Intended Use of Resources

This project has been designed so that teachers from different STEM areas can pick and choose sections relevant to their subject area to work on. All activities in this package do not need to be completed to get value from the package – each activity can be completed as a stand-alone or can be approached, as a team, as a larger project. The package has potential to be extended into a much longer project to include curriculum points from different STEM subjects.

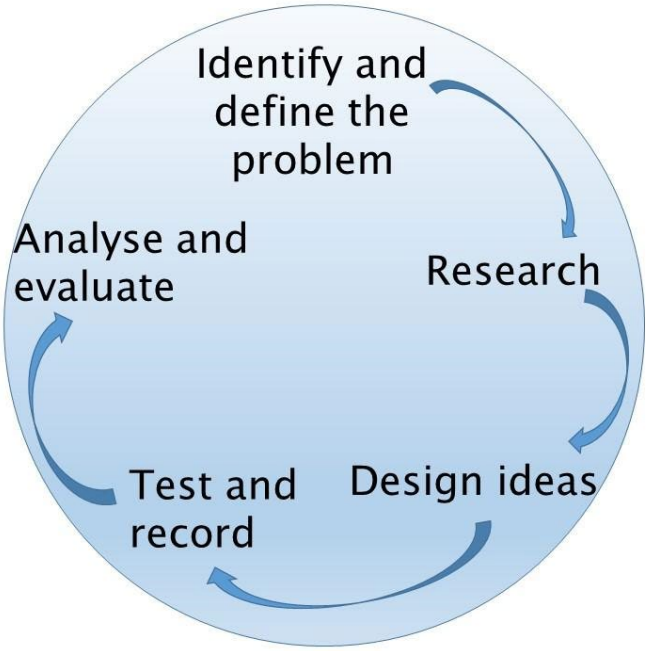
There are three **student workbooks - Open, Guided and Scaffolded,** that go alongside this resource; all have the same suggestions for activities, however, they have been written and edited to provide differentiated learning options to support good teaching practice**.** Teachers may pick and choose which versions they give which students, and may wish to edit them further to address their learning needs. Due to the differentiation of the workbooks, the **Open** activities will enable more syllabus links to be addressed, which is why each activity has its own syllabus links key. However, if you wish to give a truly open-ended investigation then you could just give the students the challenge and background information section of the Student Booklet.

The Woodside Australian Science Project (WASP) STEM resources aim to be accessible and supportive for teachers and students, please contact us if you have questions, feedback, require assistance or would like to arrange an incursion or a professional development workshop - www.wasp.edu.au

Landslide Engineering – Teacher Resource

The Challenge

Landslides can have devastating impacts, they can move and destroy roads, rail and cars, and even topple buildings. Your role is to investigate some causes of landslides and suggest methods to prevent damage from these events.



Background Information

What pulls you towards the ground when you are at the top of a slide? The answer is gravity. You have probably noticed that when you wear different clothes you might go down the slide faster or slower. This is because of friction. Reducing friction will make you move faster down a slide. Land can move for the same reasons. When land moves down slope it is known as a landslide.

Landslides can be triggered by earthquakes, volcanoes, heavy rain and even large vibrations from machinery or building work.

In 1997, a catastrophic landslide occurred in Thredbo, New South Wales. The slope above two ski lodges became unstable and just over 100 tonnes of liquefied soil slipped downhill. This destroyed two ski lodges. Witnesses reported hearing a whoosh of air, a crack and a sound like a freight train rushing down the hill. There were 18 fatalities and only one survivor from the lodges.

Figure 1. SES volunteers and firemen assisting at the Thredbo debris slope in 1997.

It can be difficult to study landslides, as scientists and engineers usually don't know when they will happen, however, scientists can use models to help make predictions about where one might occur and what might cause it. Engineers can use debris flow flumes to recreate landslides on a smaller scale so they can study them. They can use their understanding of landslides to assist them to come up with ways to either stop them from happening, or at least stop them from causing too much damage.

Landslide Engineering – Teacher Resource

Activities

This booklet contains extra information on each activity, including syllabus links the overall activity objective, suggestions for recommended equipment or alternative ways to run investigations as well as useful resources and website links. Please note that any reference websites provided in the entirety of our resource documents were current at the time of publication. Please advise if links are no longer accessible.

The syllabus links have been colour coded – please see the colour key below:

Covered in Scaffolded, guided and Open student workbook
Covered in Guided and Open Student workbook
Covered in Open student workbook

List of Activities

Landslide Engineering – Teacher Resource

Background Research

Objective

In this activity, student gain knowledge about what defines a landslide and the possible causes of one through conducting research on the internet. Some scaffolded students may benefit from a guided introductory lesson instead.

They should find that there are five modes of slope movement: falls, topples, slides, spreads and flows. Landslides in the ocean are called submarine landslides and can lead to tsunamis if they are big enough. Landslides that are caused by volcanic eruptions are known as lahars, and they are often made of a mix of ash and water from the volcano. Landslides are usually caused by natural phenomenon such as earthquakes, volcanic activity or heavy rain, but large vibrations caused by heavy machinery could also trigger them. Deforestation will make a hillside more likely to slip as the roots of trees hold soil together and create pore spaces for excess water to penetrate.

	Australian Syllabus Links
Science	ACSSU096 Sudden geological changes and extreme weather events can affect Earth's surface

Useful websites:

- Definition and different modes of landslides outlined here: https://www.usgs.gov/faqs/what-a-landslide-and-what-causes-one?qt-news_science_products=0#qt-news_science_products
- In depth discussion of different types and causes of landslides: https://science.howstuffworks.com/environmental/earth/geology/landslide3.htm

Landslide Engineering – Teacher Resource

Finding the Angle of Repose

Objective

In this activity, students determine the angle of repose (the steepest angle a material can stack at).

Another method to find the angle of repose, instead of using a protractor, would be to take some measurements. Measure the height of the pile of material and the width of the base. Draw this as a right angle triangle on a piece of paper and measure the angle from the drawing. This will allow students to practice measuring and drawing triangles.

If the sand has microbial materials in it, students should wear masks and gloves.

If students have access to microscopes, magnifying glasses or hand lenses they should look at the grains under magnification to compare how they look and use this to explain why they hold together well or slide past each other easily.

	Australian Syllabus Links
Science	ACSIS232 With guidance, pose clarifying questions and make predictions about scientific investigations ACSIS103 Identify, plans and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks. ACSIS104 Decide variables to be changed and measured and record data with accuracy using digital technologies as appropriate. ACSIS221 Compare data with predictions and use as evidence in developing explanations.
Technologies	WATPPS36 Select, and apply, safe procedures when using a variety of components and equipment to make a solution. WATPPS38 Work independently, or collaboratively when required, considering resources and safety to plan, develop and communicate ideas and information for solutions.
Mathematics	ACMSP147 Interpret and compare a range of data displays, including-including side-by-side column graphs for two categorical variables.

	ACMMG141 Investigate, with and without digital technologies, angles on a straight line, angles at a point and vertically opposite angles. Use results to find unknown angles

Useful websites

- How to measure an angle using a protractor: https://www.youtube.com/watch?v=Gzd_lsNwTOI
- Tutorial (for teachers) on the angle of repose, suggestion on how to measure it, and how water effects it, this is quite high level and not suggested for students: https://www.youtube.com/watch?v=bR-z7mG344w

Effect of Water on Slope Stability

Objective

In this experiment, students investigate the effect of adding water to slope stability. This can be carried out either as suggested in the scaffolded book or in a similar method to the angle of repose experiment, where water is added to the sand in a cup and then it is poured out into a tray and the angle of repose is measured.

Students should find that when water is first added the sand becomes more cohesive, as the water creates capillary action, sticking the sand particles together. As more water is added the sand will turn into a slurry and will not stand upright, sliding down the slope or collapsing in on itself very quickly.

A discussion point for students could be around the process of adding a layer of sand to the base of new roads. The sand is then watered to hold it together and stop it from blowing everywhere. It is important not to wet the sand too much or it will start to move.

Students can relate their findings to when there is a lot of rain; wet soil makes it slippery and too much water enables the sand particles to glide past one another.

	Australian Syllabus Links
Science	ACSIS232 With guidance, pose clarifying questions and make predictions about scientific investigations ACSIS103 Identify, plans and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks. ACSIS104 Decide variables to be changed and measured and record data with accuracy using digital technologies as appropriate. ACSIS221 Compare data with predictions and use as evidence in developing explanations.
Technologies	WATPPS36 Select, and apply, safe procedures when using a variety of components and equipment to make a solution. WATPPS38 Work independently, or collaboratively when required, considering resources and safety to plan, develop and communicate ideas and information for solutions.
Mathematics	ACMSP147 Interpret and compare a range of data displays, including side by side column graphs for two categorical variable.

Useful websites

- Short explanation of the reasons for the behaviour of soil as wetness and slope is increased (recommended for teachers): http://pharmatechg7.blogspot.com/2013/12/practical-4-angle-of-repose.html

Landslide Engineering – Teacher Resource

Plant Power

Objective

For this experiment, students will investigate the effect plants and vegetation have on the chance of a landslide occurring. They should find that as they add water to the soil with no vegetation it starts to wash down the slope (indicating a landslide could occur). However, when they add the water to the soil with an established plant growing in it much less soil washes, away as the roots hold the soil together. Indicating there would be much less chance of a landslide on a well vegetated slope.

This experiment could be extended to different types of plant, which have varying depth of roots. A deeper and more established root system would be most effective at keeping the soil in place.

Following deforestation and the death of plants through forest fires soil will no longer be so tightly held together by roots and landslides are more likely to occur.

This experiment could be further extended by students filtering the runoff water and determining how much soil has been washed away (by weighing it) in each scenario to compare results numerically.

Note: This investigation is also carried in the Flooding STEM package for Year 6 students.

	Australian Syllabus Links
Science	ACSIS232 With guidance, pose clarifying questions and make predictions about scientific investigations ACSIS103 Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks. ACSIS104 Decide variables to be changed and measured and record data with accuracy using digital technologies as appropriate. ACSIS221 Compare data with predictions and use as evidence in developing explanations.
Technologies	WATPPS36 Select, and apply, safe procedures when using a variety of components and equipment to make a solution. WATPPS38 Work independently, or collaboratively when required, considering resources and safety to plan, develop and communicate ideas and information for solutions.

Landslide Engineering – Teacher Resource

Useful website:

- ABC news article explaining how removal of vegetation has caused flooding in the UK and Australia
  http://education.abc.net.au/newsandarticles/blog/-/b/635262/lessons-from-the-summer
- Short article explaining how trees help prevent flooding, comparing vegetated to non-vegetated areas.
  http://www.greening.in/2013/05/how-trees-help-in-preventing-floods.html

Animating Undercutting

Objective

The objective of this activity is for students to explain the process of undercutting and how it can lead to landslides. This activity has a focus on both communication and teamwork, which are key STEM skills, as well as working with technology to improve their digital literacy.

The list of equipment is just a suggestion and students should be encouraged to come up with their own ideas on how they will explain undercutting.

	Australian Syllabus Links
Science	ACSSU096 Sudden geological changes and extreme weather events can affect Earth's surface ACSIS110 Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts. ACSHE099 Scientific knowledge is used to solve problems and inform personal and community decisions
Technologies	ACTDIP022 Manage the creation and communication of information, including online collaborative projects, using agreed social, ethical and technical protocols.

Landslide Engineering – Teacher Resource

Engineering a Solution

Objective

The objective of this exercise is for students to begin to understand there are many different methods to prevent landslides from occurring and that their use depends on the underlying rock and soil. Students will research the main methods used to prevent landslides and then apply their understanding of the methods to different scenarios.

Terracing or benching is a useful method of growing crops on very steep sided slopes. Terracing reduces the angle of repose making it less likely for landslides to occur.

Having good drainage near slopes can mean that the soils will not become saturated as quickly. When soil gets saturated it becomes heavier and ismore likely to slip due to the pull of gravity. An excess of water also reduces the friction between particles so can lead to slippage.

Retaining walls are commonly built next to roads or rail cuttings where a road has cut through a hillside made predominantly of soil/ andy material that would collapse if not held back. This prevents land slipping onto the road/railway. Retaining walls enable the sand/soil to be held back at a much steeper angle than its natural angle of repose.

Rock bolts are commonly used next to roads and rails where there is no or little soil and only rock. Bolts are drilled into the rocks, transferring the load from the unstable exterior to the stronger interior of the rock. Often rock bolts are a used to support wire mesh to hold back any rock that does happen to fall off.

Revegetation or afforestation is a soft engineering technique. This works on sand dunes and soil slopes where plants can grow. The roots from the plants will hold the soil together so it will not be washed or blown away as easily. The roots also create small pore spaces next to them which allows water to seep through more readily. Unlike a hard engineering technique, it can often take a long time for the plants to grow and establish, however it is generally more cost effective. Revegetation doesn't work on steep rock faces.

	Australian Syllabus Links
Science	ACSSU096 Sudden geological changes and extreme weather events can affect Earth's surface ACSIS110 Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts. ACSHE100

	Scientific knowledge is used to solve problems and inform personal and community decisions.
Technologies	ACTDEK023 Characteristics, properties and safe practice of a range of materials, systems, tools and equipment; and evaluate the suitability of their use ACTDEK019 How people address competing considerations, including sustainability when designing products, services and environments for current and future use.

Useful websites:

- Short explanations of each method of slope stabilisation:

http://www.sinaiconstruction.net/LA-foundation-retrofit-blog/slope-failure-repair-options/

- Wikipedia explanation of how a retaining wall works:

https://en.wikipedia.org/wiki/Retaining_wall

- Comprehensive publication from the US Geological Society on landslides (recommended for teacher only):

https://pubs.usgs.gov/circ/1325/pdf/C1325_508.pdf

Bibliography

(Figure numbers from scaffolded booklet)

Figure 1: SES volunteers and firemen assisting at the Thredbo debris slope in 1997,accessed at https://commons.wikimedia.org/w/index.php?curid=4837093 on 25/5/19

Figure 2: Angle of repose forces, accessed at https://commons.wikimedia.org/wiki/File:Angle_of_repose_forces.jpg, on 18/6/19

Figure 6: Cliff drop off warning sign, accessed at https://www.freepik.com/free-photo/cliff-drop-warning-sign_605980.htm, on 18/6/19

Figure 7: Old mountain road, accessed at https://commons.wikimedia.org/wiki/File:Old_mountain_road_(Unsplash).jpg, on 18/6/19