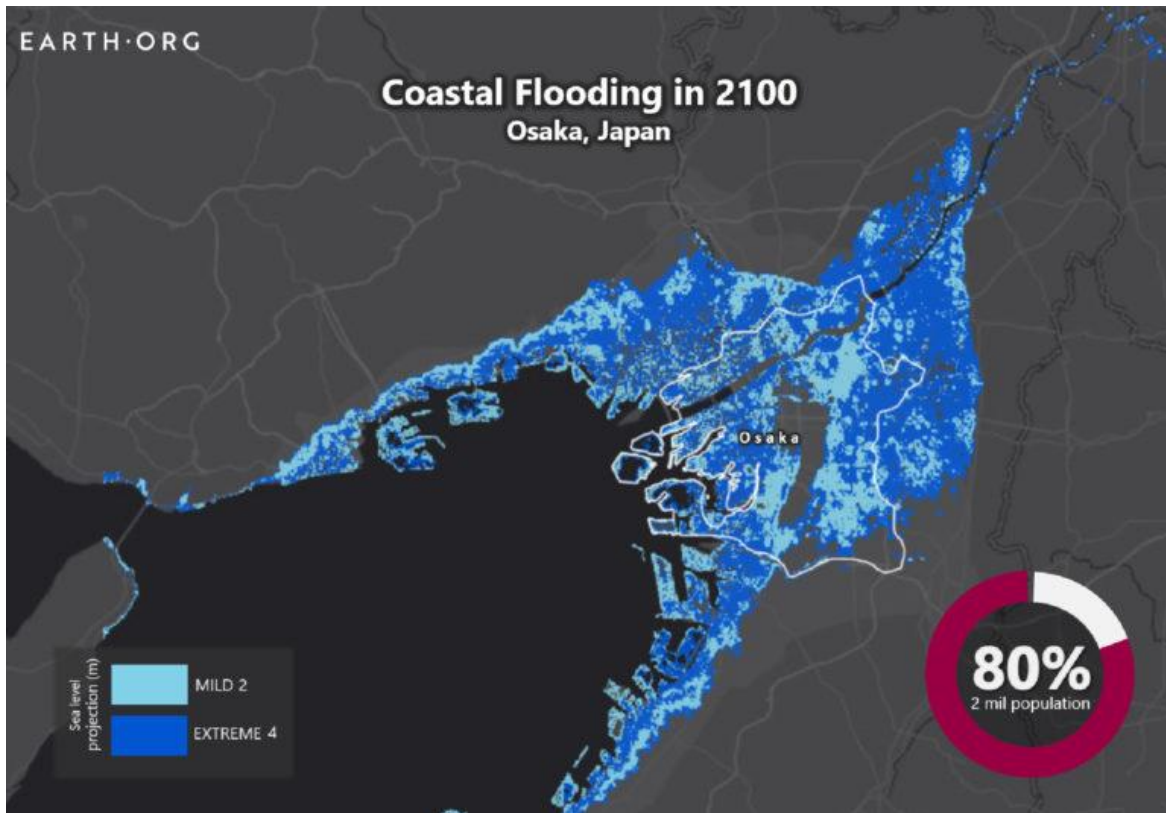
Japan

According to the Japan Meteorological Association, a trend of sea level rise has been observed in Japanese coastal areas since the 1980s (JMA, 2022). Sea level rise is a significant concern for Japan as it has an extensive coastline of more than 29,000 km and possesses many low-lying populated areas across its island archipelago that are susceptible to flooding. For more than decade, the Union of Concerned Scientists have noted that “in Japan, sea-level rise of 1 meter could put another 4.1 million people at risk of flooding and inundate more than 900 square miles of land in major cities. Such a rise is well within the range of scientists' projections, if today's trends in global warming pollution continue” (UCS, 2011). This would especially impact valuable economic and cultural assets, such as the port city of Osaka due to its low elevation. Research on Osaka has indicated that a high percentage of the city’s population are potentially exposed to sea level rise flooding (refer to Figure 4 below) (Mulhern, 2020). Additionally, according to some economists, Osaka could experience a loss or damage of up to \$1 trillion in assets due to coastal flooding by 2070 (UCS, 2011).

As mentioned previously, rising sea levels can lead to increased coastal flooding and erosion, which can damage infrastructure and threaten the livelihoods of people living in coastal communities. To counter rising sea levels, Japan's coastlines are protected at key points by sea walls. However, recent research has shown that Japan’s new sea defenses could be overwhelmed by future tsunamis as sea levels continually rise (Armour, 2019; Matanle, Littler & Slay, 2019). Expounding on Japan’s coastal defenses against rising sea levels Matanle, Littler, and Slay (2019, p. 1) state that “this continues a national pattern of disaster preparedness and response established in the early 20th century, which resulted in failure,” and they go on to compare Japan’s current coastal defenses to that of an ill-fated “Maginot Line”. The associated increase in the frequency and size of future tsunamis that are expected to arise from sea level rise is a major concern for Japan going forward. However, Japan’s developed economy and technological capabilities mean that it still has an opportunity to develop alternative countermeasures.

Figure 4

Map showing potential disastrous flooding in Osaka in 2100. Dark blue means extreme flooding. Light blue means mild flooding.



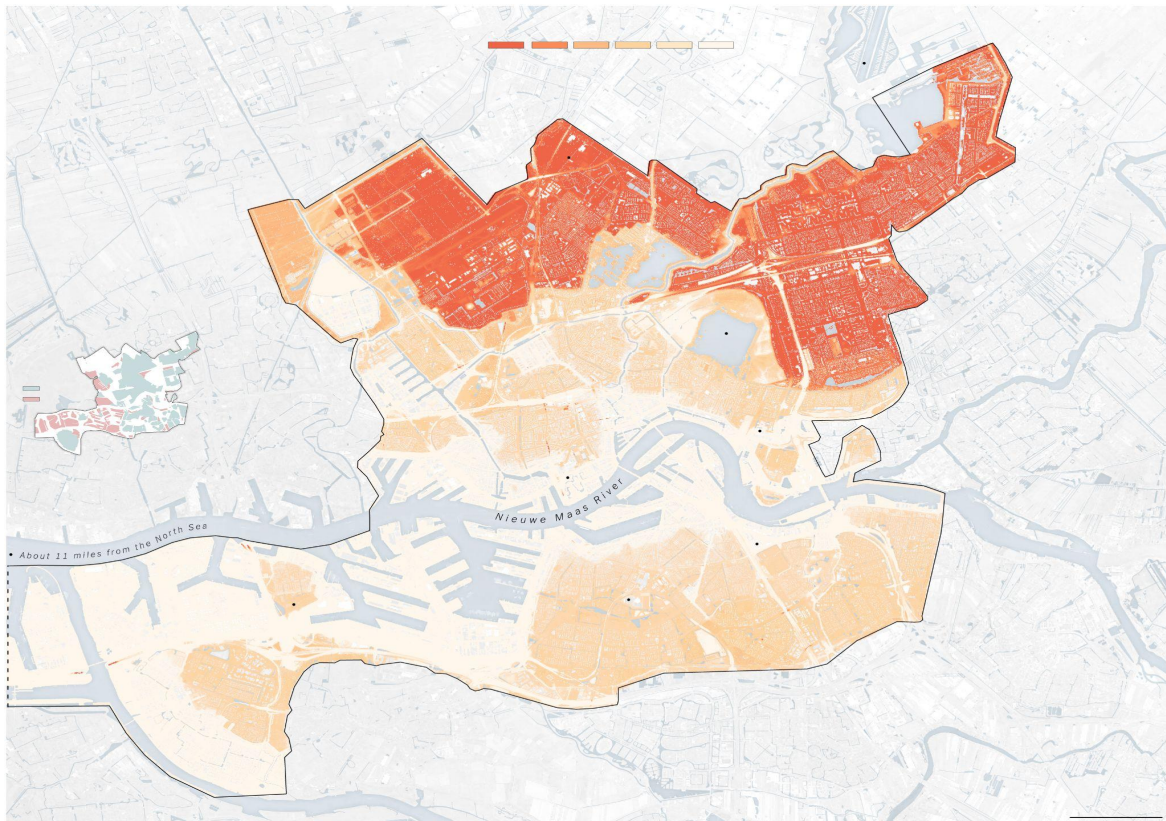
Source: Owen Mulhern. Creative Commons License.

The Netherlands

Shifting our geographic focus across the globe, the Netherlands is a small country located in Western Europe. The Netherlands has a coastline of approximately 1000 km and is comprised of many low-lying flat areas that make it particularly exposed to sea level rise. This includes some of their major urban areas such as Rotterdam, which is in some places a worrying 5 meters below sea level (refer to Figure 5 below). Given the topography of the Netherlands, they have been world leaders in advanced water management systems that include a network of sophisticated dams, dikes, and canals. However, sea-level rise may put unprecedented pressure on their sophisticated system (Smith, 2018). To prepare for this pressure, the Dutch have been investing in different ways.

Figure 5

Map of Rotterdam. The red and orange colors indicate the portions of the city below sea level.



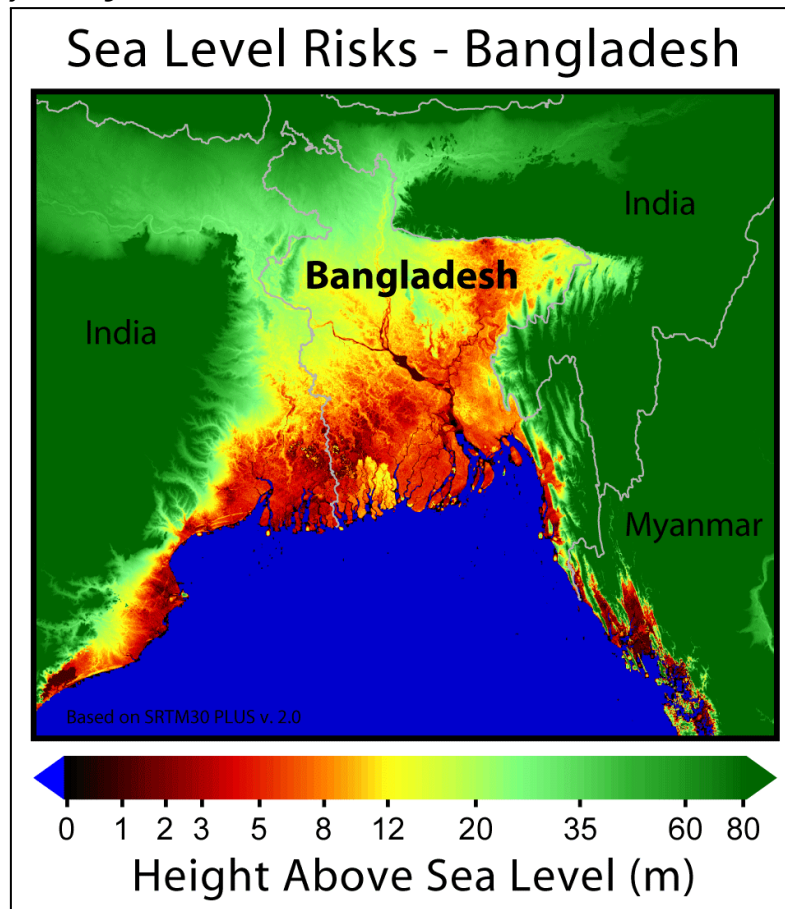
Source: Municipality of Rotterdam. Public Domain Image.

Firstly, giant artificial sand bars are being constructed to reduce the impact of waves and beach erosion. To make it a sustainable process, sand from other dredging activities is used. Secondly, new forms of salt tolerant crops such as samphire have also been adopted as salt from the sea encroaches closer to agricultural lands via wind (Smith, 2018; Van Bakel et al., 2009). Thirdly, an urban design concept of the ‘water square’ has been adopted. In this square, the benches and other features are designed to be safely submerged (Smith, 2018). This means that a public space can be used as a provisional reservoir in an emergency to store overflows of water if the water management system becomes temporarily overwhelmed. The Netherlands' relatively small size combined with a strong economy enable it to invest in and develop appropriate technology.

Bangladesh

Bangladesh is a country located in south Asia that has been described as “a vast river delta that barely rises above the sea at the best of times” (Cornwall, 2018). Because of its 580 km coastline combined with mainly low-lying areas (refer to Figure 6 below) and a developing economy, it is one of the most vulnerable countries globally to sea level rise. As such, there is great concern regarding the future of the country and its people in the face of the increasing climate crisis.

Figure 6
Sea Level Risks for Bangladesh. Red indicates low elevation areas.



Source: Robert A. Rohde. Creative Commons License.

The sea level is expected to rise by a potentially devastating 1.5 meters in Bangladesh by the year 2100 (Cornwall, 2018). Because Bangladesh is also one of the most densely populated countries in the world, there is very limited space for moving displaced communities to new land within the country itself (Golam, 2005).

While Japan and the Netherlands are wealthy countries, research has shown that Bangladesh is still carrying loss by “borrowing money from external sources like foreign aid or loans from the World Bank, pushing it back in terms of development” (Golam, 2005, p. 5). This is a good example of how climate change can be more disastrous for countries depending on their geography and economy. Bangladesh is also a very small producer of the harmful greenhouse gases which are ultimately linked to sea level rise. This displays that countries who are not largely responsible for environmental damage will still pay a high price for the actions of other countries who produce large amounts of greenhouse gases.

Teaching the topic

The following is a 90-minute lesson plan for how sea level rise can be taught in CLIL/EFL contexts. It engages several language and communication skills. The lesson plan has been used successfully with high-level, third-year science and engineering university students and the timing of the activities is based around that experience. The contents can be altered to suit any given class as needed to provide more time for each activity. The suggested timing can be considered a guideline. Alternatively, the lesson can be split into two or more classes if your students are of a lower level. Feedback from

my students indicated that they were especially interested in the website presented in the warm-up map activity, www.thetruesize.com. Many of them told me they engaged with the website outside of class. Students also enjoyed the international aspect of the lesson as they could encounter countries which do not normally feature in their everyday learning.

Warm-up map activity (10 minutes)

- Show the class a map with Japan, the Netherlands, and Bangladesh highlighted. This can be easily done by using the website www.thetruesize.com
- Divide the class into pairs. Ask them to talk with their partner in English about what the three shown countries are and what they could possibly have in common.
- Once a couple of minutes has elapsed, explain that they are all countries that will be impacted by sea level rise.
- Next, show the class a map of the world, either on a screen or on a wall-size map. I recommend using www.thetruesize.com via a projector as students' answers can be highlighted in real time by simply typing the country name into the box provided on the website.
- Ask students to identify any other coastal areas in English they can see on the map and to call them out.
- Ask students if they know of any places that have been affected by sea level rise.
- Encourage students to share any personal knowledge they may have about the issue in English.
- Introduce the title of the lesson and explain the objectives using the material provided earlier in this article regarding sea level rise, those being:
 - Introduction and topic overview
 - Negative impacts
 - Stopping sea level rise
 - Japan
 - The Netherlands
 - Bangladesh

Topic explanation and matching game (20 minutes)

- Explain the topic of sea level rise and its relationship to climate change. Use simple and clear language to best match your class.
- Next, divide the class into groups of 4-5 students. Provide each group with a list of vocabulary and definitions related to sea level rise. Cut the vocabulary and definitions into separate snippets beforehand. Placing them in envelopes is useful to keep everything together.
- Example vocabulary for the matching game (choose any you wish):

Japan

tsunami - A large ocean wave caused by a seismic event such as an earthquake or volcanic eruption.

typhoon - A tropical cyclone that occurs in the western Pacific Ocean.

sea wall - A barrier built to protect coastlines from the effects of waves and storm surges.

coastal flooding - Flooding that occurs when the sea level rises above the land along the coast.

erosion - The gradual wearing away of land by the action of water, wind, or ice.

fishing industry - The industry that provides services such as sea walls, dikes, and other coastal protection structures.

Netherlands

dikes - Barriers built to prevent flooding from the sea or a river.

dam - A barrier built to hold back water and control its flow.

water management - The management and control of water resources, including the construction of dams, dikes, and other flood protection structures.

flood plain - An area of land that is prone to flooding.

reclaimed land - Land that has been recovered from the sea or a river, typically through the construction of dikes or dams.

sluice gates - A gate used to control the flow of water in a canal or river.

Bangladesh

delta - A low-lying area of land formed at the mouth of a river where sediment is deposited.

monsoon - A seasonal wind that brings heavy rainfall to certain regions, typically in the summer.

flooding - The overflow of water from a river or other body of water, often caused by heavy rainfall or a storm surge.

freshwater sources - Sources of freshwater such as rivers, lakes, and aquifers.

displacement - The forced or voluntary movement of people from their homes or communities due to a disaster or other event.

disaster risk reduction - The practice of reducing the risk of harm caused by natural hazards such as floods through planning, preparedness, and mitigation measures.

- Have students work in their groups to match the vocabulary words with their definitions.
- Check and correct the definitions as a class.

Analysis activity (15 minutes)

- Show the class pictures of coastal areas affected by sea level rise and ask them to analyze and discuss the possible impact on those areas in their small groups.
- You can source images easily via Google or Flickr image search
https://images.google.com/?hl=xx-elmer&gws_rd=ssl

Reading activity (15 minutes)

- Show or distribute to students a short reading passage from National Geographic about the impact of sea level rise. You can select portions of the article rather than the full thing if your students are lower level.

- The article can be found here:
<https://www.nationalgeographic.com/environment/article/sea-level-rise-1>
- If you want to increase the challenge, have students answer some comprehension questions about the article.

Example questions

- How much of the heat caused by greenhouse gasses has the ocean absorbed?
- How much has the average sea level risen since 1880?
- How much is the sea level projected to rise by 2050?
- Why are the East and Gulf Coasts in the United States particularly vulnerable to the effects of sea level rise?
- Will the projected sea level rise occur even if carbon emissions are drastically cut?

Country role-play research and presentation activity (30 minutes)

- Students will work in large groups to research and present information about the impact of sea level rise on their assigned country.
- Divide the class into three groups with one group assigned to research Japan, one to the Netherlands, and one to Bangladesh.
- Provide each group with access to the internet or library books to conduct their research.
- Suggested research themes for each country have been introduced earlier during the topic explanation and students can use these as anchor points for their research:
 - ★ The history of sea level rise in their assigned country,
 - ★ Current sea level rise projections,
 - ★ The impact of sea level rise on the coastal communities and infrastructure
 - ★ Steps their country is taking to address the issue.
- Once the groups have completed their research, have each group present their findings to the class. Group spokespeople can be decided via rock, paper, scissors if necessary.
- After all the groups have presented, have a class discussion about the similarities and differences in how each country is impacted by sea level rise and the steps they are taking to address the problem.
- This activity will help students understand the impacts of sea level rise on various countries, communities, infrastructure, and the measures taken to mitigate its effects.

Conclusion

As presented in this paper, sea level rise is a crucial issue for humanity that has major consequences for many coastal communities around the world, including places in Japan such as Osaka. As teachers, it is our responsibility to provide our language students with the information and linguistic skills necessary to understand and describe the natural world, including the causes and impacts of climate change. This will empower them to engage in conversations and debates across a range of scales, from the local to the international. It is critical that we educate ourselves and future generations on the causes and impacts of sea level rise so that we can take action to mitigate its effects. It is hoped that this lesson will prove useful in bringing the issue of sea level rise into the CLIL/EFL language classroom in an active and engaging manner.

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