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ECONOMIC ANALYSIS SCREENING TOOL: GUIDELINES

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Western Australia and the Bushfire & Natural Hazards CRC





Version	Release history	Date
1.0	Initial release of document	31/05/2021



Australian Government
 Department of Industry, Science,
 Energy and Resources

AusIndustry
 Cooperative Research
 Centres Program

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Publisher:

Bushfire and Natural Hazards CRC

May 2021

Citation: Florec ., Rogers AA & Pannell DJ (2021) Economic Analysis Screening Tool: Guidelines, Bushfire and Natural Hazards CRC, Melbourne.

Cover images, clockwise: Christchurch earthquake damage by Sharon Davis on Flickr, Bushfire by bertknot on Flickr, Vincent St flooded by Angus Veitch on Flickr, Economics from moodlemonkey.com.



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ACKNOWLEDGMENTS

We would like to thank all our partners and end-users for their comments, suggestions, and questions at different stages of development of the tool. They all contributed to get the tool to where it is now.



ABSTRACT

This document provides an overview of the Economic Analysis Screening Tool (EAST) and its development, as well as the instructions on how to use it and how to interpret the results derived from it. EATS was developed by researchers from the University of Western Australia as part of the BNHCRC funded project “Economics of Natural Hazards.”

These Guidelines should be used in conjunction with EAST and should be considered an integral part of the Tool package. We recommend users read these Guidelines before using EAST.



INTRODUCTION

The Economic Analysis Screening Tool (EAST) was developed by researchers from the University of Western Australia as part of the “Economics of Natural Hazards” project. The project, which is funded by the Bushfire and Natural Hazards CRC, aims to provide information on the economic, social and environmental impacts of natural hazards, in order to help hazard managers in their decision making. The purpose of our research is to help emergency service and land management agencies better prioritise their investments in mitigation. Using economic tools and expertise, we assess the impacts of hazard mitigation on tangible and intangible (non-market) values, in order to shed light on the real (total) costs and benefits of natural hazards and help agencies better allocate their resources for mitigation.

Before commencement of the project, we asked our end-users what they wanted to get from our work. The two most common answers were:

- they needed simple and robust tools that would help them better allocate budgets between different mitigation options for natural hazards,
- have the capacity to go to Treasury and discuss those budgets.

We then set out to develop user-friendly tools, video courses and workshops, that would help end-users evaluate different mitigation options from an economic perspective and increase the economic knowledge and capacity in the emergency and natural hazards management sector. EAST is one of the tools developed for these purposes.

This document provides an overview of EAST and its development, as well as the instructions on how to use it and how to interpret the results derived from it. These Guidelines should be used in conjunction with EAST and should be considered an integral part of the Tool package. We recommend users read these Guidelines before using EAST.

We have also created a series of videos where we explain the basic economic concepts used in EAST to conduct economic analyses of mitigation options for natural hazards. If you would like to better understand these concepts, we recommend you watch a series of 10 short videos published in the BNHCRC YouTube channel. You can find the whole [video series here](#).



BACKGROUND

In the context of natural hazards, a mitigation option is an action that aims to reduce the risk of natural hazards or minimise their impacts to society and/or the environment. These actions are undertaken because they are believed to generate benefits. Examples could include the construction of a dam to prevent flooding in a flood-prone area, the application of controlled fire (prescribed burns) to a landscape to reduce the risk and intensity of wildfires, or the improvement of building standards to reduce cyclone impacts. The objective of mitigation is then to protect the values affected by natural hazards.

The 2015 Productivity Commission's report on natural disaster funding arrangements in Australia found that government agencies generally overinvest in post-disaster reconstruction and underinvest in pre-disaster mitigation activities that would limit the impact of natural disasters. Given the multitude of natural hazards that require mitigation and response from government and the tighter budgets at both State and national levels, natural hazards managers are increasingly under pressure to justify the use and allocation of resources for mitigation efforts. Government agencies need to ensure that the benefits justify the costs and allocate resources in order to get the best value for money out of mitigation investments.

To know which option provides best value for money, managers have to compare mitigation investments between different hazards and different locations and weigh up all the economic, environmental and social outcomes of the options considered. With this information, managers can then rank and prioritise mitigation options by benefits gained per dollar invested. However, this information is often not available and comprehensive analyses that shed light on the trade-offs between the different options considered are rare. At the State and National levels, there is a need for simple and robust tools that help to prioritise treatment options for natural hazards.

A TOOL FOR THE ECONOMIC EVALUATION OF MITIGATION OPTIONS

We have filled this gap by developing EAST, which links the economic, social and environmental impacts from natural hazard with the costs and potential effectiveness of mitigation options in a simple and robust way. EAST was inspired by INFFER (the Investment Framework for Environmental Resources), which is currently used in many Australian and international Natural Resource Management organisations to assess and prioritise environmental projects.

INTENDED AUDIENCE

EAST is intended to be used by government agencies, emergency management organisations, natural hazard researchers, aid and recovery groups, or any other organisations involved in natural hazard risk management, mitigation of hazard impacts, the promotion of preparedness activities, or post-event recovery.



THE PURPOSE OF THE TOOL

The purpose of EAST is to:

1. provide a quick overview of the value for money that can be obtained from different mitigation options, and
2. improve the ability of managers to make a business case for natural hazard mitigation in order to discuss appropriate budget levels with policy makers and treasury.

EAST also aims to facilitate the inclusion of intangible (non-market) values in natural hazards policy and budget decisions, thereby enhancing the capacity of managers to undertake proper evaluation of mitigation options with a more complete picture of the costs and benefits (including both tangible and intangible values).

With EAST, managers will be able to:

- conduct economic analyses in weeks rather than months or years,
- identify the options that are most worth developing business cases for,
- identify and prioritise the type and quantity of information that is needed to improve decisions and the confidence in those decisions,
- clarifying the counterfactual (business as usual or another baseline), and
- determine the importance of non-market values for different decisions.

The tool provides economic results that are easy to read and understand, with the help of tables and graphs. It automatically generates net present values (NPVs), benefit-cost ratios (BCRs) and internal rate of return (IRR) estimates that can be easily compared between the different options evaluated. It is built in a way that allows the user to easily make changes to parameters and understand the consequences of those changes in the results. The sensitivity analysis shows how proportional changes to different parameters affect the results with the help of simple and clear graphs that allow the user to compare the impact of all key parameters. The information derived from the results and the sensitivity analysis helps the user to quickly determine which parts of the analysis require additional data and by how much the confidence in the results can be increased with it.

WHAT EAST IS NOT INTENDED FOR

EAST is not intended to be used to evaluate impacts of natural hazards on the wider economy (i.e. Gross Regional or National Domestic Product), different sectors of the economy or any other type of evaluation that is relevant to the macro scale. The tool does not estimate the opportunity costs of a given loss or revenue gains/losses for different industries. The analysis in EAST is done at the micro scale, which considers the loss for the individual household or business, and is only concerned with the cost of replacing the assets damaged and the losses incurred as a result of the damage (i.e. direct and indirect impacts).

EAST is not intended for evaluating the impact of a hazard on communities in order to make political decisions and allocations of aid funds. The tool does not include inflows of money into the area affected, such as insurance payments,



payments by government, recovery and restoration programs, aid funds or donations, and it does not incorporate potential economic benefits resulting from the hazard, such as an economic boost to the construction industry post-disaster.

Although EAST can be used to estimate the damage of a single hazard event and can provide estimates for cost-of-impact assessments, it is not the purpose of the tool. EAST should be used instead as an ex-ante analysis tool (rather than a post-event analysis tool) for strategic decision making to help prioritise resource allocation between different mitigation options.

DISCLAIMER

The Bushfire and Natural Hazards CRC and the University of Western Australia have endeavoured to ensure that all information in this publication is correct. The BNHCRC and UWA make no warranty with regard to the accuracy of the information provided and will not be liable if the information is inaccurate, incomplete or out of date nor be liable for any direct or indirect damages arising from its use. The contents of this publication should not be used as a substitute for seeking independent professional advice.

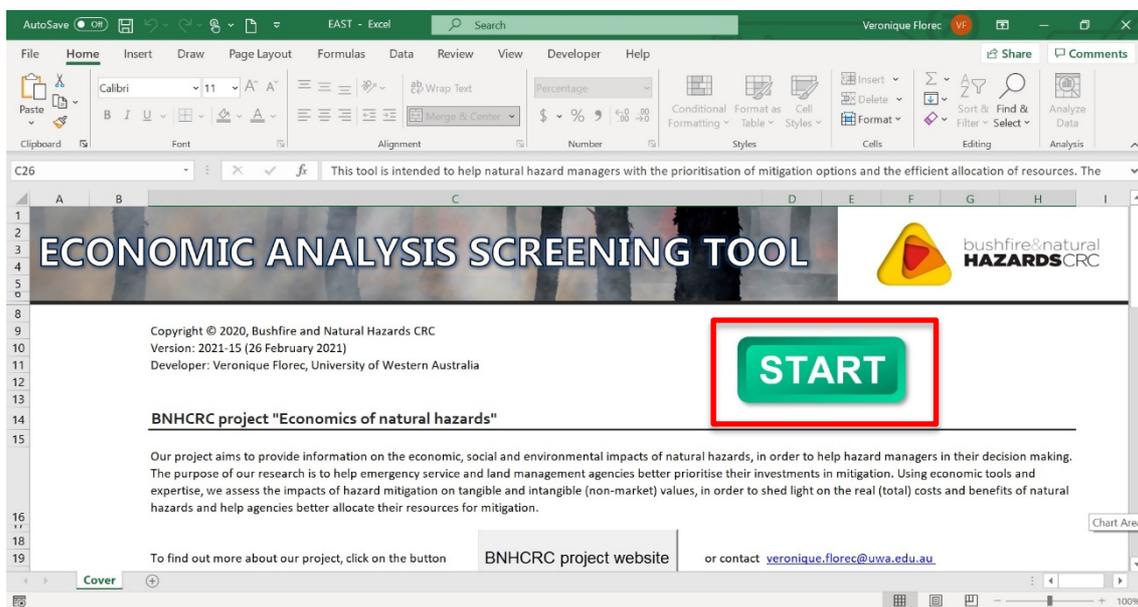
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HOW TO USE THE ECONOMIC ANALYSIS SCREENING TOOL

Open EAST by double clicking on the Microsoft Excel Macro-Enabled Worksheet **EAST.xlsm**, make sure that macros are enabled (you might need to ask permission from your system administrator to enable macros on this file). Without macros enabled, the tool will not work.

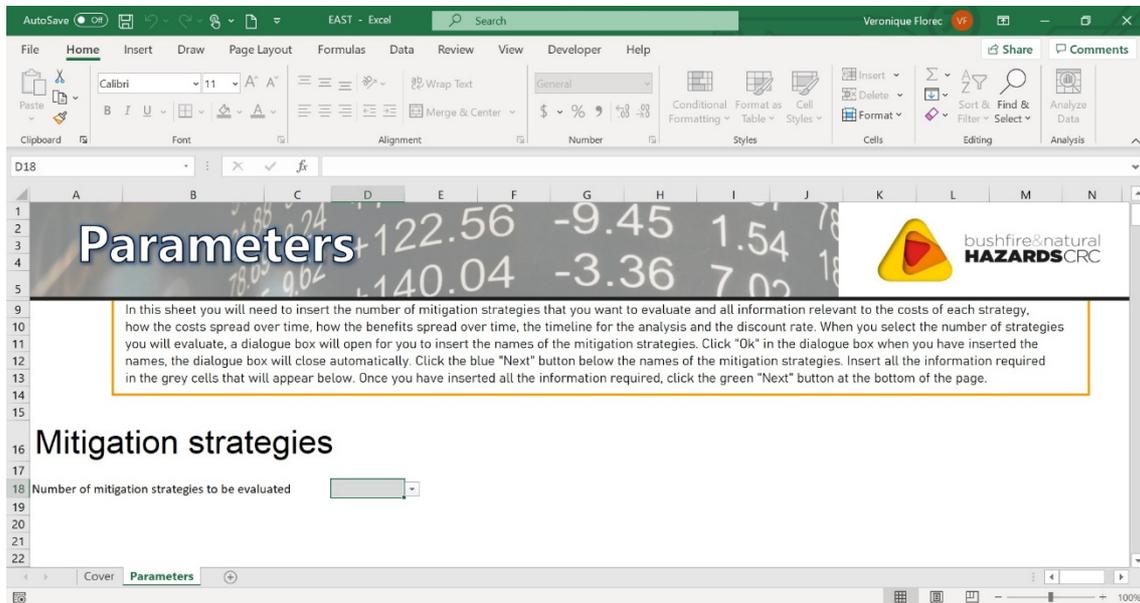
As you open EAST, the first sheet that opens is the Cover sheet. This sheet contains a short description of our project, a brief summary of what the tool is intended for, and the disclaimer and copyright information. Click on the green **START** button to start using the tool.



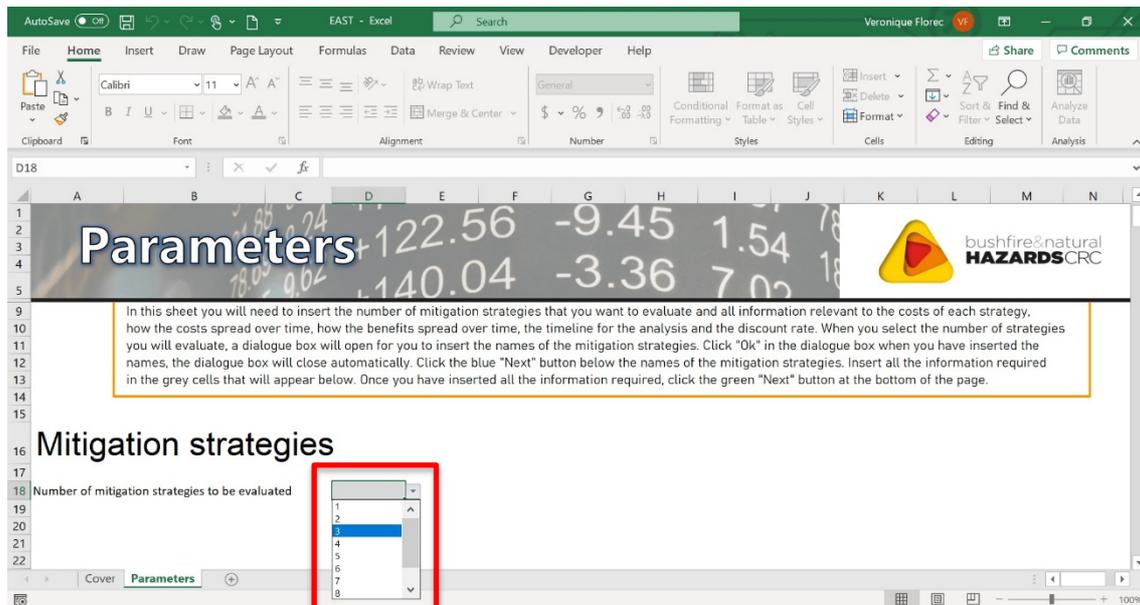
Throughout the tool, you will see information icons . Click on any of the information icons to open a small box that will provide you with a short explanation of the data you need to insert in the section where the icon appears.

PARAMETERS

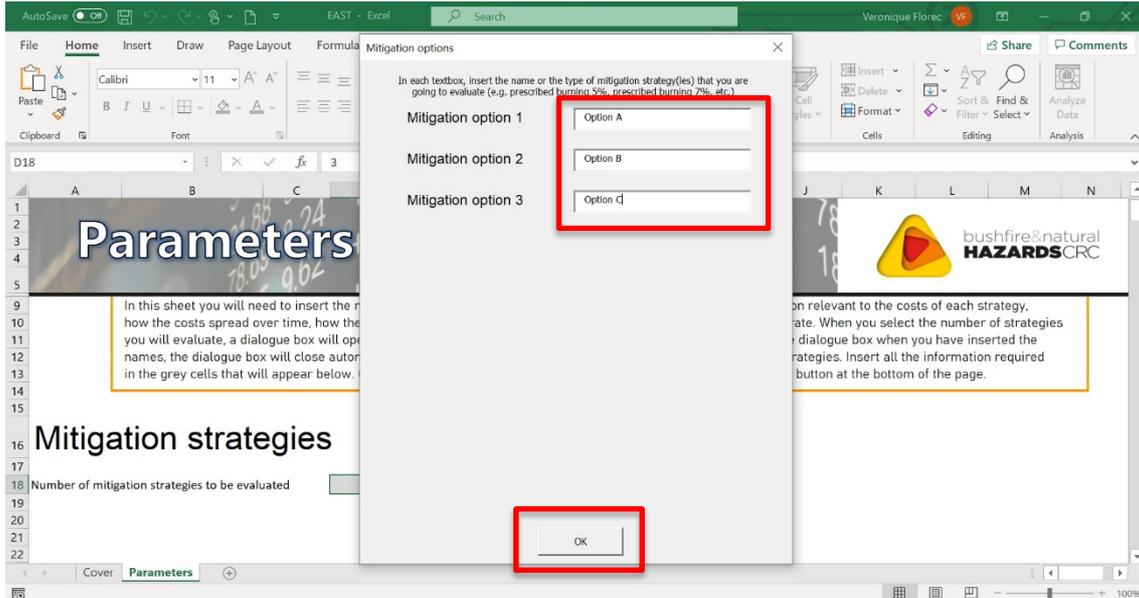
The *START* button takes you to the Parameters sheet, where you need to input the number of mitigation options that you will evaluate, the cost of each mitigation strategy, when the benefits are likely to be realised, and information on the length of the analysis and the discount rate.



In the section Mitigation strategies, click on the drop down menu in cell D18 and select the number of mitigation strategies that you want to evaluate, or simply enter a number between 1 and 10 in cell D18.

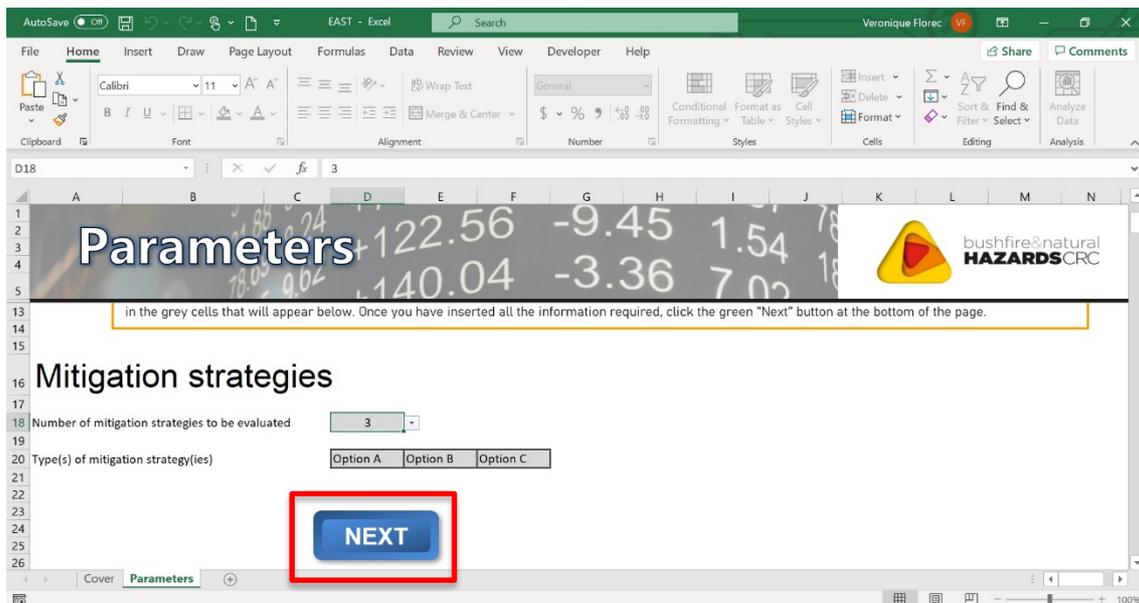


This will open a dialogue box with blank fields to insert a short name for each mitigation strategy.



The names you insert here will be used in other sections of the tool to allow you to easily identify each mitigation option and differentiate it from the others. Insert names that make sense to you and that you will easily remember what they correspond to. Enter the names of your mitigation strategies in each text box and click OK at the bottom of the dialogue box.

Once you have inserted the names of the mitigation options, click on the blue button *NEXT*. The rest of the parameters appear. You will need to insert information in all the grey boxes for the tool to be able to calculate the results. Each of the sections in the Parameters sheet is described below.

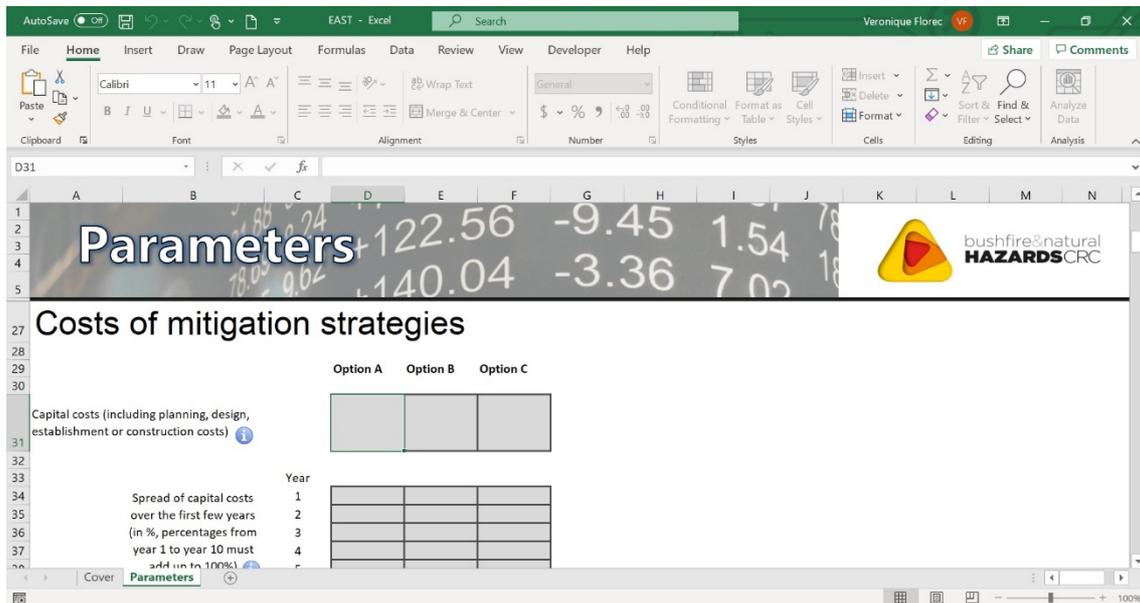


Costs of mitigation strategies

Scroll down to the section *Costs of mitigation strategies*. The costs of mitigation strategies are divided into two types of costs: 1) capital costs, and 2) annual



operation and maintenance costs. Below you will find the definition of each type of cost and what data you should insert in EAST for each of these costs.



Capital costs

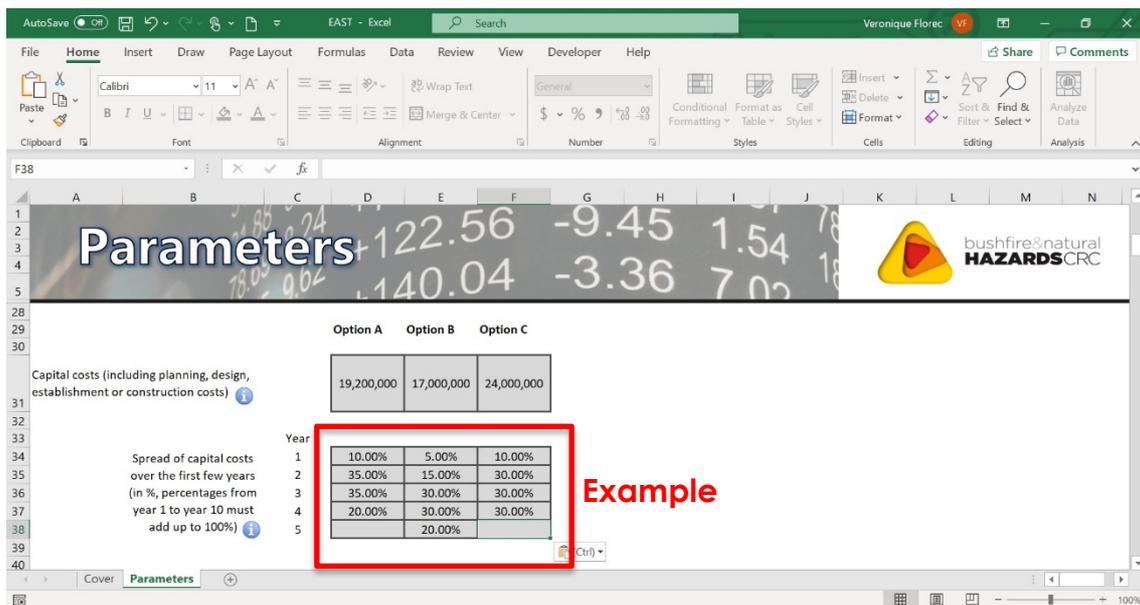
Capital costs include all time and money spent on planning, designing, establishing or building the necessary elements of each mitigation strategy. Here you should include all expenditures necessary to be able to get the mitigation option started or in place. These could be, for instance, the money needed to build a dam or a levee, or the money needed to establish a prescribed burning program or a fire education program, or the money needed to retrofit houses to mitigate cyclone impacts. Once capital costs are spent (and the dam is built, or the education program is established, or the houses are retrofitted), the mitigation option is considered to be in full implementation. You need to insert in EAST the total amount of capital costs for each mitigation option in the grey boxes in row 31 in the Parameters sheet.

Whenever you need a quick reminder of the type of data you need to insert in each section, click on the information icon  to open a small box with a short explanation of the data required.



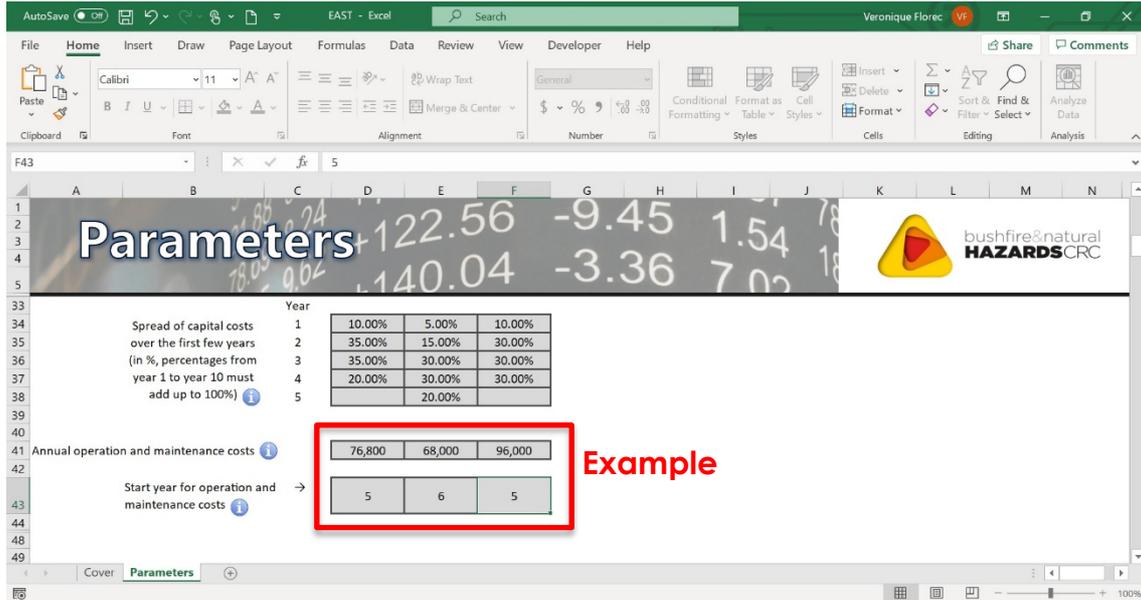


Depending on the type of mitigation option, capital costs might spread over several years (e.g. it takes several years to build a dam). To take this into account, we have included a section where total capital costs can be divided between the first few years (grey boxes in rows 34 to 38 in the Parameters sheet). Insert here the percentage of the costs that should be attributed to each year. Type the percentage points, i.e. the full number in the boxes (10 for 10.00%, 50 for 50.00%, 25.2 for 25.20%, and so on), this section is already formatted to percentages. The sum of the percentages for all years (1 to 5) for each mitigation option **should be** equal to 100% (that is, the sum of cells D34 to D38 should be equal to 100%, the sum of cells E34 to E38 should be equal to 100%, the sum of cells F34 to F38 should be equal to 100%, and so on for each mitigation option).

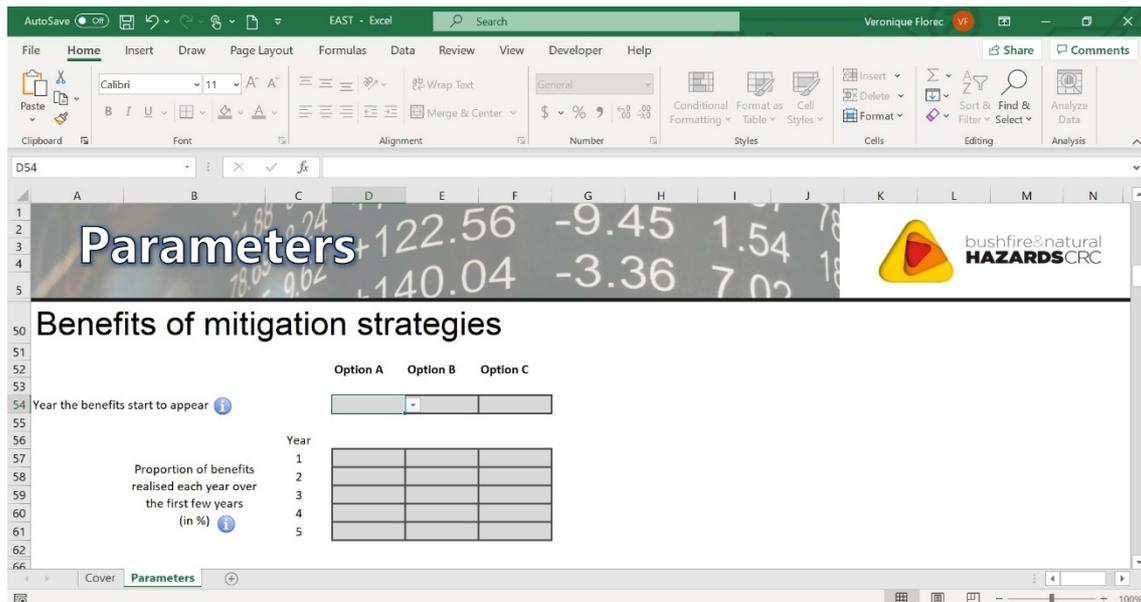


Operation and maintenance costs

Operation and maintenance costs are those that are necessary after the implementation of the mitigation option, on an ongoing basis, to keep risk levels at the intended levels. For instance, this can be the annual costs of dam maintenance, or the costs of conducting prescribed burns every year after the program has been established, or the annual costs of running education campaigns. In some cases, operation and maintenance costs start right from the beginning; and in other cases, these costs are only incurred after a few years (e.g. when the construction of the dam is completed). We have included a section where you can specify the amount of annual operation and maintenance costs (row 41) and in which year these costs start (row 43).



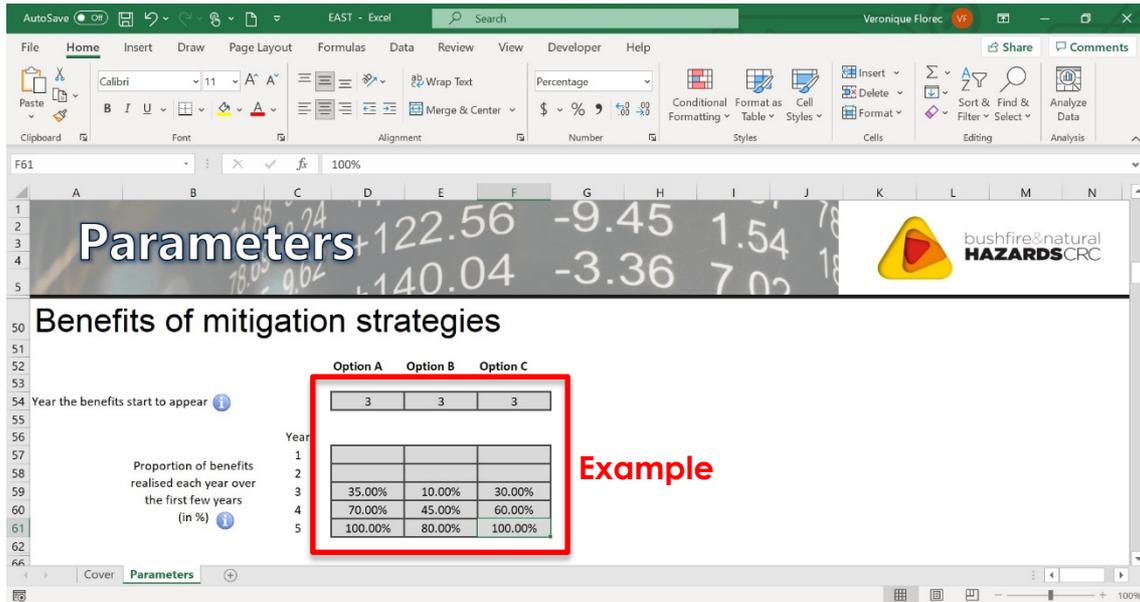
Scroll down to the section *Benefits of mitigation strategies*.



Benefits of mitigation strategies

The benefits of a mitigation option may be realised at different points in time for each option. Some might generate benefits immediately after the investment starts (e.g. a prescribed burning program can generate benefits from year 1, right after the first burns have been completed), others might generate benefits when the investment is underway (e.g. a dam might provide some flood protection even before construction is completed, not all the protection it is expected to provide, but a proportion of that), and yet others might generate benefits only when everything has been implemented (e.g. viaducts and new river courses can provide flood protection after construction is completed and from the moment they are operational, but not before). This needs to be taken into

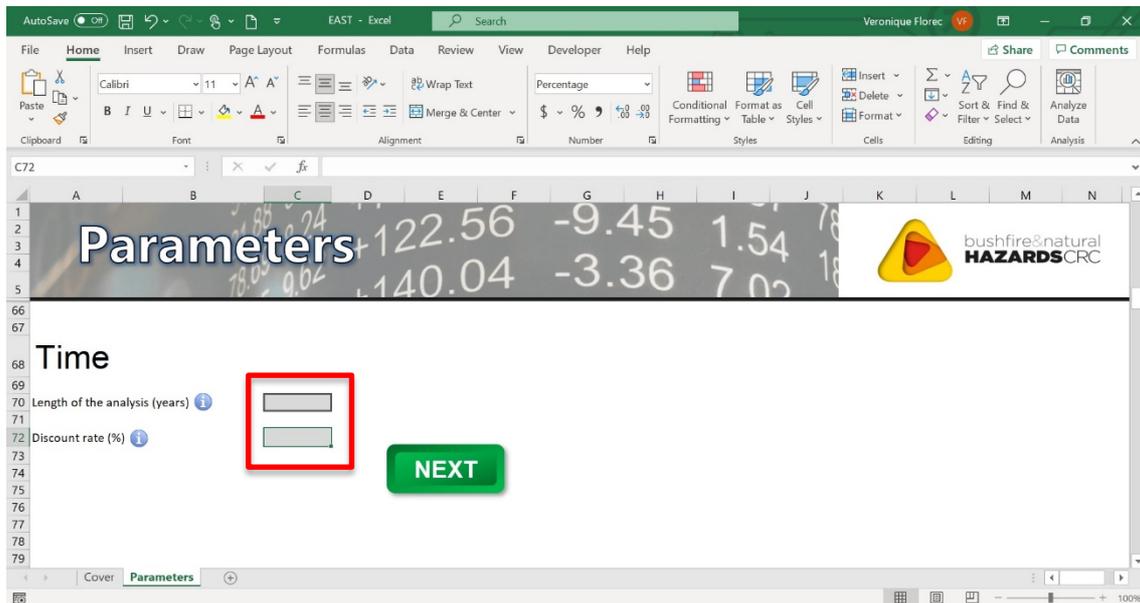
account in an economic analysis. Thus, we have included a section where you can specify in which year the benefits start to appear for each mitigation option (grey boxes in row 54) and the proportion of the benefits that is realised each year (rows 57 to 61). Note that in this section, the percentages you insert in years 1 to 5 (in rows 57 to 61) **do not** need to add up to 100%; you simply need to specify what proportion of the benefits is realised each year between years 1 and 5. The tool assumes that after that (from year 6 on) the entirety of the expected benefits (i.e. 100%) are produced by all mitigation options.



Scroll down to the section *Time*.

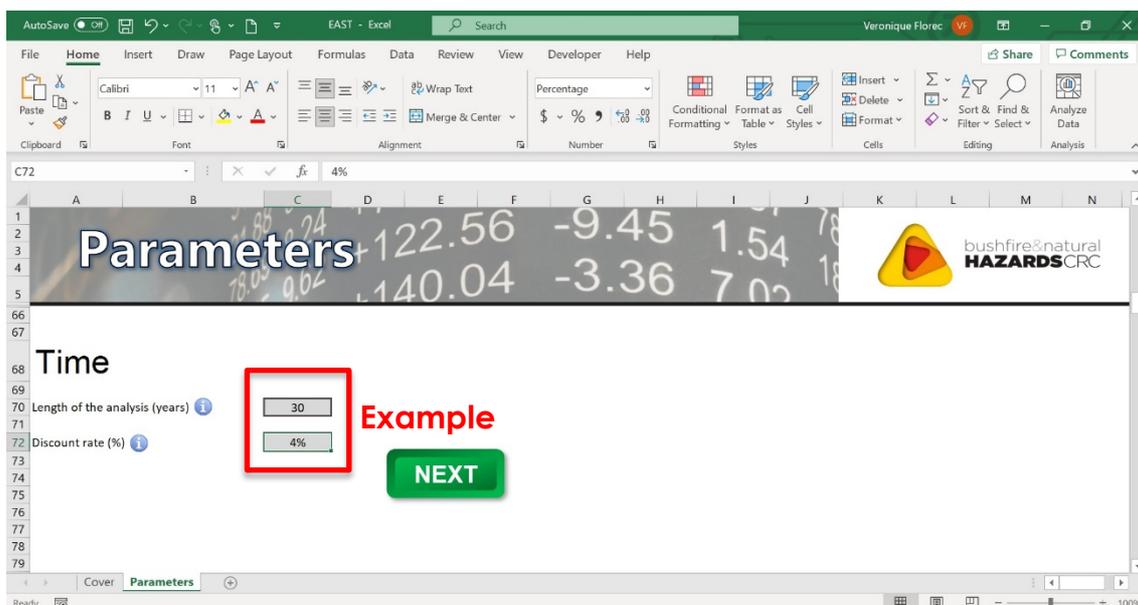
Length of the analysis and discount rate

Insert the number of years for the analysis (e.g. 30 years) in the grey box in cell C70 and the discount rate (e.g. 7%) in the grey box in cell C72.



What should the length of your analysis be? Unfortunately, there is not a straight and simple answer to this, and different timeframes could be justified. There is no rule of thumb that says “for this type of mitigation options, we should have this length of analysis”, we have to choose a timeframe that is sensible for the mitigation options we are evaluating and look at different timeframes if necessary. In theory, the length of the analysis should be the amount of time that maximizes the estimated economic efficiency of the project, after which we should consider a replacement for the project. In practice, the length of the analysis usually extends through the useful life of the project or its most long-lived alternative (for example, the expected life of a levee or a dam). We could also choose a timeframe at some point in the future when meaningful estimates of the effects of mitigation are no longer possible.

And what should be your discount rate? Here again, there is not a straight and simple answer. The best you can do is choose a discount rate that can be justified and perform sensitivity analysis on it to see how changes to the discount rate affect the results. But why do we need to discount values in the first place? This is because you will have costs and benefits that extend for several years and they are not comparable with each other unless they are all brought to a common point in time. Let's say that you have selected 20 years as the length of the analysis. The values that we have for costs and benefits in year 5 are not comparable to the values that we have in year 15, because we do not value them equally. We tend to prefer sums of money closer to the present than far in the future, and because of this preference, individuals might have a bias in favour of projects that produce benefits sooner rather than far into the future. For this reason, we need to bring all costs and benefits to a common point in time. Usually, we bring them all to the present. To do that we have to decide at which rate the values change between now and a point in the future. This rate is called the discount rate.

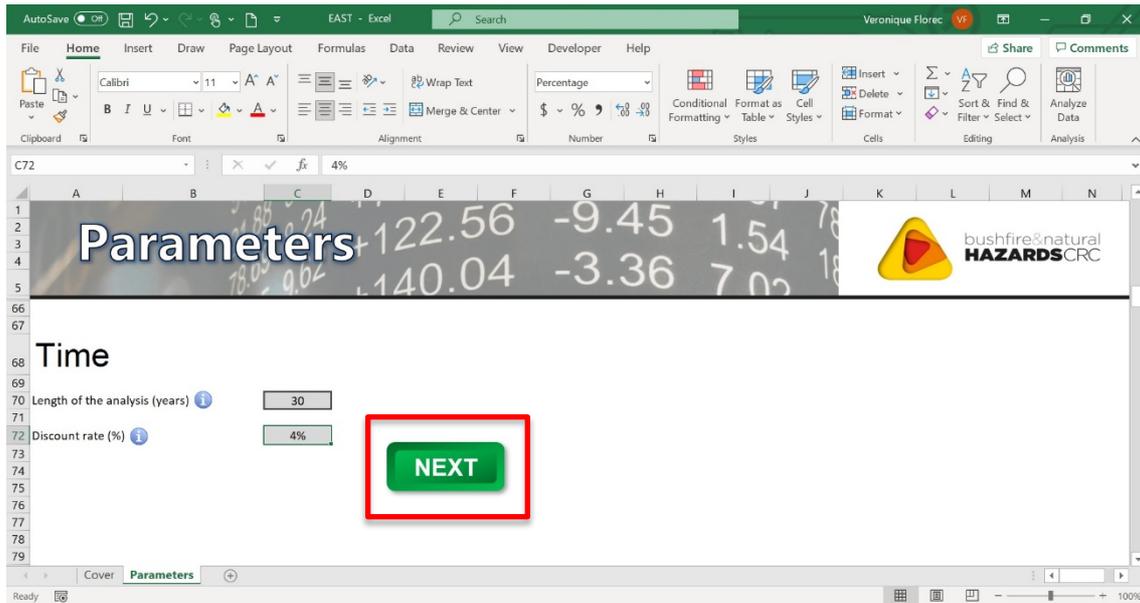


The best thing to do to set a discount rate is to follow the recommendations of the Office of Best Practice Regulation that is part of the Australian Department of the Prime Minister and Cabinet. The Office of Best Practice Regulation suggests

the use of a discount rate of 7%, and suggests conducting sensitivity analysis with a 3% and a 10% discount rates. Since 2018 however, this has been subject to debate and a recent report recommended that the Australian Government adopt a 4% discount rate for infrastructure projects because the current 7% rate is too high given the historically low level of interest rates, and it might be an obstacle to investing in specific projects.

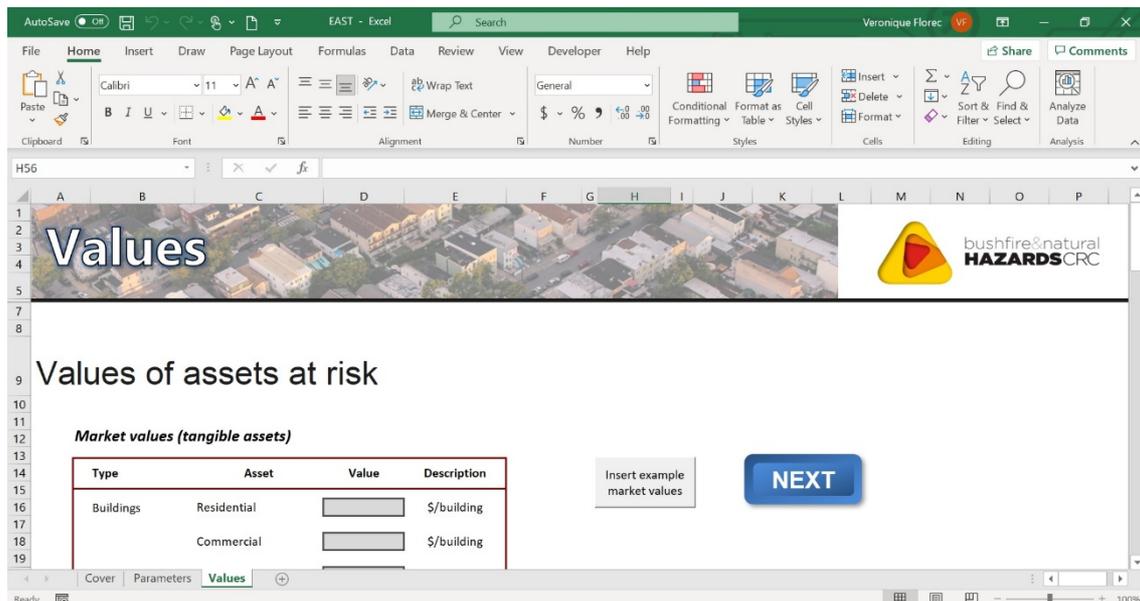
If you want to better understand timeframes for the analysis and discounting, watch [this video](#).

Click on the green button **NEXT** to continue. This opens the Values sheet.

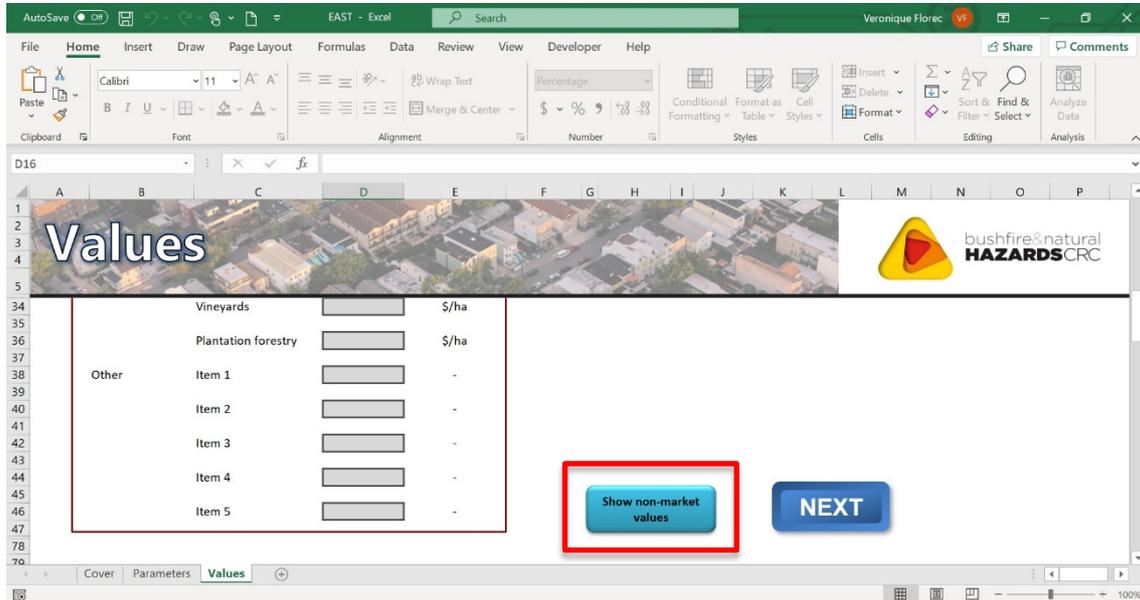


VALUES

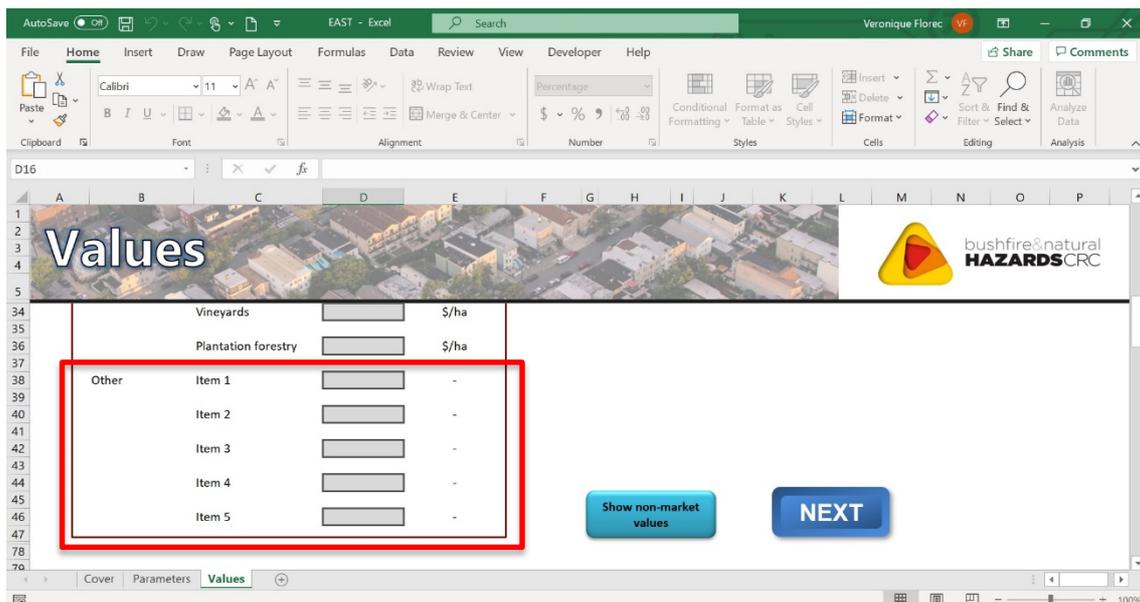
The Values sheet is where you will insert the value (in dollars) of all of assets at risk.



There are two sections in this sheet: Market values (tangible assets) and non-market values (intangible assets). By default, you only see the list of market values; if you want to see the list of non-market values, scroll down until you see the light blue button that says *Show non-market values* and click on it.



The market and non-market values lists include some of the most common assets that are directly impacted by natural hazards. However, this list is by no means exhaustive and many other assets could be affected by natural hazards. The list does not include indirect impacts, such as business interruptions, disruption to public services, tourism, legal costs, stress, anxiety, and disruptions to living. These and any other impacts that do not appear in the list can be added in the lines at the bottom of each box (Item 1 to Item 5) in the category *Other*.





Each type of value (market or non-market) is estimated differently, and there is also a difference when they are impacted directly or indirectly by the hazard. Here are some rules of thumb that you can follow to know what dollar amounts you should insert in the Values sheet:

a. Market values (i.e. tangible assets) that would be directly impacted by the hazard

This could be, for instance, houses, commercial buildings, infrastructure, crops, livestock, fences, sheds, etc. For this type of values, you need to insert what is called the “reconstruction” value of each asset, which is the amount of money that it would cost to reinstate the asset to its formal state, before it was damaged or destroyed by the natural hazard event. For example, the reconstruction value of a house (or any type of building) would be the amount of money that it would cost to rebuild the house and replace all its contents. This value has nothing to do with the sale price of a house (which includes the price of the land). Similarly, the reconstruction value of a vineyard (or any agricultural value) would be the amount of money that it would cost to get the vineyard to produce the same amount of grapes that it was producing before the natural hazard event happened, plus the harvest lost for all the years the vineyard is not producing what it was producing prior to the event destroying it. This would be a much higher value than the value of the harvest lost in the year the event happened.

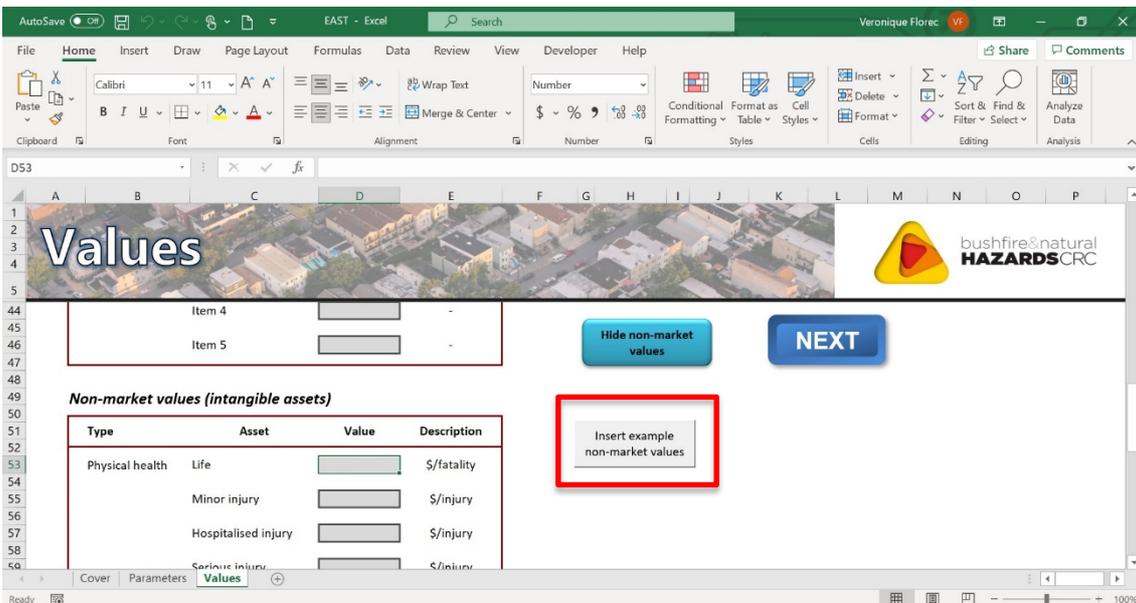
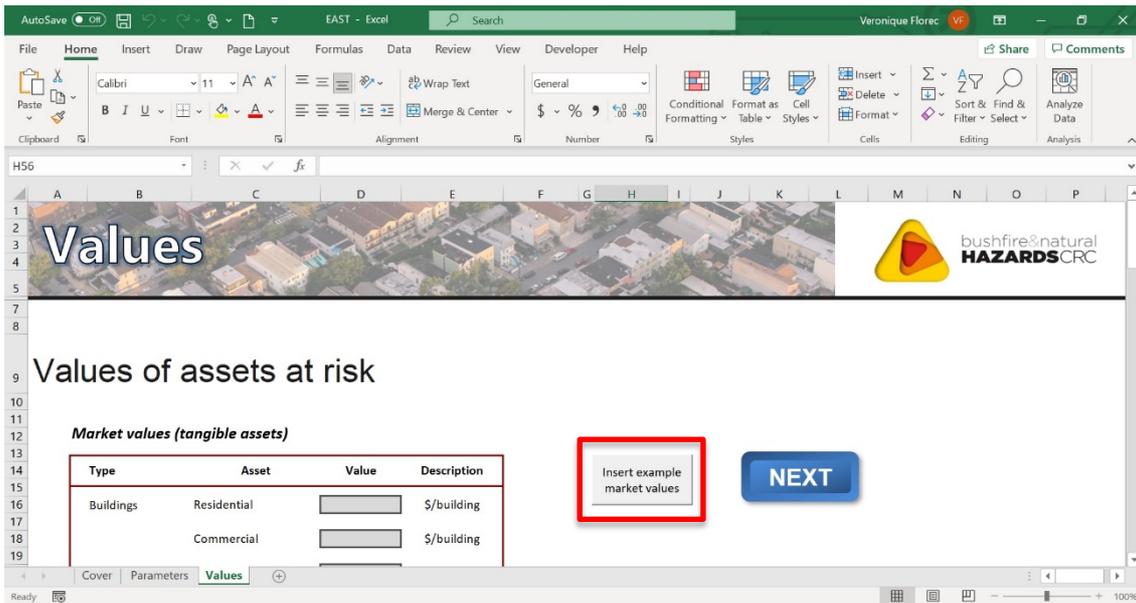
b. Market values (i.e. tangible assets) that would be indirectly impacted by the hazard

These correspond to the flow-on effects of the hazard (the secondary consequences of having some assets destroyed by the hazard), such as business disruptions, disruption to essential services, impacts on tourism, legal costs, etc. To be able to estimate these impacts, you would need to collect data from emergency management organisations, public services and the businesses affected to know the extent of losses caused by previous natural hazard events of different intensities. This is usually done through surveys after a natural hazard event. You could then use this information to predict potential losses from future events.

c. Non-market (intangible) values, both direct and indirect

Direct non-market impacts would be things like lives lost, impacts to the environment, impacts to cultural heritage, animal welfare, memorabilia, etc. Indirect non-market impacts would be things like inconveniences caused by the hazard, anxiety, mental health, losses in community cohesion, ecosystems that cannot recover, etc. There is not a cost that can be readily attached to them, so estimating their value in dollars requires the use of specialised techniques. We use a set of techniques known as non-market valuation, where we either look at people’s behaviour and infer values from the choices they make, or use surveys to get people to state their preferences and estimate values from their choices in the survey. You will often have to use people’s willingness to pay (WTP) to protect the different non-market values that can be affected by natural hazards.

In the research that we have conducted on the economics of natural hazards management, we often had to estimate the value of some market and non-market assets. To help the user get started with the tool, we have estimated an average value for some of the assets. You can insert these average estimates by clicking on the light grey buttons *Insert example market values* and *Insert example non-market values* (the latter is only visible when you have non-market values unhidden). However, these values are approximations and may not be accurate for all scenarios and all areas; it is important for each user to obtain information on the value of all assets at risk for their context and their case study area.



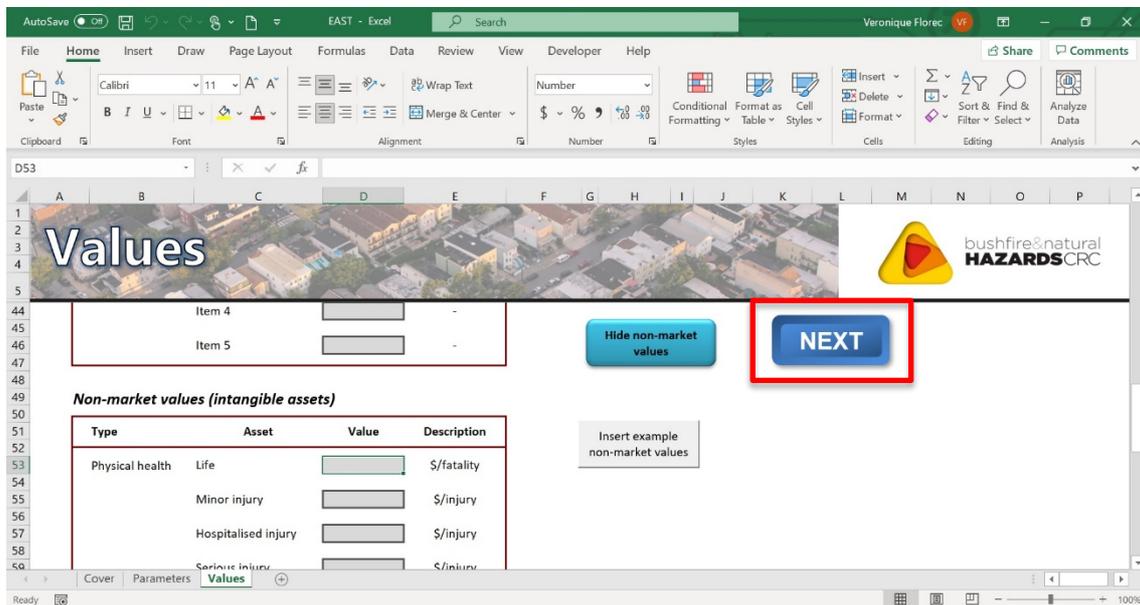
Data sources

Collecting data on the value of different assets is not an easy feat. The values that are inserted automatically with the light grey buttons *Insert example market values* and *Insert example non-market values* have been collected in previous

studies we have conducted. Here are some of the information sources we used to obtain that data:

- a. The Australian Exposure Information Platform (AEIP) www.aeip.ga.gov.au for data on reconstruction costs (reconstruction and contents) of residential, commercial and industrial buildings. The platform also has a wealth of information on businesses and people; public facilities and infrastructure assets; agricultural commodities, and environmental holdings in Australia. The AEIP was developed through Bushfire and Natural Hazards CRC research.
- b. Australian Bureau of Statistics (ABS) www.abs.gov.au for data on agricultural commodities (mostly value of annual harvests). For information on the costs of reinstating a crop, or a vineyard, or an orchard to its undamaged state before it was damaged by the hazard, we recommend you contact the growers' association for the commodity of interest.
- c. Power pole replacement costs, data from [Ausgrid here](#).
- d. Data from previously damaged assets recorded in newspapers or news articles (e.g. bridge replacement costs [from an example in WA](#) and rail replacement costs [from an example in NSW](#))

When you have inserted all values, click on the blue button NEXT. The Effect Mitigation sheet opens.

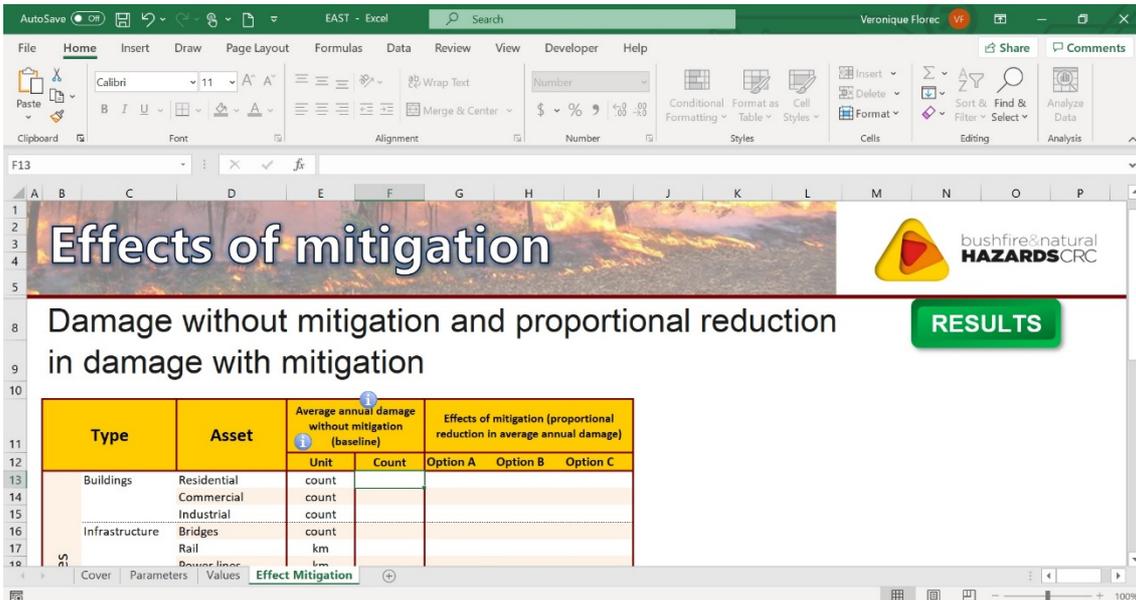


EFFECT MITIGATION

In the Effect Mitigation sheet, a table appears where two important sections need to be filled by the user: 1) one section where you insert the average annual damage that the case study area would experience without mitigation (column F), and 2) another section where you insert the proportional reduction in average annual damage that is expected from each mitigation option after they are fully

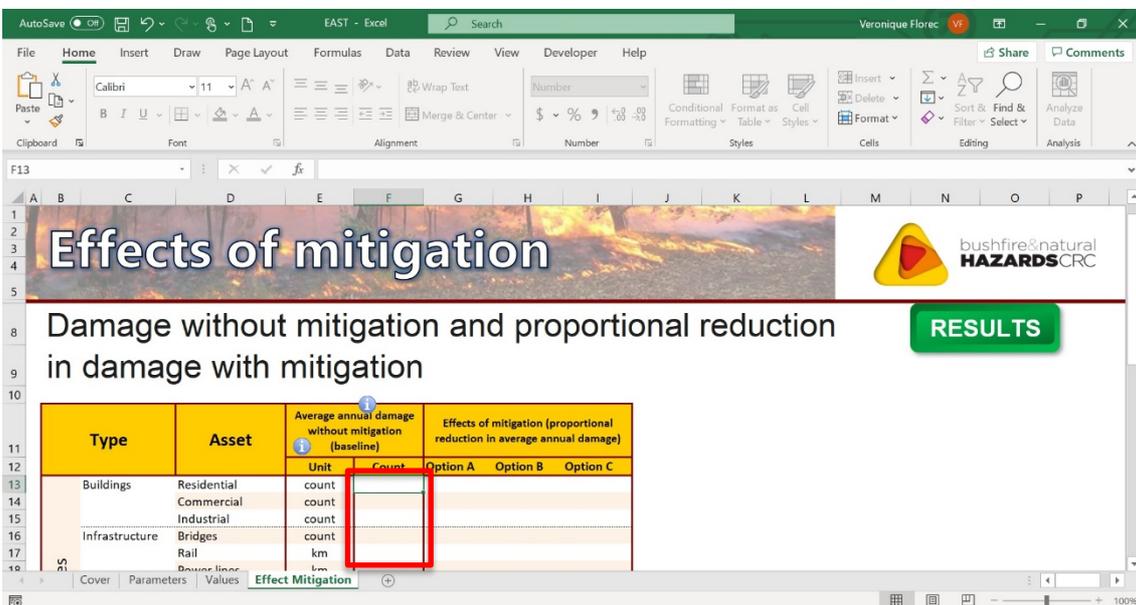


implemented (columns G to P). Below is a more detailed explanation of each of these sections.



Average annual damage without mitigation (baseline)

Here you need to insert the average annual damage each of the assets at risk was experiencing before any of the mitigation options you are going to evaluate are implemented.



This is your baseline or counterfactual (i.e. the scenario that you are going to compare things to). In order to determine what the average annual damage is for each asset for the baseline, you first need to know the level of damage caused by hazard events of different sizes and multiply that by the probability of occurrence of each event. For instance, let's imagine that the number of residential buildings destroyed by bushfires in our case study area are as follows:



TABLE 1. NUMBER OF RESIDENTIAL BUILDINGS DESTROYED BY BUSHFIRES OF DIFFERENT SIZES

Bushfire size	Annual exceedance probability	Number of houses destroyed per event
Very small	0.5	0
Small	0.2	0
Medium-small	0.1	1
Medium	0.05	4
Medium-large	0.02	12
Large	0.01	50
Very large	0.002	350
Catastrophic	0.001	2,000
Maximum fire size ¹	0.0001	5,000

With this information, you can calculate the average number of residential buildings destroyed per year by bushfires (for all bushfire events combined). Using trapezoidal sums, we calculated the average number of residential buildings destroyed per year at 6.65 for the example above. This average annual number is the information that you need to insert in column F in the Effect Mitigation sheet for each asset. If you want to know how to use trapezoidal sums to calculate average annual damages, watch [this video](#).

Something very important to remember is that the information you insert in column F should represent your baseline. This can mean that your baseline scenario is one where there is no mitigation implemented (zero investment in mitigation), but it can also mean that there is some mitigation already in place and you want to evaluate whether changing what you are doing will result in higher benefits to society and the environment. The title in column F says *Average annual damage without mitigation (baseline)*, but this doesn't necessarily mean that in our baseline scenario there is no mitigation at all (it can mean that, but it doesn't have to). This title needs to be read as *Average annual damage before implementing the mitigation options that I am going to evaluate with the tool*.

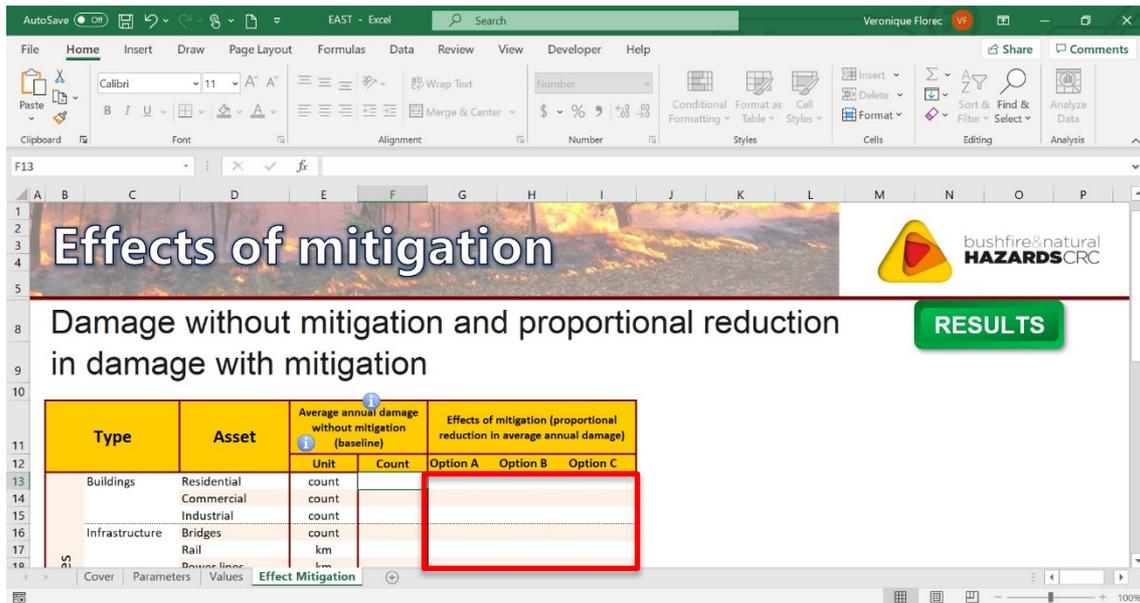
Whether the baseline is a scenario of no mitigation or business as usual (i.e. with current mitigation in place), is entirely up to you. It depends on what you want to evaluate and what you need the analysis for. For instance, if you want to evaluate a completely new strategy that has never been implemented before, or you need to know the amount of benefits generated by a mitigation option to justify your investment, then a scenario of no mitigation for the baseline might be more appropriate. But if you need to know what improvements you can do to your current mitigation strategies in order to generate even more benefits, then your baseline scenario should be your current mitigation levels (business as

¹ The maximum fire size defines the maximum extent of bushfire-prone land in our case study area. It is difficult to define a meaningful Annual Exceedance Probability for the maximum fire size (it depends on how large the case study area is), but it is commonly assumed to be of the order of once in 10,000 to once in 10,000,000 years. For our example, we have calculated the Annual Exceedance Probability of 1 in 10,000 years for the maximum fire size.

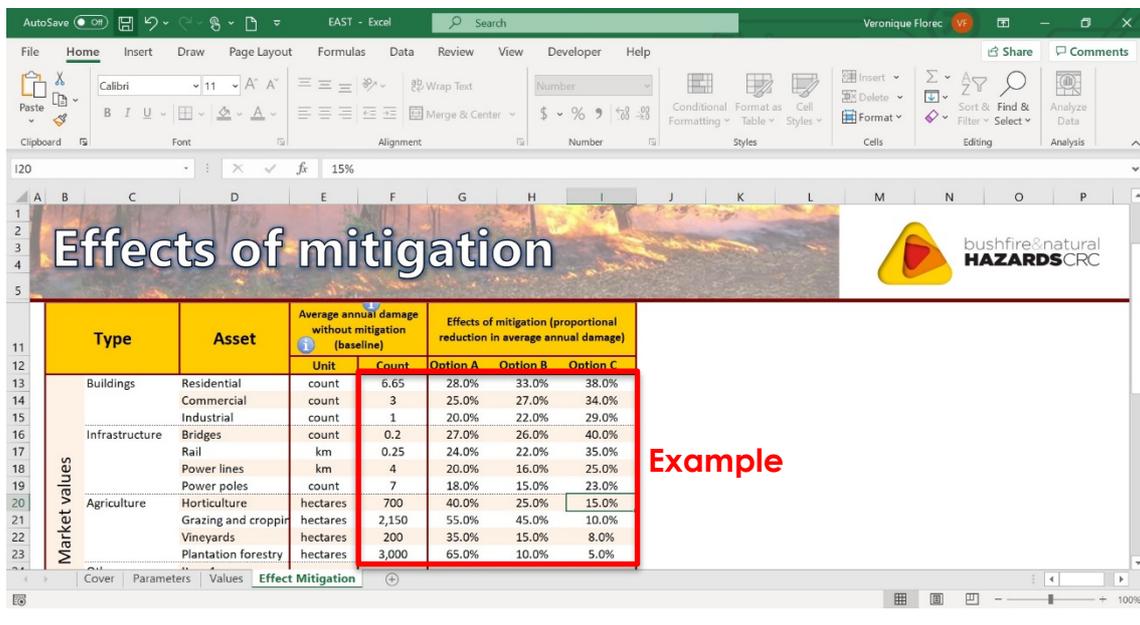
usual). In this case, the costs of mitigation should only be the costs of changing your current mitigation strategies.

Effects of mitigation (proportional reduction in average annual damage)

Depending on the number of mitigation options you are evaluating, this section in the table can have 1 to 10 columns (from column G to column P in the Effect Mitigation sheet).

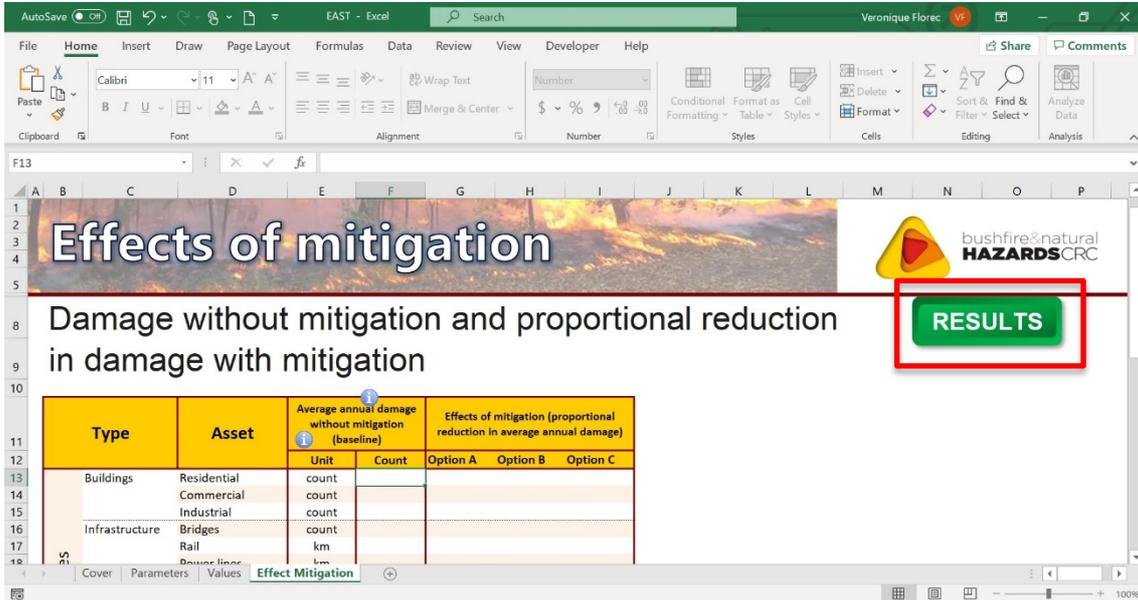


In this section you need to insert by how much (in percentage) each mitigation option will reduce the damage caused by natural hazards to each asset (on average per year). For example, if the average number of residential buildings destroyed per year by bushfires for our baseline is 6.65, and this number is reduced to 4.79 when we implement fuel reduction burns, then this strategy results in a reduction of 28% in the average number of residential buildings destroyed per year ($1 - 4.79/6.65 = 0.28$). This is the percentage that you should insert in this section for each asset and each mitigation option.



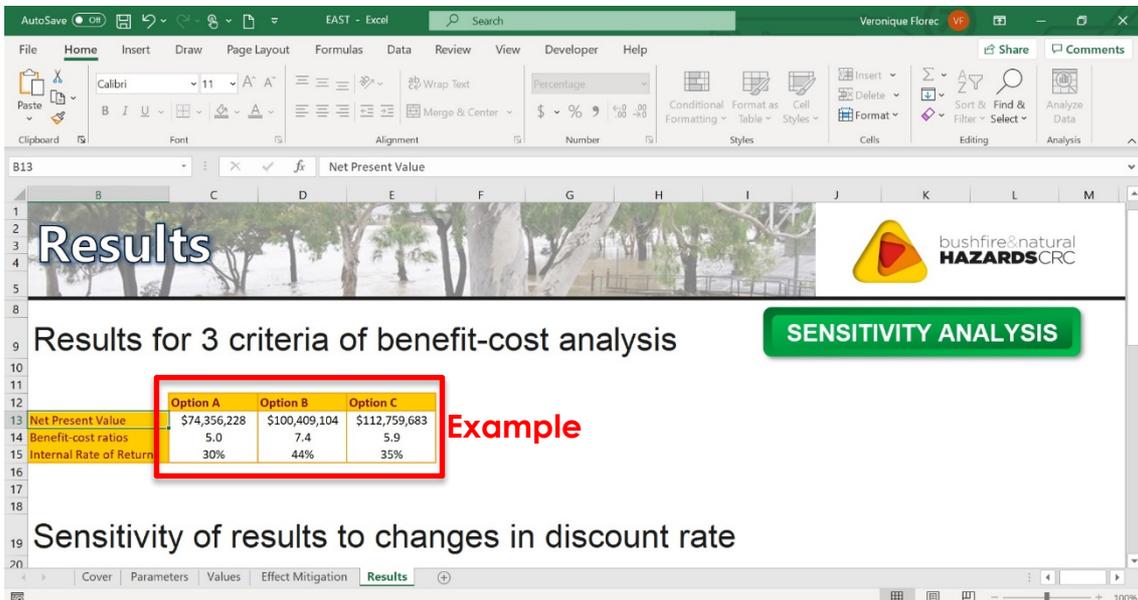


Once you have finished inserting all the data in the Effect Mitigation sheet, click on the green button **RESULTS**. There is one located at the top of the page, and another one below the table. The Results sheet appears.



RESULTS

In the Results sheet you will see a table and 2 charts. The table shows the results for three criteria: Net Present Value (NPV), Benefit-Cost Ratios (BCRs), and Internal Rate of Return (IRR). Each of these criteria are explained below.



Net Present Value (NPV)

Net Present Value simply means net benefits, but because these net benefits happen over several years (the number of years is specified in the length of the analysis in the Parameters sheet), we need to bring them all to the present to



make them comparable, hence the name Net Present Value. So NPV is simply the benefits minus the costs over a period of time. NPV tells you the total gains that can be expected from implementing each mitigation option over the period of time specified, given the benefits they generate and the costs of implementing them.

If one mitigation option generates substantial benefits, but the costs of implementation are very high, the NPV might be small; and another option that generates moderate benefits, but has very low implementation costs, could result in a much higher NPV. As long as the NPV is positive, it means that the option generates gains (i.e. the benefits exceed the costs). If the NPV is equal to zero, that means that the benefits are equal to the costs and the option just breaks even. If the NPV is negative, it means that the costs are higher than the benefits, the mitigation option is generating a loss, and it might not be worth implementing that option.

Benefit-Cost Ratios (BCR)

As its name indicates, a benefit-cost ratio is the ratio between the benefits and the costs. More precisely, it is calculated by dividing the present value of the benefits by the present value of the costs. This ratio is simply telling us how many dollars we get in benefits for each dollar invested in the mitigation option. If the BCR is higher than 1, it means that the benefits are greater than the costs. Let's say we get a BCR of 2.3 for one of our mitigation options, this means that for each \$1 invested in that option, we get a benefit of \$2.3, so the benefits generated by this option are more than double the costs of implementation. If the BCR is equal to 1, it means that the benefits are equal to the costs and we are breaking even. If the BCR is smaller than 1, it means that the benefits are smaller than the costs and we are losing money on that investment.

Internal Rate of Return (IRR)

The Internal Rate of Return is the rate for which the net present value is equal to zero. If the discount rate is equal to the IRR, then the NPV is equal to zero and the BCR is equal to one. If the discount rate is higher than the IRR, then the NPV is negative and the BCR is lower than 1. This means then that when the IRR is higher than the discount rate selected, the NPV will be positive (greater than zero) and the BCR will be greater than 1. The IRR is useful when we want to know whether it is worth borrowing money to finance a mitigation project. If the IRR is greater than (or at least equal to) the cost of financing the mitigation investment (i.e. the interest rate), then we should borrow money to finance the investment. If the IRR is lower than the interest rate, then it is not worth borrowing money to finance the mitigation option.

Selecting the appropriate criteria to rank mitigation options

So which criteria do we use to rank mitigation options and select the one that generates the highest benefits to society and the environment? Well, it depends on the mitigation options we are evaluating, how they relate to each other, and whether we have a funding constraint or not.

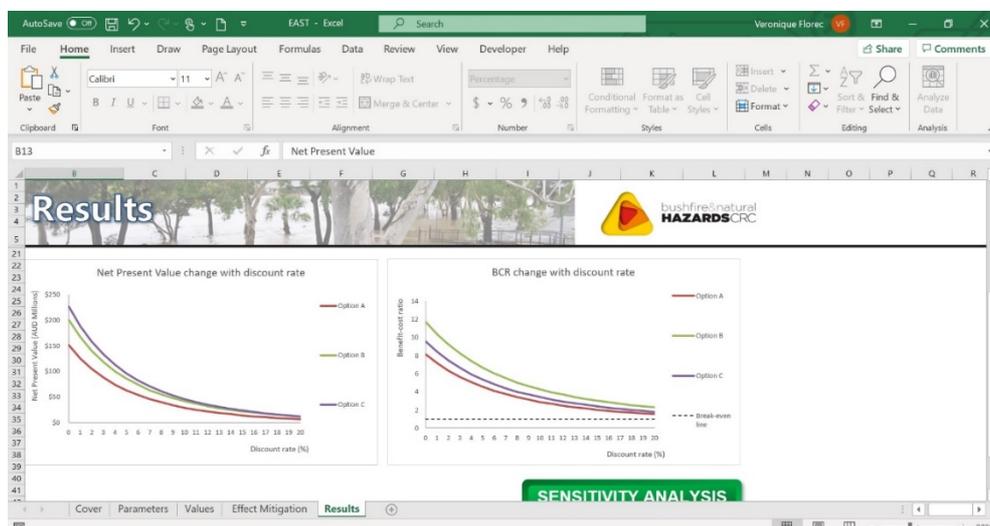
Often enough, the option with the highest NPV will also have the highest BCR and the highest IRR, but in some cases, we might see results where the ranking of the options according to NPV vs. BCR would be different. Also, it is likely that there will be a funding constraint for mitigation investments, but if there isn't one, this could change which criteria we should use to rank the options.

Very often, textbooks on benefit-cost analysis (BCA) advise the use of a criteria, without delving into the nature of the projects/options evaluated (whether they are independent from each other or mutually exclusive). Mitigation options are mutually exclusive when, if one is selected, the others are discarded (several options cannot happen at the same time, only one can be selected). They are independent when, after selecting one, some (residual) funds can be diverted to another option, so we end up investing most of the money in one of the options and some money in one or several other options. Below is a summary of which criteria to use for different scenarios: when there is or there isn't a funding constraint (a limited budget, which is often the case in natural hazards management) and when the options are all independent, all mutually exclusive, or there is a combination of independent and mutually exclusive options.

- a. **When all mitigation options are independent:** fund all options with NPV > 0 when there is no funding constraint, and rank options by BCR if there is a funding constraint.
- b. **When all mitigation options are mutually exclusive:** fund the option with the highest NPV when there is no funding constraint, and fund the option with the highest NPV that does not exceed the funding constraint when there is one.
- c. **When there is a combination of independent and mutually exclusive options:** if there is no funding constraint, then fund all independent options with NPV > 0 as well as the mutually exclusive option with the highest NPV; if there is a funding constraint, the run an optimisation model to rank the options (NPVs and BCRs may not provide enough information in this case).

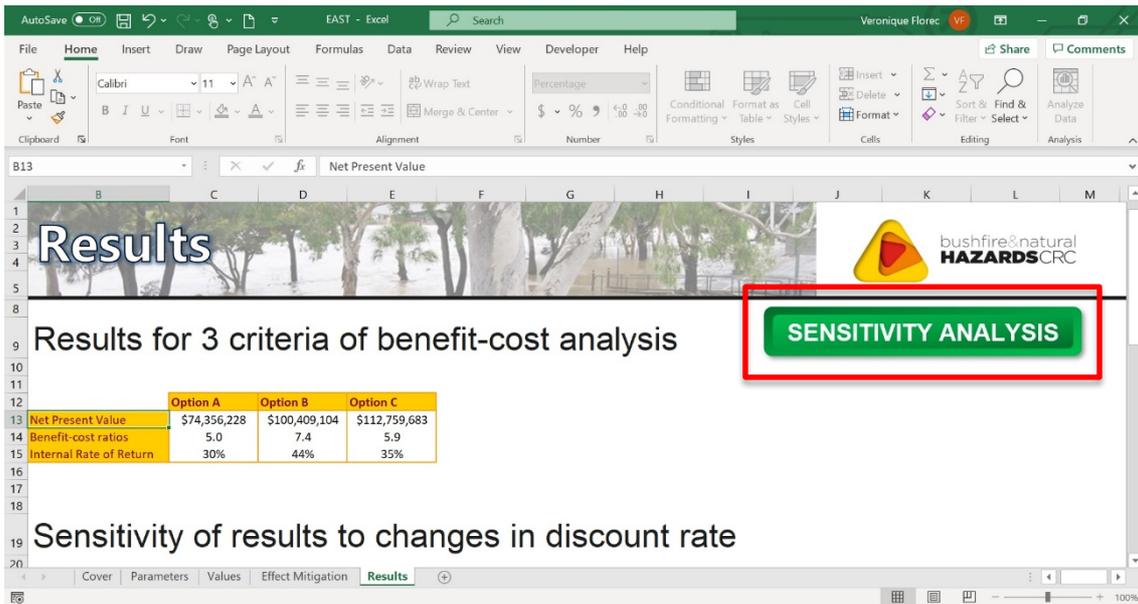
Sensitivity of results to changes in discount rate

In the Results sheet you will also see 2 charts. The chart on the left side shows how the NPV changes with different discount rate and the chart on the right shows how the BCR changes with different discount rates.



Notice that as we increase the discount rate, both the NPV and the BCR decrease (the curves slope downwards), but how fast they decrease might be different for each option (some curves might decrease rapidly, others more slowly). As long as the NPV curves are above the x axis, (the horizontal line), the NPVs are positive. Similarly, as long as the BCR curves are above the dotted line (which is when they would be equal to 1), the BCRs are greater than 1 and the benefits exceed the costs.

To continue, click on the green button *SENSITIVITY ANALYSIS*. This opens the Sensitivity sheet.



The screenshot shows an Excel spreadsheet titled 'Net Present Value'. The spreadsheet contains a table with the following data:

	Option A	Option B	Option C
Net Present Value	\$74,356,228	\$100,409,104	\$112,759,683
Benefit-cost ratios	5.0	7.4	5.9
Internal Rate of Return	30%	44%	35%

A green button labeled 'SENSITIVITY ANALYSIS' is highlighted with a red box. The spreadsheet also includes a header with the text 'Results' and 'Results for 3 criteria of benefit-cost analysis', and a logo for 'bushfire&natural HAZARDS CRC'.

SENSITIVITY ANALYSIS

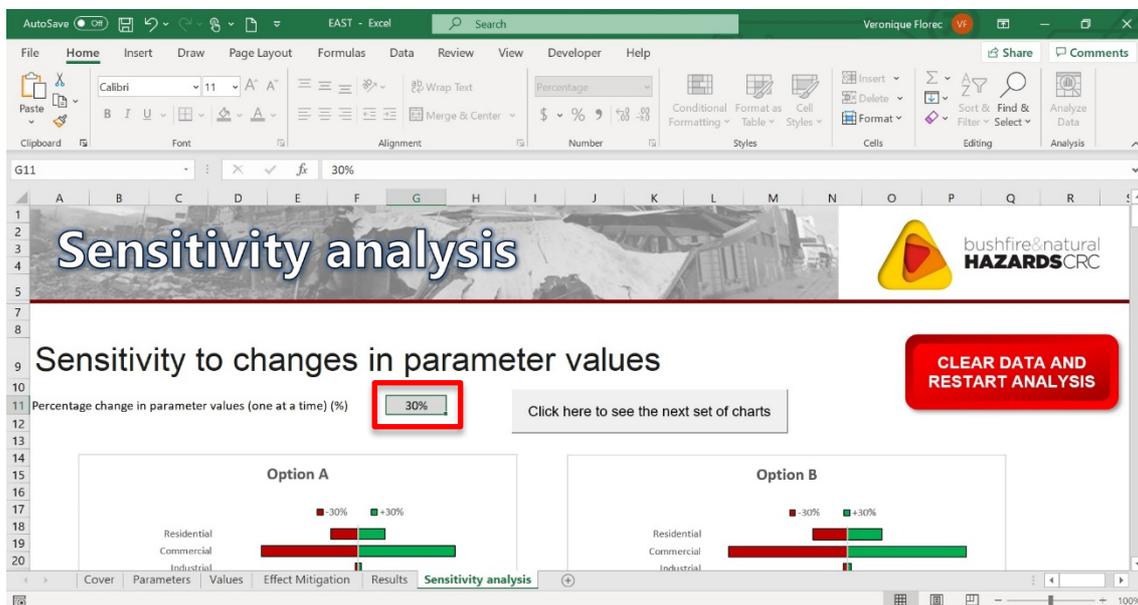
Every time we conduct an economic analysis, it is very important to conduct a sensitivity analysis. This is where we assess the confidence we can have in our results. A sensitivity analysis provides information about how changes in the information that we have used to conduct our analysis, that is, changes in the different parameters, will affect the costs and benefits of the proposed mitigation options, and the overall results (more specifically the NPV). In some cases, by changing the values of some of the parameters, we might obtain different NPVs that result in a different ranking for our mitigation options, and we need to be aware of that. The sensitivity analysis shows us how sensitive the results (the NPV) are to changes in the values of uncertain parameters and to changes in any of the assumptions we have made to conduct our study. Basically, it tells us whether the uncertainty we have about a piece of information matters or not for the results.

EAST does a particular type of sensitivity analysis, called a One-at-a-time (OAT) analysis. In an OAT analysis we change the value of only one parameter at a time, while holding the value of all the other parameters constant, and we observe how the results change with changes in each value. There are other types of sensitivity analysis that are more statistically robust, but they require a lot more information and a very good understanding of probability distributions. For the purpose of this tool (which is to conduct a screening process), the OAT

provides a wealth of useful information without requiring very complex calculations. If the results don't change much when we change an uncertain parameter or change an assumption, they are said to be robust results. We can then be confident that the decision we make and the mitigation option we choose is likely to continue to generate benefits even when circumstances change (creating a change in the parameter or in the assumption in question).

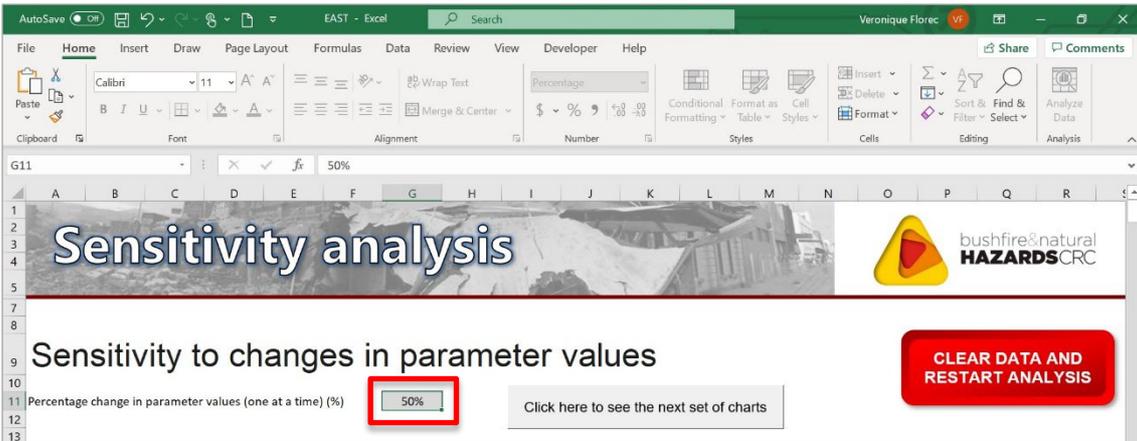
If you want to learn more about risk, uncertainty and other types of sensitivity analyses, watch [this video](#).

To run the sensitivity analysis in EAST, insert a percentage change in cell G11 in the Sensitivity sheet. This will estimate how the NPV changes when each parameter (one at a time) is increased or decrease by the indicated percentage.

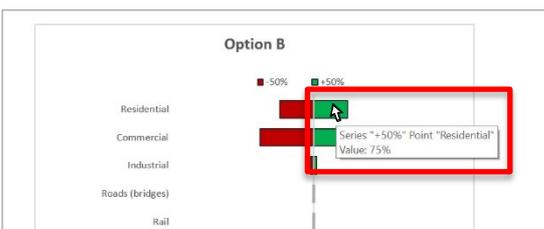
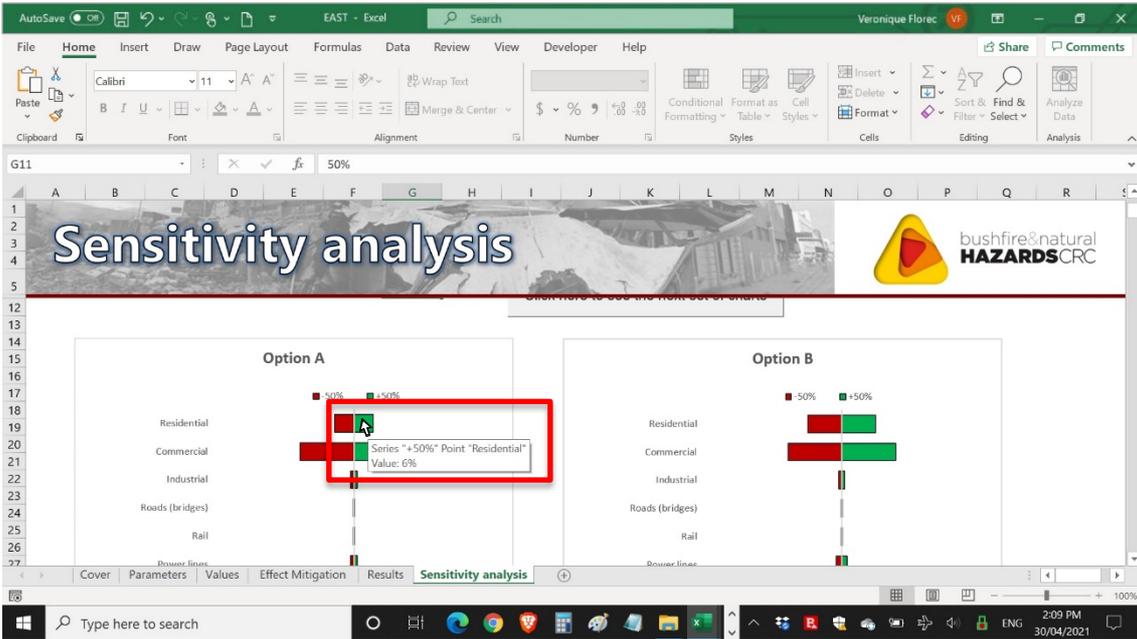


The red bars in the graphs indicate the proportional change in the NPV when the value of the parameter listed on the right is decreased by the selected percentage and the green bars indicate the proportional change in the NPV when the value of the parameter listed on the right is increased by the selected percentage. If the proportional change in the NPV is lower than the proportional change in a parameter, the results are considered non-sensitive to that parameter, but if the proportional change in the NPV is higher than the proportional change in the parameter, the results are then considered sensitive to the parameter.

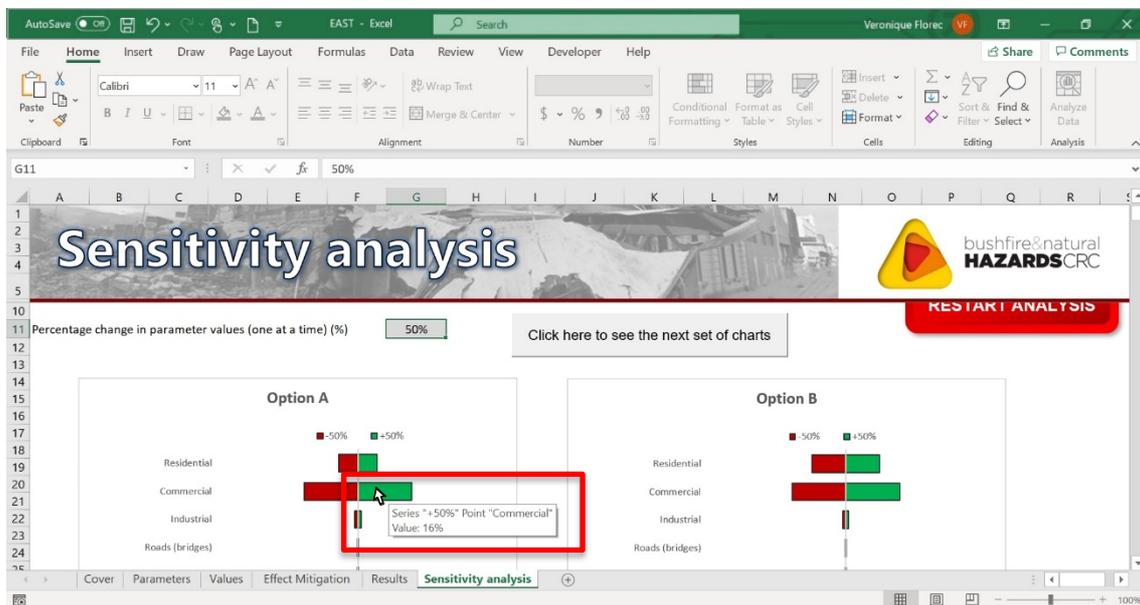
Let's look at an example to explain this. Let's say that we want to conduct an OAT analysis with changes of 50% in the value of each parameter. We insert 50 in cell G11 in the Sensitivity sheet.



Let's look at how the NPV of three different options (A, B and C) would change if we increase and decrease the value of residential buildings by 50%. We need to hover the mouse pointer above the green or red bars to see the percentage change in NPV. We will only look at changes in the value of residential and commercial buildings, but the same principle applies to all parameters. See the results of the sensitivity analysis for options A, B and C in the images below.



If we increase (or decrease) the value of residential buildings by 50%, but leave every other value intact, the NPV increases (or decreases) by 6%, 75% and 2226% for options A, B and C respectively. So, we could say that the results for option A are not sensitive to changes in the value of residential buildings (or changes in the information we have in the Effect mitigation sheet for residential buildings). In contrast, the results for option B are more sensitive to changes in the information about residential buildings, and the results for option C are extremely sensitive. Similarly, if we increase (or decrease) the value of commercial buildings by 50%, but leave every other value intact, the NPV increases (or decreases) by 16%, 119% and 1356% for options A, B and C respectively. The results for option A are not sensitive to changes in the value of commercial buildings (or changes in the information we have in the Effect mitigation sheet for commercial buildings), but are sensitive for option B and extremely sensitive for option C.

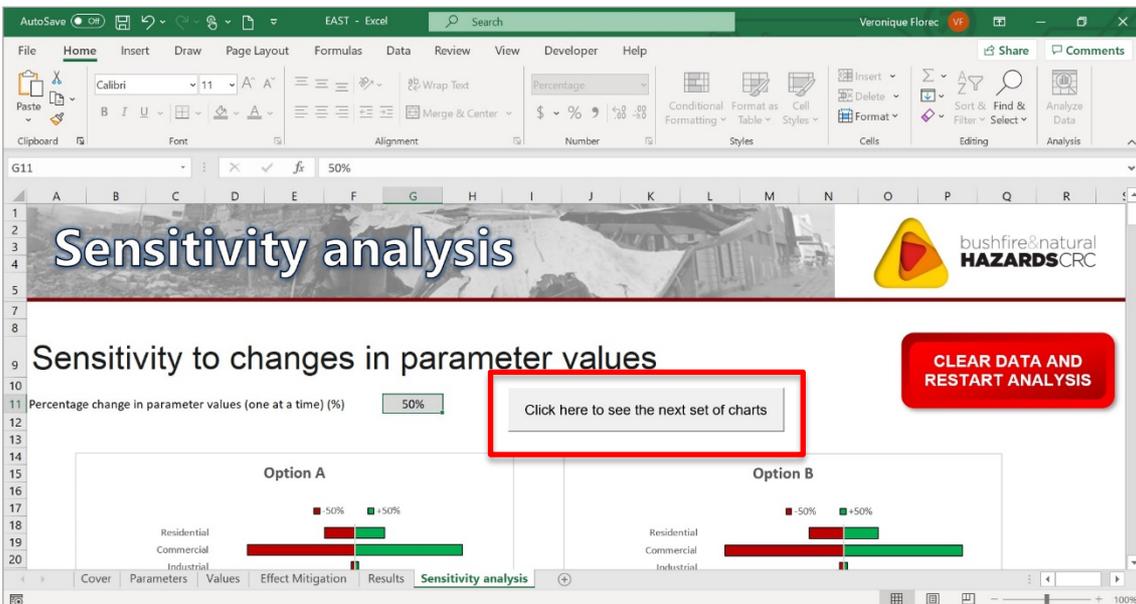


In summary, if we find that varying a parameter has a substantial effect on the results, then uncertainty about its value (or the effects of mitigation on that asset) becomes important and we need to get more information about it in order to increase the confidence we have in our decision. If the results don't change much despite changes to all parameters, the results are then considered to be robust. The one-at-a-time sensitivity analysis makes it clear for decision makers how the results are affected by uncertainty about the value of a particular parameter and for which parameters it would be better to collect additional information in order to increase our confidence in our decisions.

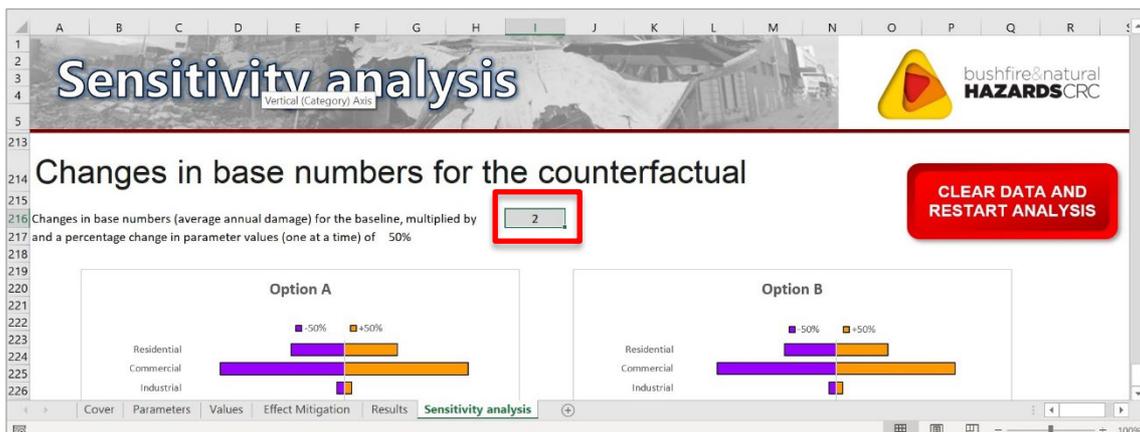
Changes in base numbers

Sometimes we might want to know how changes in a parameter of a much bigger scale would affect the results. This is often the case when we have a high level of uncertainty about the value of a parameter and we want to see larger changes to it, maybe even changes of different orders of magnitude. To do this, we could set the percentage change in the sensitivity analysis to very high percentages (1000%, 2000% or more) and check in the graphs if the NPV changes by a higher or lower percentage (the red and green bars). Another way of doing this, without reverting to very high percentages, is to multiply the value of the different assets by a factor of 10, 20 or any number you think would be appropriate, and then change the value by +50% and -50%. This will then cover a much wider range of possible values for each parameter.

To do this, click in the light grey button that says *Click here to see the next set of charts* or scroll down in the Sensitivity sheet until you see the title *Changes in base numbers for the counterfactual*.



Insert the number you want to use to increase the value of all parameters in cell I216. This will automatically multiply the value of all parameters by that number and perform a sensitivity analysis on that value by the percentage indicated (at the top) in the Sensitivity sheet.



For example, if we inserted \$500,000 as the value of a residential building (in the Values sheet) and we conduct a sensitivity analysis on this value with 50%, then the tool will estimate the NPV when the value of residential buildings is \$250,000 and \$750,000. The green and red bars in the sensitivity analysis graphs will then show you the proportional change in the NPV when residential buildings take these two values. If you go to the section *Changes in base numbers for the counterfactual* and insert the number 2 in cell I216, all the asset values you entered in the Values sheet are multiplied by 2 (you do not see the change in the Values sheet, the tool does it in the background). In this case, the new base value for residential buildings would be \$1,000,000 and the tool will estimate the NPV when the value of residential buildings is \$500,000 and \$1,500,000, which covers a wider range of values. The purple and orange bars in the new sensitivity analysis graphs will then show you the proportional change in the NPV when residential buildings take these two values (compared to an initial value of \$1,000,000). This second analysis is useful when there is a high level of uncertainty about the value of an asset (or the proportional reduction in damages generated by the mitigation options) and we think that the value (or the effect of mitigation) could potentially be of a different order of magnitude.

SAVING YOUR RESULTS AND STARTING A NEW ANALYSIS

The best way to save your results is to save the completed version of EAST in a different folder in your computer and rename the Excel file with keywords that will allow you to quickly identify your analysis (e.g. EAST_bushfire_mitigation_2021-01.xlsm). If you do not need to go back and look at the calculations, you can save each sheet in the workbook as a pdf.

Start a new analysis

If you want to start a new analysis, click on the red button **CLEAR DATA AND RESTART ANALYSIS**. This will remove all data, hide all the sheets, and take you back to the Cover sheet.

The screenshot displays the Microsoft Excel interface for the EAST application. The title bar shows 'EAST - Excel' and the user 'Veronique Florec'. The ribbon includes 'File', 'Home', 'Insert', 'Draw', 'Page Layout', 'Formulas', 'Data', 'Review', 'View', 'Developer', and 'Help'. The main content area shows a dashboard with the following elements:

- Title:** Sensitivity analysis
- Subtitle:** Sensitivity to changes in parameter values
- Input:** Percentage change in parameter values (one at a time) (%) set to 50%.
- Action:** A red button labeled 'CLEAR DATA AND RESTART ANALYSIS' is highlighted with a red box.
- Charts:** Two bar charts, 'Option A' and 'Option B', showing the proportional change in NPV for Residential, Commercial, and Industrial asset values. Each chart compares a -50% change (red bar) and a +50% change (green bar).
- Navigation:** A 'Click here to see the next set of charts' button is located below the input field.
- Footer:** The bottom of the dashboard shows a navigation bar with tabs for 'Cover', 'Parameters', 'Values', 'Effect Mitigation', 'Results', and 'Sensitivity analysis'.



EXAMPLE

In this section, we will take you through a step-by-step exercise using EAST, so that you can get more familiar with the tool and are able to start using it straight away. We will use an example of flood mitigation measures in a rural area with mixed land use.

Remember that all the information that is entered in tool in this exercise does not necessarily reflect reality. The numbers and percentages that you will insert for this exercise have been generated for the purpose of this exercise only.

All points to action on the EAST tool are in bold.

I. Context

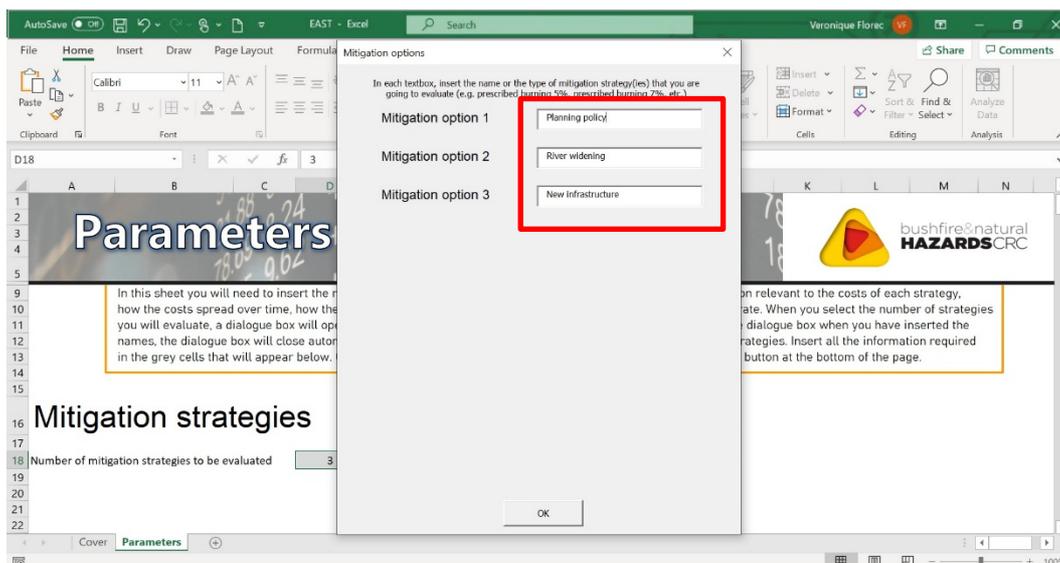
In this exercise we will look at an example of flood mitigation in a rural area that has a mix of land uses: rural-residential, environmental, and agricultural areas. The area also has important infrastructure (rail and bridges) that is at risk of being flooded. The mitigation options are:

- a. **Planning policy**: involves buying out some of the most flood-prone land (current land use would be forgone) and doing modifications (e.g. widening and deepening) of floodplains in bought-out agricultural areas.
- b. **River widening and farmers compensation**: involves claiming extra space for water in areas affected by frequent flooding, as well as reducing agricultural production (e.g. decrease grazing density by 30%) in areas where incidental flooding will still occur and compensating agricultural producers for forgone production.
- c. **New infrastructure**: focuses on protecting existing infrastructure by building viaducts and new river courses close to infrastructure at risk.

II. Inserting information in the EAST

Follow the instructions below:

1. Close any other Excel files you may have open.
2. Open the file EAST.xlsm (Excel Macro-Enabled Workbook)
3. **Click the green button START**. The Parameters sheet will appear.
4. In the Parameters sheet, **click on cell D18** and **select the number 3** in the drop-down menu. A dialogue box appears.
5. In the dialogue box, **type** “Planning policy” in the first box, “River widening” in the second, and “New infrastructure” in the third, then **click OK**.



6. Click on the blue button NEXT that appears below the 3 mitigation options.
7. Read the information below on capital and annual operational costs and insert the data into the appropriate boxes in the tool.

Capital costs

The capital costs of each mitigation strategy and how they spread over the first five years is spelled out in Table 2.

TABLE 2. CAPITAL COSTS AND HOW THEY SPREAD OVER TIME FOR EACH MITIGATION STRATEGY

	Planning policy	River widening	New infrastructure
Capital costs (total)	28,000,000	18,000,000	65,000,000
Year	Spread of capital costs		
1	50%	40%	30%
2	25%	20%	20%
3	25%	20%	20%
4		20%	20%
5			10%

Operation and maintenance costs

Each option will also require annual operation and maintenance costs. For the **planning policy option**, the areas where the river will be widened and deepened will need to be monitored every year and may require some maintenance. These costs will **start in year 4**, after the works have been completed. For the **river widening** and farmers compensation option, the areas where the river will be widened will require monitoring and maintenance, and farmers will be compensated for forgone production (which would also be an ongoing operation cost), starting after completion of the widening works, in **year 5**. For



the **new infrastructure** option, all new infrastructure will require monitoring and maintenance, starting after completion of the widening works, in **year 6**. Operation and maintenance costs for each option are shown in Table 3.

TABLE 3. OPERATION AND MAINTENANCE COSTS (PER YEAR)

	Planning policy	River widening	New infrastructure
Operation and maintenance costs	115,000	350,000	260,000

When the benefits are realised

Each mitigation option would generate different benefits, and those benefits start to appear at different times for each option. Here is how the benefits are realised for each option.

- a. **Planning policy:** A large portion of the benefits (**60%**) are realised immediately after the most flood-prone land is bought (from **year 1**), since most flood damages occur in this area. After the widening and deepening of floodplains in bought-out agricultural areas is finished (**from year 4 on**), all benefits (**100%**) from this mitigation option will be realised.
 - b. **River widening and farmers compensation:** the widening of the river provides immediate benefits to the surrounding areas, but all of the benefits (**100%**) are realised only after the works are completed (**from year 5 on**). In **year 1**, about **50%** of the benefits would be realised, **65%** in **year 2**, **80%** in **year 3**, and **90%** in **year 4**.
 - c. **New infrastructure:** The complete (**100%**) benefits of the new infrastructure projects would only be realised when the works are completed and the viaducts and new river courses are in full use (**from year 5 on**).
- 8.** Once the data on the costs and benefits of mitigation strategies is entered in the Parameters sheet, it should look like this:



Parameters

Costs of mitigation strategies

	Planning policy	River widening	New infrastructure	
Capital costs (including planning, design, establishment or construction costs)	28,000,000	18,000,000	65,000,000	
Spread of capital costs over the first few years (in %, percentages from year 1 to year 10 must add up to 100%)	Year 1	50.00%	40.00%	30.00%
	Year 2	25.00%	20.00%	20.00%
	Year 3	25.00%	20.00%	20.00%
	Year 4		20.00%	20.00%
	Year 5			10.00%
Annual operation and maintenance costs	115,000	350,000	260,000	
Start year for operation and maintenance costs	4	5	6	

Benefits of mitigation strategies

	Planning policy	River widening	New infrastructure	
Year the benefits start to appear	1	1	5	
Proportion of benefits realised each year over the first few years (in %)	Year 1	60.00%	50.00%	
	Year 2	60.00%	65.00%	
	Year 3	60.00%	80.00%	
	Year 4	100.00%	90.00%	
	Year 5	100.00%	100.00%	100.00%

9. Scroll down to the Time section and insert the following information: the time for the analysis is 30 years. The discount rate is 4%.

Parameters

Time

Length of the analysis (years)

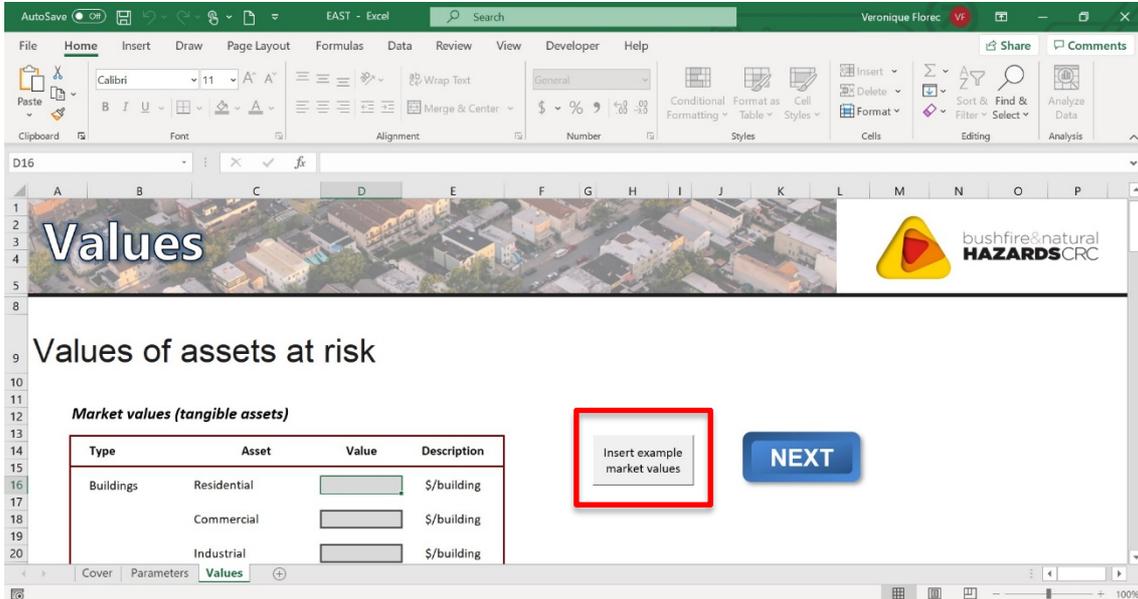
Discount rate (%)

NEXT



10. Click on the green button NEXT at the bottom of the Parameters sheet. The Values sheet appears.

11. Use the default values for all (tangible) market assets, click on the button “insert example market values.”



12. Click on the blue button NEXT at the bottom of the page. The Effect mitigation sheet appears.

13. Read the information below and insert the data in Table 4 in the appropriate cells in the Effect mitigation sheet.

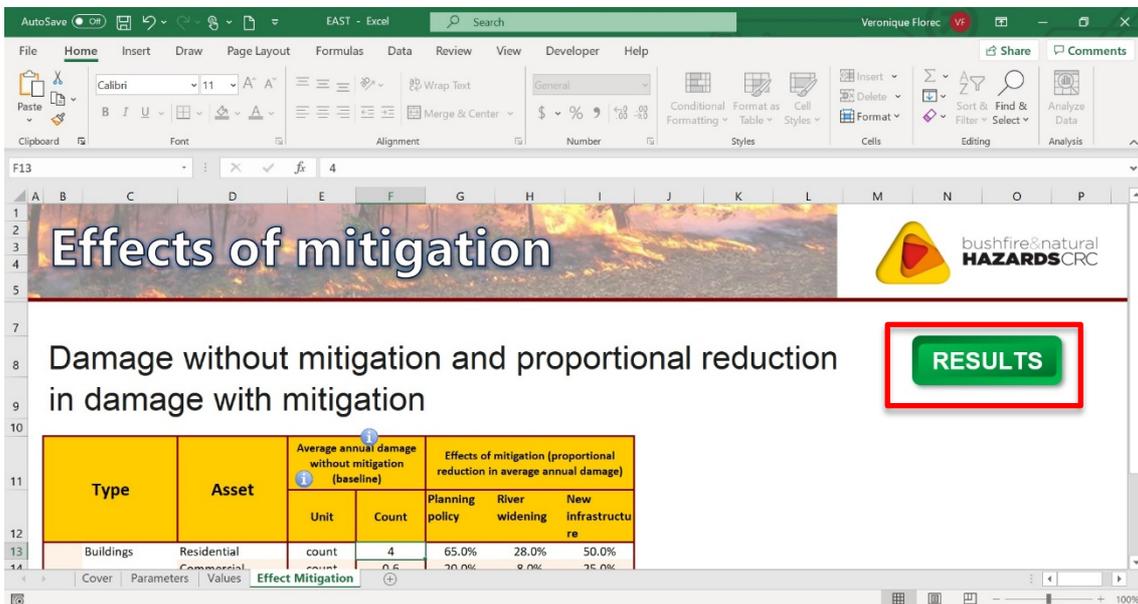
Current damage and effects of mitigation

Current flooding in the case study area causes substantial damage to the flooded properties. The different mitigation options considered have different effect on the level of damage. Table 4 shows the current average annual damage (without mitigation) for each type of asset and the effects of the mitigation strategies; that is, the proportional reduction in damages that can be expected from the implementation of each strategy.

TABLE 4. AVERAGE ANNUAL DAMAGE (WITHOUT MITIGATION) AND PROPORTIONAL REDUCTION IN DAMAGE DUE TO MITIGATION

Type	Asset	Average annual damage (without mitigation)	Planning policy	River widening	New infrastructure
Buildings	Residential	4	65.0%	28.0%	50.0%
	Commercial	0.6	20.0%	8.0%	25.0%
	Industrial	0.2	30.0%	10.0%	25.0%
Infrastructure	Bridges	0.3	8.0%	15.0%	45.0%
	Rail	0.0625	7.0%	12.0%	15.0%
	Power lines	3	16.0%	22.0%	45.0%
	Power poles	5	16.0%	22.0%	45.0%
Agriculture	Horticulture	10	15.0%	5.0%	7.0%
	Grazing and cropping	12.5	50.0%	40.0%	20.0%
	Vineyards	2.5	20.0%	15.0%	10.0%
	Plantation forestry	1	10.0%	8.0%	2.0%

14. Click on the green “Results” button at the bottom of the “Effect mitigation” sheet in order to open the Results sheet.

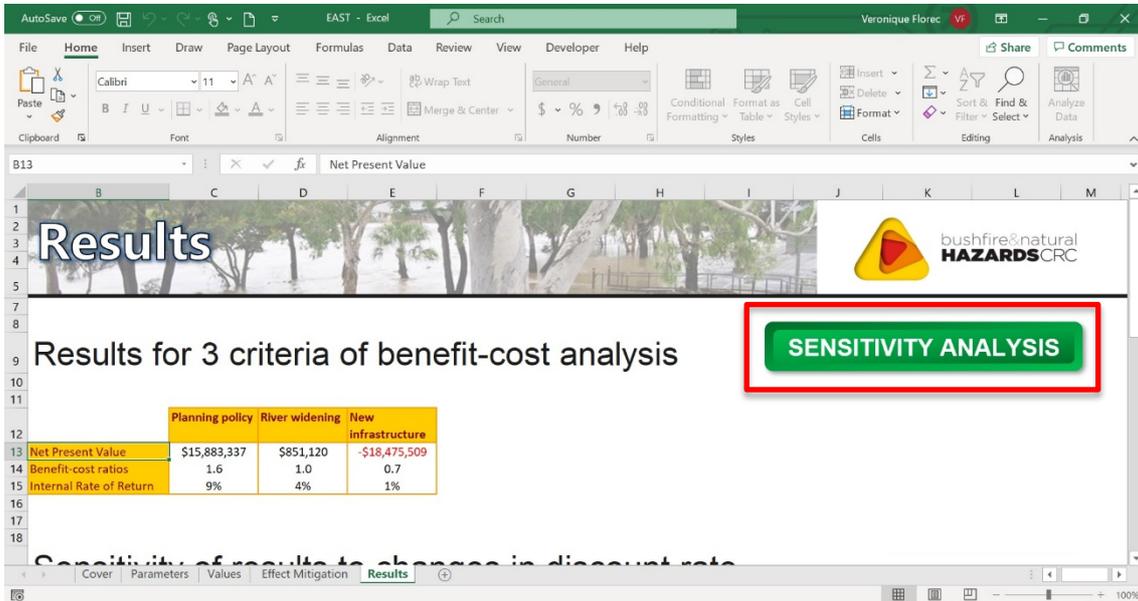


III. Interpret the results

15. Reflect on the following questions:

- a. Which mitigation option has the highest net present value (NPV)?
- b. Which one has the highest benefit-cost ratio (BCR)?

- c. If the budget for flood mitigation in the case study area is \$50 million (for capital costs) and up to \$350,000 for operating and maintenance costs, which option should be selected?
- d. Would the ranking of the options change if the options are mutually exclusive or if they are independent?



The screenshot shows an Excel spreadsheet with the following data table:

	Planning policy	River widening	New infrastructure
Net Present Value	\$15,883,337	\$851,120	-\$18,475,509
Benefit-cost ratios	1.6	1.0	0.7
Internal Rate of Return	9%	4%	1%

A green button labeled "SENSITIVITY ANALYSIS" is highlighted with a red border in the spreadsheet.

16. Now **click on the green button “Sensitivity Analysis”**

17. Have a look at the three charts presented to you.

- a. Which parameters are the results most sensitive to?
- b. How much confidence can we have in these results?
- c. What would improve the confidence we have on the results?

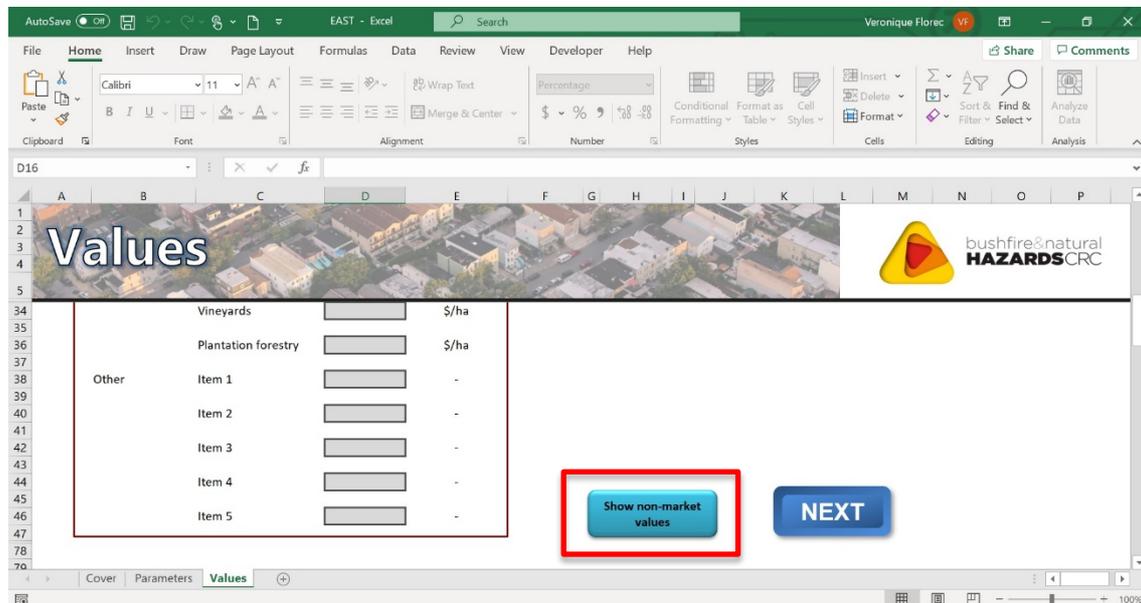
IV. Integrating non-market values

No we will have a look at how to integrate non-market values (intangible values) into our economic analysis. We will include them in the analysis in dollar values, which means that they will be directly comparable to other items in the analysis (i.e. market values).

We will use another tool that was also developed at the University of Western Australia as part of the “Economics of Natural hazards” project: the Value Tool for Natural Hazards, which can be downloaded from [this link](#). The steps we will follow in the remainder of the exercise will help you understand how to select amongst the different non-market values currently available in the Value Tool and will give you an idea of the challenges encountered when adapting these values to a different context from the original study. This is done through a technique called benefit transfer. To fully understand this process, we recommend you also read the Value Tool Guidelines, available [here](#).



1. **Go to** the Values sheet in EAST, scroll down the sheet and **click on** the light blue button that says *Show non-market values*. This unhides the table non-market values table. In this exercise we will retrieve information for 4 different non-market values from the Value Tool (life, unable to return, and native vegetation for local and non-local residents), adjust the values as needed and insert them into EAST.



2. **Open the file** Value Tool for Natural Hazards DATABASE_V2.3.xlsm (Excel Macro-Enabled Workbook).
3. We will need to adjust the non-market values extracted from the Value Tool to the context of our study. **Read the box below** to understand the type of adjustments we need to make to non-market value estimates that we take from a study in order to adapt them to a different study area or policy context. For more information about why and how to adjust non-market values from one study to another one, we recommend you read the Value Tool Guidelines, available [here](#).



Making adjustments to non-market values transferred from a study to a different case study area

In some (rare) cases, the non-market values available in the Value Tool can be used as they appear in the database. However, in most cases they need to be adapted and adjusted to the context of our study, which is different to the context of the study in which the values were calculated. This is because context matters for non-market values, and people are willing to pay more (or less) for different non-market goods and services depending on the context. The technique used to adjust non-market values from a study to another is called benefit transfer. To understand the steps needed when adjusting transferred values, please read the Value Tool Guidelines. The key steps to follow are:

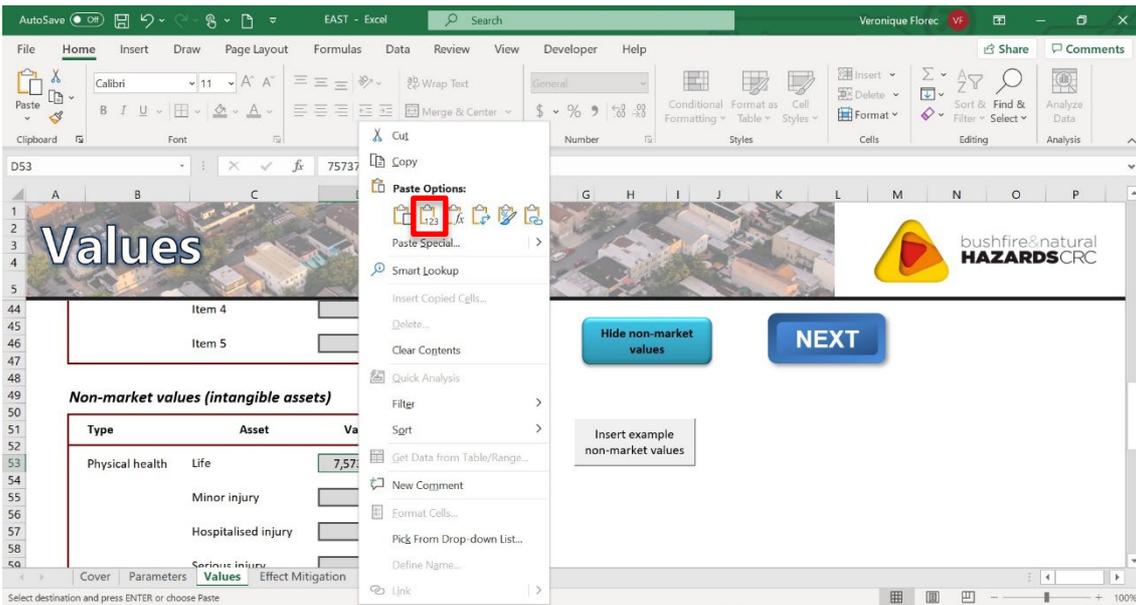
- Convert the value in the study to Australian currency if the study was not conducted in Australia (this step is already done by the Value Tool).
- Convert the value in the study to current Australian dollars using the Consumer Price Index (this step is also done by the Value Tool).
- Aggregate for population size. In most cases, non-market values are expressed as willingness to pay per person or per household. These values need to be aggregated over the relevant population (i.e. multiply \$ x number of people). To be able to do this we need to know the size of the relevant population.
- Adjust for socio-demographic differences (e.g. average income of the population sampled in the original study vs. the population that we are looking at in our own analysis).
- Scale over the quantity or quality of the good being valued. In the original study, we could have a willingness to pay (WTP) of \$100/person for 10 units of the good being valued. If in our study we need to know the WTP for 20 units of the good, the transferred value would be \$200/person. The problem here is that this assumes that utility (i.e. the measure of wellbeing) is linear with respect to increases in quantity, but often times this relationship exhibits decreasing marginal returns, so the \$200/person is likely to overestimate the non-market value. In this case, using a wide range of values in the sensitivity analysis is recommended.

4. Go to the Health values sheet. In column L, click on the dropdown menu, select (Select All) to deselect all categories, then click on Fatality.

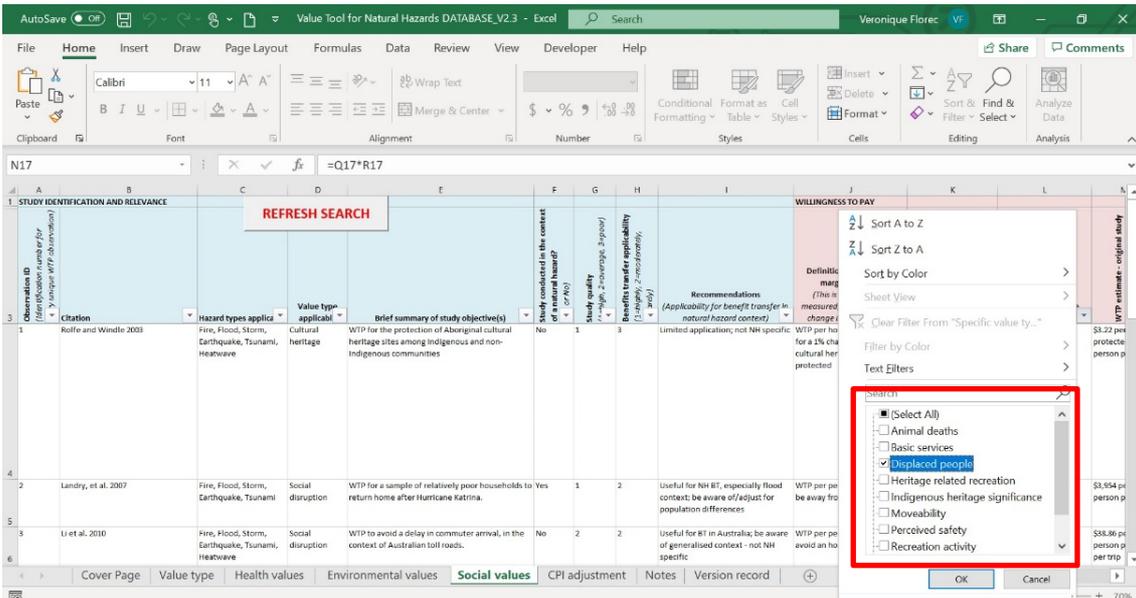
The screenshot shows an Excel spreadsheet with a dropdown menu open over cell L6. The menu options are: (Select All), Fatality, Hospitalised injury, Illness or disease, Minor injury, Pain, and Serious injury. The 'Select All' option is highlighted with a red box. The spreadsheet background shows a table with columns for 'Value type', 'Brief summary of study objective(s)', 'Study considered in the context of the current study', 'Study quality', 'Benefits transfer applicability', 'Recommendations', 'Definitive margin', and 'WILLINGNESS TO PAY'. The 'WILLINGNESS TO PAY' column contains values like '\$95.03 per person per symptom day' and '\$6,036,000 per life'.



5. **Read** in Column E the brief description for each of the values available. We will use the value obtained from the meta-analysis (\$7,573,782).
6. The Value of Statistical Life (VSL) represents a value per case or per occurrence of an incident, so it does not need to be aggregated for population size. We will use the exact value extracted from the Value Tool in EAST.
7. **Go to** the Values sheet in East and **type 7,573,782** in cell D53 (value of life), or copy cell N6 from the Health values sheet in the Value Tool and paste it in cell D53 in the Values sheet in EAST, by right-clicking on your mouse and selecting to paste only the Values.



8. **Go to** the Social values sheet. In column L, **click on** the dropdown menu, **select (Select All)** to deselect all categories, then **click on Displaced people**.





9. **Read** in Column E the brief description for each of the values available. Which of the two values available do you think would be the most appropriate for the cost of being unable to return home due to floods? We will use the example from Hurricane Katrina (\$7,238.29), but we need to adjust the value to our context first.

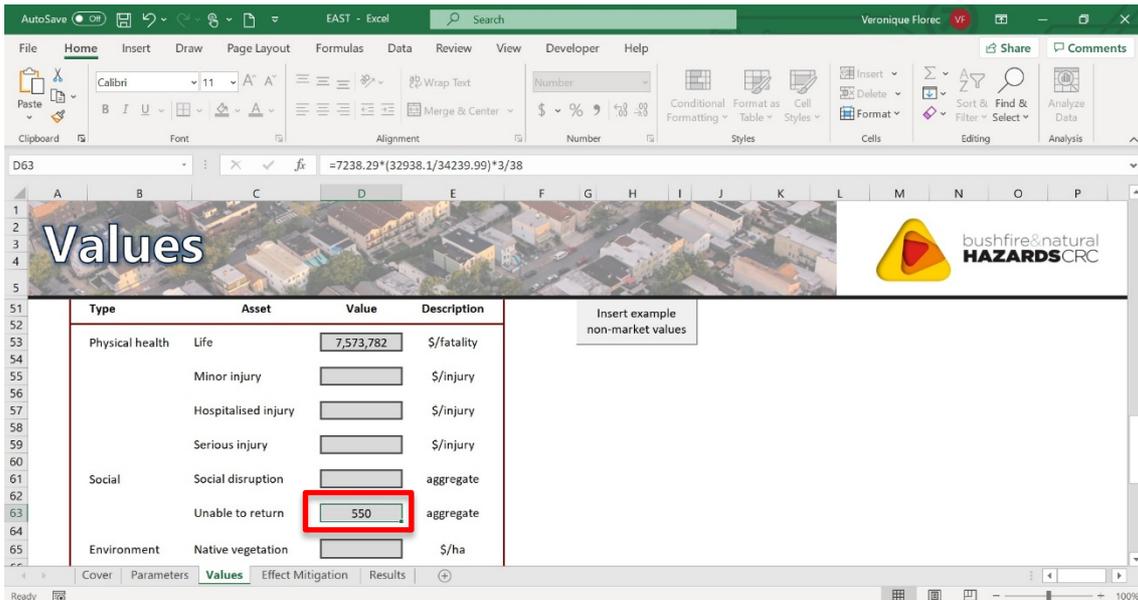
Unable to return: for the purpose of this exercise, we will assume that our case study area is **located in South Australia** and that floods cause, on average, a **3 days displacement of 1,000 residents every 50 years**. To adjust the willingness to pay (WTP) to return home, follow these steps:

- a. **Aggregate for population size:** this step is not necessary in our example for this particular value (only in this example and only for this value), simply because EAST does the aggregation automatically when it calculates average annual damage (the tool does this by multiplying the value of returning home x average annual number of people affected in the Effect mitigation sheet, which is one of the steps to calculate the results).
- b. **Adjust for income:** income in New Orleans (US) and in South Australia are different, so we need to adjust for that difference. But we have information on the average income of people in New Orleans for 2005 (US\$18,704), so we need to convert that to Australian dollars in 2019. US\$18,704 in 2005 = \$24,678.07 in 2005 AUD, which is = \$34,239.99 in 2019 AUD. We then multiply the value extracted from the Value Tool (\$7,238.29) by the difference in US vs. South Australian income ($\$32,938.1 \div \$34,239.99 = 0.962$).
- c. **Scale over the quantity of the good being valued:** After hurricane Katrina, people were away from home for an average of 38 days, whereas in our example they are away for an average of 3 days. We need to adjust for that too by multiplying the adjusted value by $3 \div 38$.
- d. **The calculation of the adjusted unable to return value looks like this:**

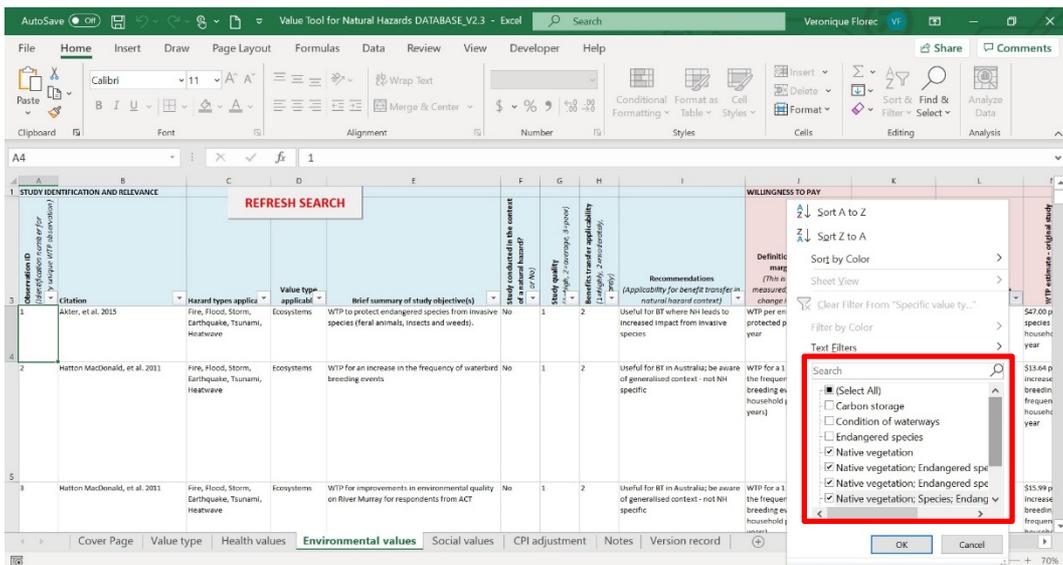
$$=7,238.29 * (32938.1 / 34239.99) * 3 / 38$$
 This is equal to **\$550**. If our case study area was in NSW for instance (where the average annual income is higher), this would be equal to \$608.

Insert the formula or **type \$550 in cell D63** in the Values sheet in EAST.

The information on the number of residents affected and the frequency (1,000 residents every 50 years) is only needed to estimate the average annual damage without mitigation that we will insert in the Effect mitigation sheet ($1,000 \div 50 = 20$ residents affected on average per year). It is not needed to adjust the WTP to return home.



10. Go back to the Value Tool and open the Environmental values sheet. In column L, click on the dropdown menu, select (Select All) to deselect all categories, then click on all categories that contain the words Native vegetation.



11. Read in Column E the brief description for each of the values available.

To select the most appropriate value and adjust it to our study, we need more context on the case study area. The case study area is **located in South Australia** and the vegetation that is at risk of being damaged by floods is mostly **scrublands**. **Local households** (defined in this exercise as living inside the case study area) and **non-local households** (defined in this exercise as living outside of the case study area, but within the region) are **willing to pay different amounts** for improving the quality of the scrublands. The total number of households in the region is 165,000. Of these, 105,000 are regional households (located outside the case study area) and 60,000 are local households (located inside the case study area).



12. We have selected two WTP measures:

- a. **For local residents (native vegetation of local relevance):** the WTP to increase the size and improve the quality of scrublands in the Upper South East, South Australia, for Upper South East respondents (\$1.16).
- b. **For regional residents (native vegetation of regional relevance):** the WTP to increase the size and improve the quality of scrublands in the Upper South East, South Australia, for Adelaide respondents (\$0.87).

13. Now we need to adjust these values and insert them into EAST.

Native vegetation (of local relevance): To adjust the willingness to pay (WTP) to improve the quality of scrublands by local residents, follow these steps:

- a. **Aggregate for population size:** multiply the value extracted from the Value Tool (\$1.16) by the number of local households (60,000).
- b. **Adjust for income:** Not necessary since the study was conducted in South Australia.
- c. **Scale over the quantity of the good being valued:** we need to convert the value per 1,000 hectares to a value per hectare, so divide the value by 1,000. EAST will automatically scale over the correct amount of hectares damaged and estimate average annual damage by multiplying the adjusted value of native vegetation by the number of native vegetation hectares (of local relevance) affected by the hazard.
- d. **The calculation formula looks like this:**

$$=1.16*60000/1000$$

$$= 70$$

Insert the number 70 in cell D65 in the Values sheet in EAST.

Native vegetation (of regional relevance): To adjust the willingness to pay (WTP) to improve the quality of scrublands by regional residents, follow these steps:

- a. **Aggregate for population size:** multiply the value extracted from the Value Tool (\$0.87) by the number of households in the region (105,000).
- b. **Adjust for income:** Not necessary since the study was conducted in South Australia.
- c. **Scale over the quantity of the good being valued:** we need to convert the value per 1,000 hectares to a value per hectare, so divide the value by 1,000. EAST will automatically scale over the correct amount of hectares damaged and estimate average annual damage by multiplying the adjusted value of native vegetation by the number of native vegetation hectares (of local relevance) affected by the hazard.
- d. **The formula in cell I9 should look like this:**

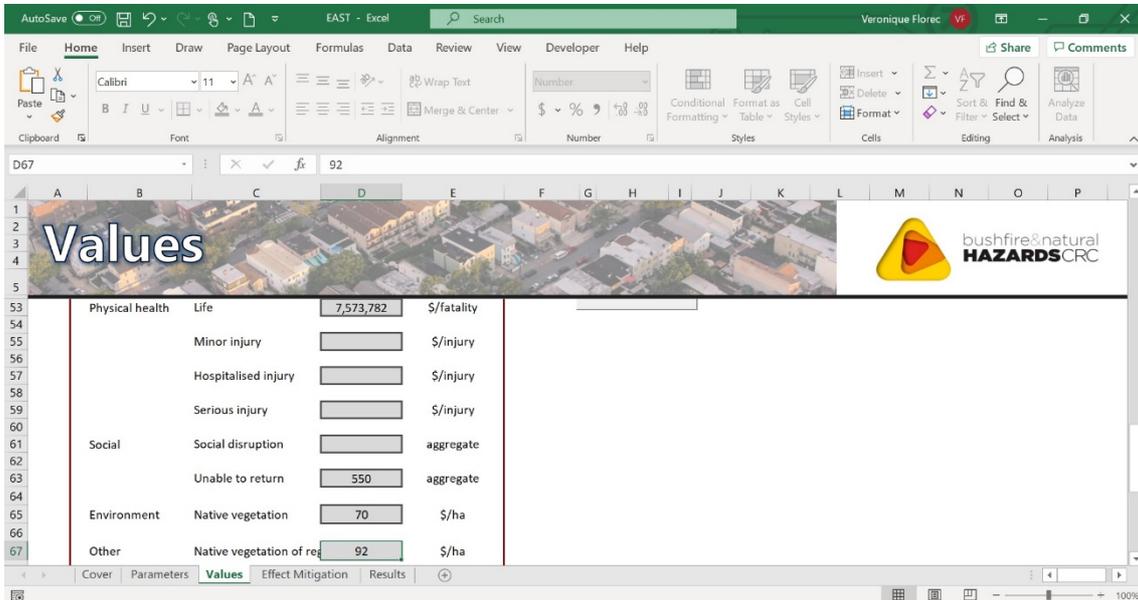
$$=0.87*105000/1000$$



= 92

Insert the number 92 in cell D67 in the Values sheet in EAST.

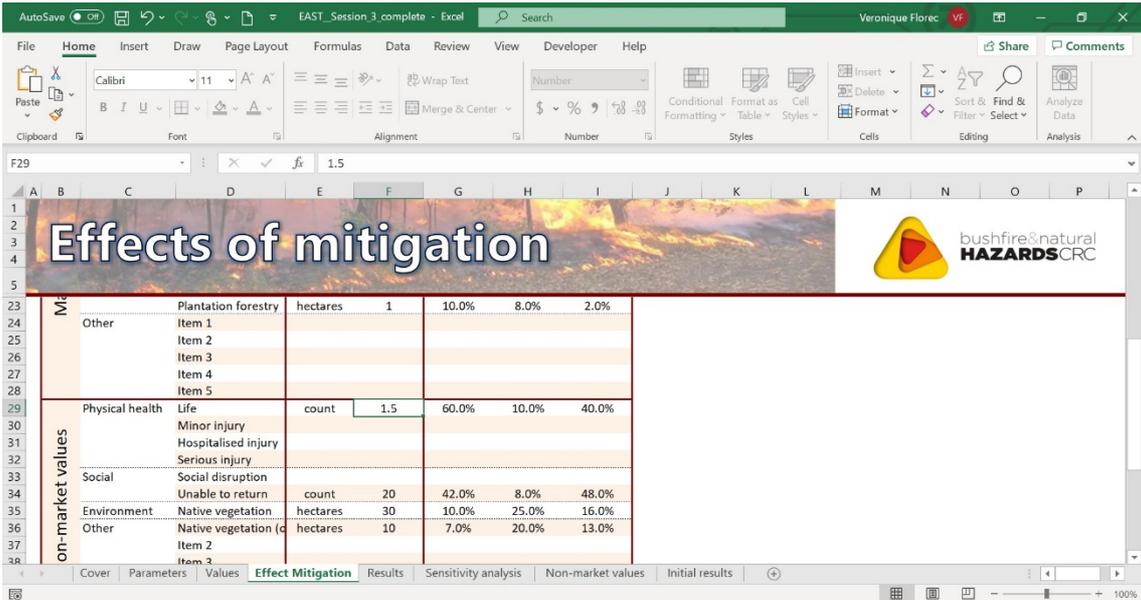
- 14. Change the label in cell C67 to “Native vegetation of regional relevance” and the label in cell E67 to “\$/ha.”



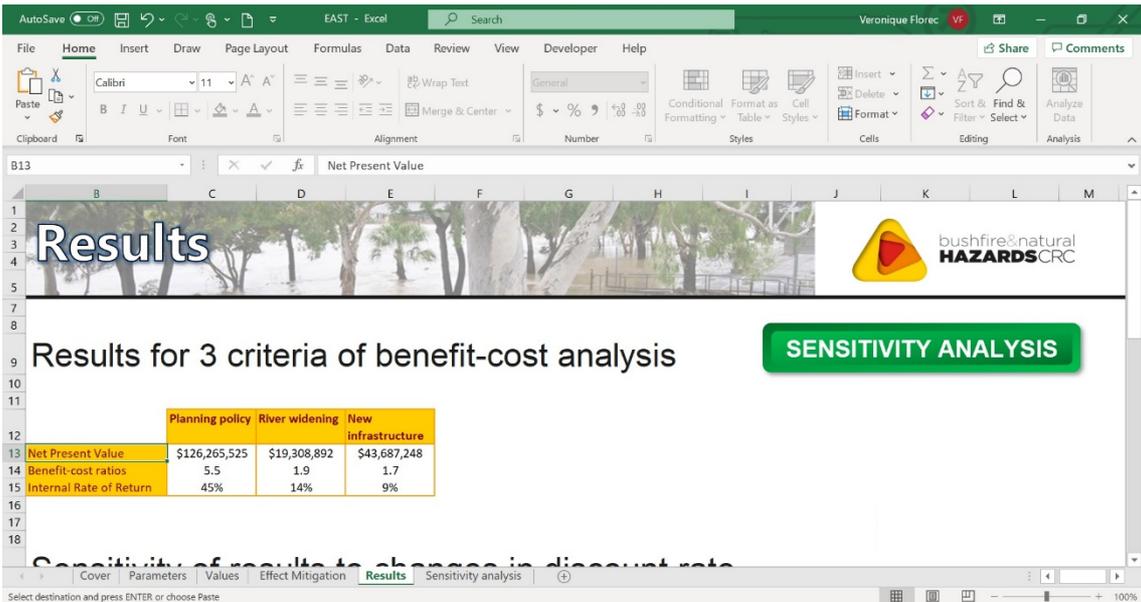
- 15. Go to the Effect mitigation sheet and insert the information in Table 5 in the appropriate cells.

TABLE 5. AVERAGE ANNUAL DAMAGE (WITHOUT MITIGATION) AND PROPORTIONAL REDUCTION IN DAMAGE DUE TO MITIGATION FOR NON-MARKET VALUES

Type	Asset	Average annual damage (without mitigation)	Planning policy	River widening	New infrastructure
Physical health	Life	count	1.5	60.0%	10.0%
Social	Unable to return	count	20	42.0%	8.0%
Environment	Native vegetation	hectares	30	10.0%	25.0%
Other	Native vegetation (of regional relevance)	hectares	10	7.0%	20.0%



16. Go to the Results sheet. What difference does it make in this example to include non-market values (NMVs)?



17. Which non-market value accounts for most of the difference?

18. Go to the Sensitivity analysis sheet, which NMVs are the results most sensitive to?