Slide 1: Hi everyone! Today we will be introducing you to the education toolkit for our secondary school peatland education. We will make use of this set of slides, together with worksheets to conduct this session.

Slide 2: To begin with, I believe that some of you may have not heard of the word “Peat” before. Peat refers to the organic layer of a soil surface. This organic layer consists of decomposed organic matters such as plants, mosses and animal carcasses. Peat is formed with these organic decays accumulated under waterlogging, oxygen deficiency, high acidity and nutrient deficiency.

Slide 3: Peatlands are therefore the accumulation of peats, and are wetland ecosystems where the production of organic matters exceeds the decomposition. They make up 70% of natural freshwater wetland in the world and cover 3% of our land surface.

Slide 4: Now that you have an idea of what peatlands are, consider this question: Why are peatlands so important? Well, firstly, peatlands are an important wildlife habitat for many wildlife species, which differs across countries. Southeast Asia’s tropical peat-swamp forests, in particular, are home to at least 1,524 plants, 123 mammals, 268 birds, 219 freshwater fish species and an unknown, but very high number of invertebrates, ferns and fungi. Secondly, peatland serves as a natural carbon sink. This means it absorbs more carbon than it releases, helping to lower the concentration of carbon dioxide in the atmosphere. In fact, peatland absorbs more than twice the carbon compared to all other trees and vegetations in the world. For every hectare of peatlands we protect, we save CO2 emissions of 16.515mt per year (or 4.5mt of carbon), equivalent to driving 60,000 kilometers with an average car!

Slide 5: In their natural state, peatlands are not conducive for the cultivation of commercial crops like oil palm, which is an important source of income for local communities. Therefore, a lot of peatlands were drained in order to convert them into arable lands and to make space for other forms of agriculture and land development. This led to large-scale peatland degradation and destruction.

Slide 6: You may ask, why is peatland protection so important? What are the dangers of Peatland Degradation?

Slide 7: There are four dangers of Peatland Degradation: Transboundary Haze, Peat Fires, Habitat Loss and Global Warming.

Slide 8: As we all know, Singapore has experienced smoke haze on multiple occasions, and I’m sure that most of you would have found the smell of the haze to be very unpleasant. Many of you may be wondering, what exactly does haze have to do with peatlands? Well, when peatlands become highly-flammable, the risks of peat fires increase tremendously. Even a cigarette butt or match can result in peat fires. Such fires can easily become out of control, resulting in the transboundary haze being produced. Such transboundary haze can affect regions hundreds of kilometres across, resulting in unhealthy and hazardous haze levels in countries. Short-term haze would cause physical illnesses such as irritation to eyes and noses, as well as result in breathing difficulties. And for the long-term effects, haze would increase risks of heart complications such as strokes or heart failures for adults and reduced lung development for children.

Slide 9: From the previous slide, we know that peat fires are the primary cause of the multiple hazes that we have experienced over the years. However, do you know the negative health effects that it can cause to individuals? Firstly, recent research has shown that emissions from the burning of peatlands contain potent carcinogens and over 90 different gases, some of which are highly toxic. If you are unsure of what carcinogens are, carcinogens are agents that can cause cancer in humans. Moving on, the airborne particles as a result of the peat fires are highly detrimental to the health of individuals, in particular, those who have acute respiratory issues such as asthma. Furthermore, the World Health Organization has found that these airborne particles can lead to increased mortality, as a result of heart and lung diseases.

From these points alone, we can see how detrimental the health effects of emissions from the burning of peatlands are.

Slide 10: As mentioned in the benefits of peatlands, Peatlands are home for many wildlife species, including orangutans, Sumatran tigers, and jelutong. The clearing of peatlands destroys their habitats and increases their vulnerability. As a result of peat fires, or the destruction of peatlands, the result would be a massive displacement of wildlife species due to habitat loss.

Slide 11: In addition to the detrimental effects illustrated in the previous slides, the destruction of peatlands contributes greatly to global warming. Peatlands are known to be the largest natural terrestrial carbon store, storing more carbon than all other vegetation types in the world. Currently, damaged peatlands contribute an approximate 10% of greenhouse gas emissions from the land use sector, whereas burning or draining one hectare of peatlands is equivalent to emitting an average of 55 million kg of carbon dioxide. In 2015 for instance, Indonesia’s peat swamp fires resulted in approximately 16 million tonnes of carbon dioxide being emitted daily. Clearly, the draining and burning of peatlands result in the release of significant amounts of carbon dioxide and greenhouse gases into the surroundings. These gases help to keep Earth warm through the trapping of heat, but the overabundance of such gases would result in additional heat being trapped, leading to extreme weather conditions such as tropical storms, wildfires, severe droughts and heat waves. Evidently, the detrimental effects are far-reaching, making peatland conservation efforts extremely crucial.

**In class activity 1: Slides 12 - 17**

Slide 12: Now, we will be moving on to the in-class activity. This activity consists of two parts, the first being a crossword puzzle, and the other being a worksheet for students to work on. This in-class activity will allow students to have the opportunity to research more on peatlands on their own, as well as to further pique their interests through the use of fun activities like the crossword puzzle. Please split the students into groups of five, with half working on the first worksheet and the other half working on the second. All students should be provided with a copy of the crossword puzzle. As only 15 minutes will be allocated to the students, our recommendation would be to have them work on the worksheets first before proceeding to the crossword puzzle.

Slide 13:

***Please show the answers and allow students to check.***

After the 15 minutes of discussion time is up, please go through the answers of the crossword puzzle and worksheets with the students.

Slide 14:

***Please show the answers and allow students to check.***

In the first worksheet, there is an image depicting a smouldering peatland post-burning in the Kampar, Riau province. This was an actual event that happened In Indonesia in 2019, and I believe that many of us experienced the effects of the haze that affected Singapore as a result of Indonesia’s forest fires. This worksheet focuses on reinforcing the students’ knowledge on the detrimental effects of the burning of peatlands, as well as how individuals can protect themselves from such effects.

Slide 15:

***Please show the answers and allow students to check.***

Slide 16:

***Please show the answers and allow students to check.***

Slide 17:

***Please show the answers and allow students to check.***

The last question of the worksheet is intended for students to come up with their own solutions. Therefore, we would not be providing the solution for the last question.

Slide 18:

***Please show the answers and allow students to check.***

The second worksheet consists of four questions. This image depicts an orangutan in the rehabilitation centre in Central Kalimantan Province, Indonesia. Orangutans are typically found on trees, making nests in trees of vegetation to sleep at night and to rest during the day. About 104,700 orangutans are found in Borneo, 13,846 in Sumatra and 800 in Tapanuli. Forest fires can result in the loss of habitat, respiratory infections, burns and other injuries.

Slide 19:

***Please show the answers and allow students to check.***

Next, the solution is that they can be rescued and brought to rehabilitation centres. However, the problem is that such solutions have limited effectiveness, and it is highly difficult for conservationists to rescue all animals affected by forest fires. If animals are kept at rehabilitation centres for too long, they might lose the ability to survive in the wild.

Slide 20:

***Please show the answers and allow students to check.*** As a result, any animal or plant species found in peatland forests are at risks of the loss of biodiversity, particularly for species which are already endangered.

Slide 21: Now we will be discussing how damaged peatlands can be restored.

Slide 22: Firstly, peatland restoration can be done through canal blocking, which refers to the blockage of canals that drain water from peatlands and cause them to dry out. Secondly, water management ensures that the amount of water in peatlands is maintained at an optimal level.

Thirdly, re-vegetation restores biodiversity in peatlands and lastly, restoring the livelihoods of local communities near peatlands allows peatlands to be managed in a more sustainable manner and improves the economic welfare of such local communities.

Slide 23:

**(Step 1: Canal Blocking)**

Between 1990 and 2000, many drainage canals were constructed inside Indonesia’s forest peatlands for planned agricultural projects. These canals were often dug by illegal loggers, for the purposes of floating out the chopped timber. Although most of these agricultural projects have failed, the canals still remain inside the forest.

These canals drain the peat and prevent it from retaining water during dry seasons, causing it to dry out. Therefore, blocking these canals can slow the rate of drainage and allow the peat to retain more water.

**(Step 2: Water Management)**

The next step is water management, which refers to maintaining the amount of water in peatlands at desired levels. This allows the peatlands to be used for agricultural purposes, since crops have the right conditions to grow. It also minimises the environmental impact caused by peatland degradation, such as carbon emissions produced by peatland fires.

Water management aims to protect peatlands from drought in the dry season. This can be done through the use of water control structures such as dams to allow the peat to retain water.

However, during the rainy season, there might be a risk of flooding if too much water collects in the peat. In this case, drainage canals are needed to prevent floods from occurring.

Slide 24:

**(Step 3: Re-vegetation)**

We can also make use of re-vegetation for peatland restoration. Re-vegetation is the process of planting new vegetation in degraded peatlands to replace the vegetation that was destroyed in peat fires. For example, we can plant local species of plants such as rubber and timber. Given that peatlands are also homes for many species of animals, revegetation can help to restore the habitats and biodiversity.

**(Step 4: Restoring Livelihoods)**

Lastly, we can also restore livelihood in the place. It is important to cultivate peatlands as it can help to alleviate poverty for local rural farmers. Developing local livelihoods can increase the economic welfare of peatland communities and allow for more sustainable peatland management -- this can be done through harvesting and weaving of purun to generate economic growth for the local rural communities.

Slide 25: Now, we will move on to the case study. In this case study, we will be exploring restoration efforts in Sungai Tohor in Riau, Indonesia.

Slide 26: Firstly, revegetation efforts were done through seedling nurseries. This is done through collecting 57 species of seedlings from 29 plant species, with 17 being pioneer tree species and the other 40 being climax tree species that can be easily found for restoration. A peatland nursery was built to nurture the seedlings, with the current capacity for 6.500 saplings. It is expected to reach a capacity of 10,000 at the end of project year.

Slide 27: Afterwards, seedlings were translocated from the nursery to the restoration sites. Maintenance of the restoration site was done through weeding and watering. In total, 1970 pioneer species were introduced as of May 2020, expected to reach 6,000 by the end of the project year.

Slide 28: Rewetting was done through canal blocking and monitoring. 4 canal blocks were established and maintained. Monitoring was done by measuring peat water levels, peat subsidence, amount of rainfall, tree growth and carbon stock.

Slide 29: Apart from the measures mentioned in the case studies, how else can peatland degradation be avoided? Firstly, this can be done by cultivating peat-friendly cash crops, such as sago palms, rice and soybean, which can provide a livelihood for villagers while reducing peat degradation. Secondly, this can be done through paludiculture, which refers to planting crops on wet soils. This avoids the negative environmental impacts of drainage of peatlands that we discussed just now, such as greenhouse gas emissions. At the same time, the land can continue to be used to produce agriculture and biomass.

**In-class activity 2: Slides 30-31**

Slide 30: Now we will move on to the final in-class activity, poster designing.

Slide 31: Students are encouraged to let their creative juices flow and make use of the things they have learned during the presentation to design a poster about peatland protection and environmental sustainability. If there is insufficient time in class, this can be done as a take-home activity as well.

Slides 32-33: We hope that this session has given you a greater understanding of what peatlands are, why they are important and how to protect them. Thank you.