Disaster Risk Modeling Interface – User Guide

TA-9878: Developing a Disaster Risk Transfer Facility in the Central Asia Regional Economic Cooperation (CAREC) Region

2022

CAREC
Central Asia Regional Economic Cooperation Program

ADB

willistowerswatson.com

GEM GLOBAL EARTHQUAKE MODEL working together to assess risk

JBA risk management

ODI

Pengwern Associates

METABIOTA

Willis Towers Watson

User Guide Contents

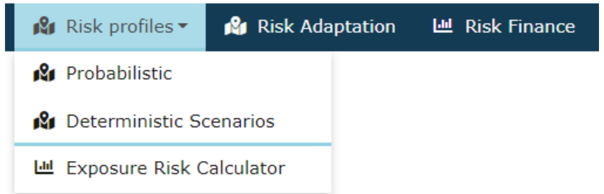
1. About this Guide

- This guide is intended to help users navigate the Disaster Risk Modeling Interface (DRMI) and access information for knowledge development, awareness raising, and policy-related decision-making
- The guide uses screenshots from the DRMI to help visualize and select appropriate data and build familiarity with the system. These screenshots are indicative of the content available but may differ from the user's specific experience depending on their permitted access to data
- The guide provides an overview of the different functions in the DRMI, it does not provide technical information on the risk modeling methodology. This is provided separately in the Risk Modelling Technical Note.
- This guide will continue to evolve based on user feedback.

2. Overview of the DRMI

- The DRMI provides users with access to information generated by TA-9878 Developing a Disaster Risk Transfer Facility in the Central Asia Regional Economic Cooperation Region
- Earthquake, flood and infectious disease risk profiling for all CAREC members has been conducted using state of the art modeling
- Risk metrics quantifying impacts to people, property and the economy from all three hazards are available on the interface, with an option to adjust exposure. Historic impacts are also available
- Climate adaptation scenarios inform on the costs and benefits of implementing different hazard mitigation mechanisms. These are modelled for current conditions, as well as future climate scenarios and for future economic growth scenarios
- A disaster risk financing dashboard allows testing of parameters of risk financing programmes, drawing on the risk modeling results to understand the extent and indicative costs of risk financing
- Users have the functionality to download data for further analysis

2. Overview of the DRMI: Structure



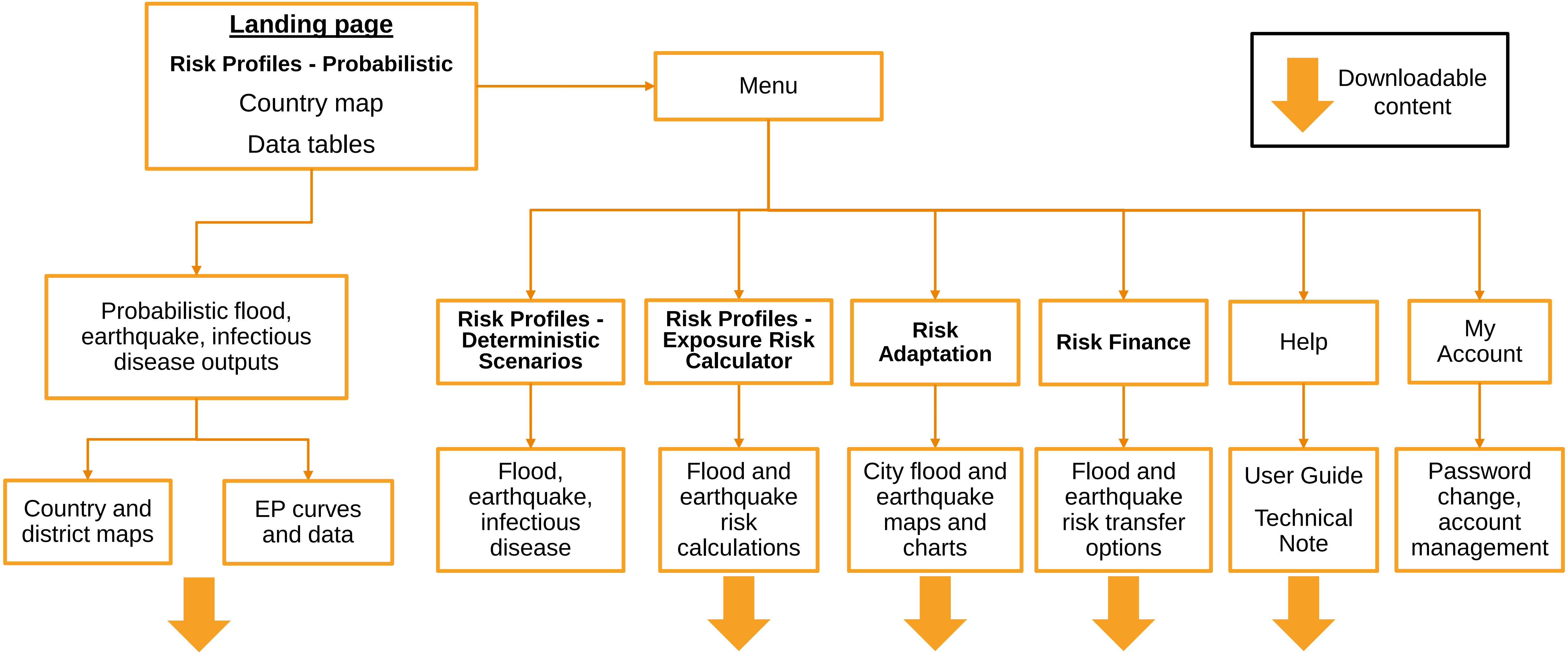
There are three core functions of the DRMI, containing data sets and tools for the user.

1. Risk Profiles
   - Probabilistic – map-based view of economic losses, number of people affected and fatalities from catastrophe modeling of flood, earthquake and infectious disease
   - Deterministic Scenarios – map-based view of historic earthquake and flood events, and infectious disease outbreaks
   - Exposure Risk Calculator – a tool to enable adjustments to the exposure component of the probabilistic risk assessments

2. Risk Adaptation
   - Map-based view of the cost-efficiency of mechanisms to mitigate the impact of floods and earthquakes, including under different climate and economic growth scenarios

3. Risk Finance
   - Tool to enable testing of different key risk financing parameters

2. Overview of the DRMI: Site Map



3. User Access: Login

- The DRMI is accessed via web browser
- Login requires a username and password
- User registration is controlled centrally
- Each user has tailored access to information on the DRMI, depending on their location (i.e., not all users can see all data)
- Upon login, the map-based probabilistic section is automatically loaded

3. User Access: Navigation

- Consistent throughout the tool is a top navigation panel that allows you to move between the core functions of the tool

4. Risk Profiles - Probabilistic

- Probabilistic modelling combines hazard, vulnerability and exposure components to generate a description of the distribution of impacts of disaster risk: metrics are available for physical damage, people affected and fatalities on a geographical basis.

- The two main outputs from the probabilistic modelling are average annual losses (AALs) and exceedance probability (EP) curves.
  - Average annual loss is the mean value of an EP distribution. It indicates the expected impact per year, averaged over a long period
  - An EP curve describes the probability that various levels of impact will be exceeded. If 10,000 years are simulated, then there is a 0.01% (1/10,000) probability that the largest impact in the set will be exceeded. Similarly, there is a 1% (1/100) probability that an event that occurs on average every 100 years will be exceeded

- The modelling is based on models from GEM (earthquake), JBA (flood), and Metabiota (infectious disease). Additional information is provided in the Risk Modelling Technical Note.

4. Risk Profiles - Probabilistic

Benefits of probabilistic modelling:

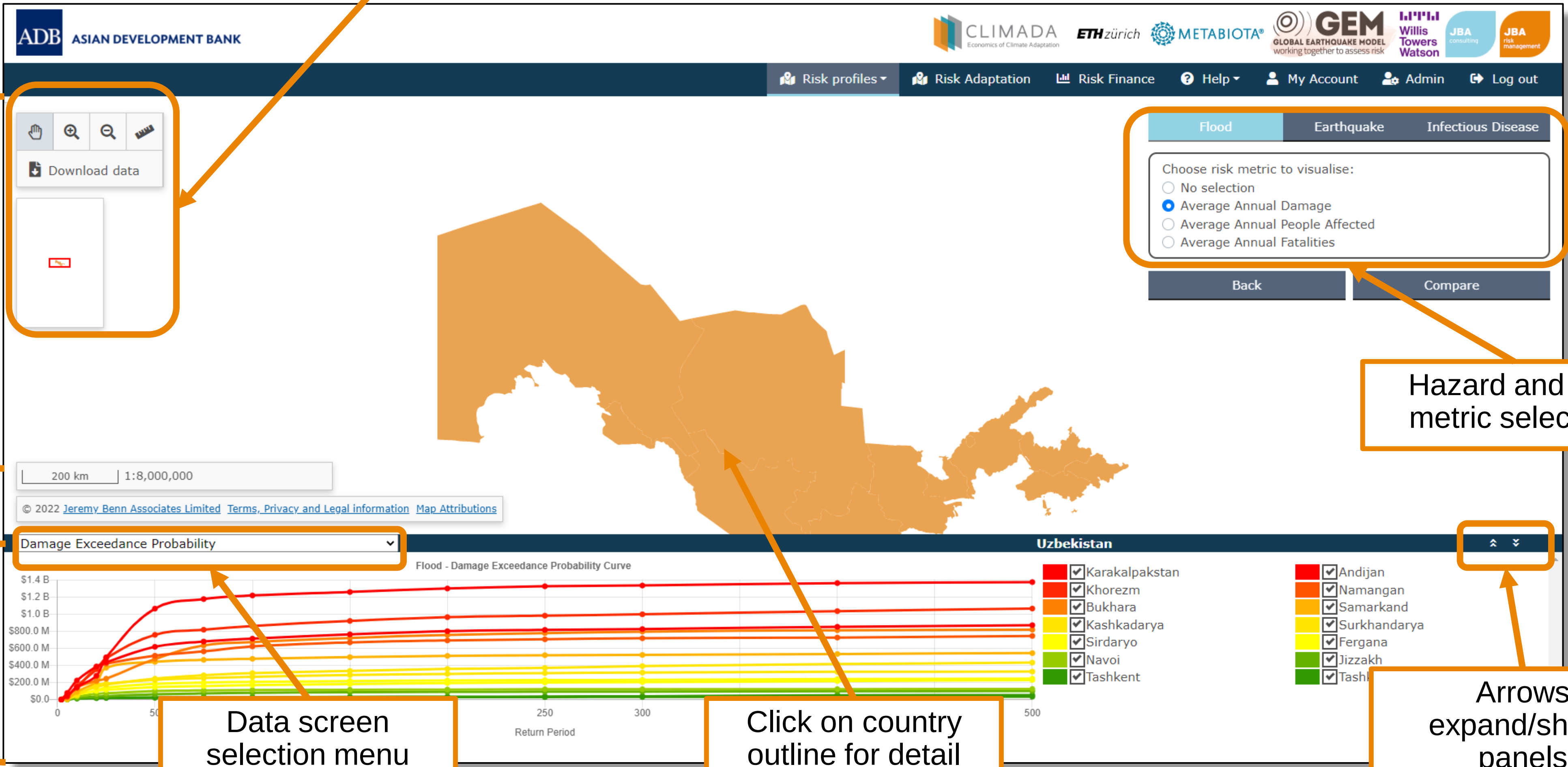
- Widely used by insurers and reinsurers to understand the risk from natural hazards when managing their portfolios and pricing insurance
- Probabilistic catastrophe models can provide a view of risk at a location or aggregate level where suitable exposure data is available
- The use of large sets of simulated events means that the models can estimate risk for extreme events of much greater intensity than anything that has been observed in recorded history
- Using the full probabilistic distribution of risk that the models generate, users can base their decisions on a modelled level of impact (e.g. $50m of economic loss) or a specific frequency of event (e.g. 1 in 50 years)
- Probabilistic models represent the uncertainty in the hazard and exposure components used to generate risk outputs
- Probabilistic models are increasingly used to model risk beyond the traditional insurance market

4. Risk Profiles - Probabilistic

Map location, pan/zoom and data download functions

Map panel
- Country level
- Province level
- Comparisons

Hazard and risk metric selection



Data panel
- EP curves
- Data tables

Data screen selection menu

Click on country outline for detail

Arrows expand/shrink panels

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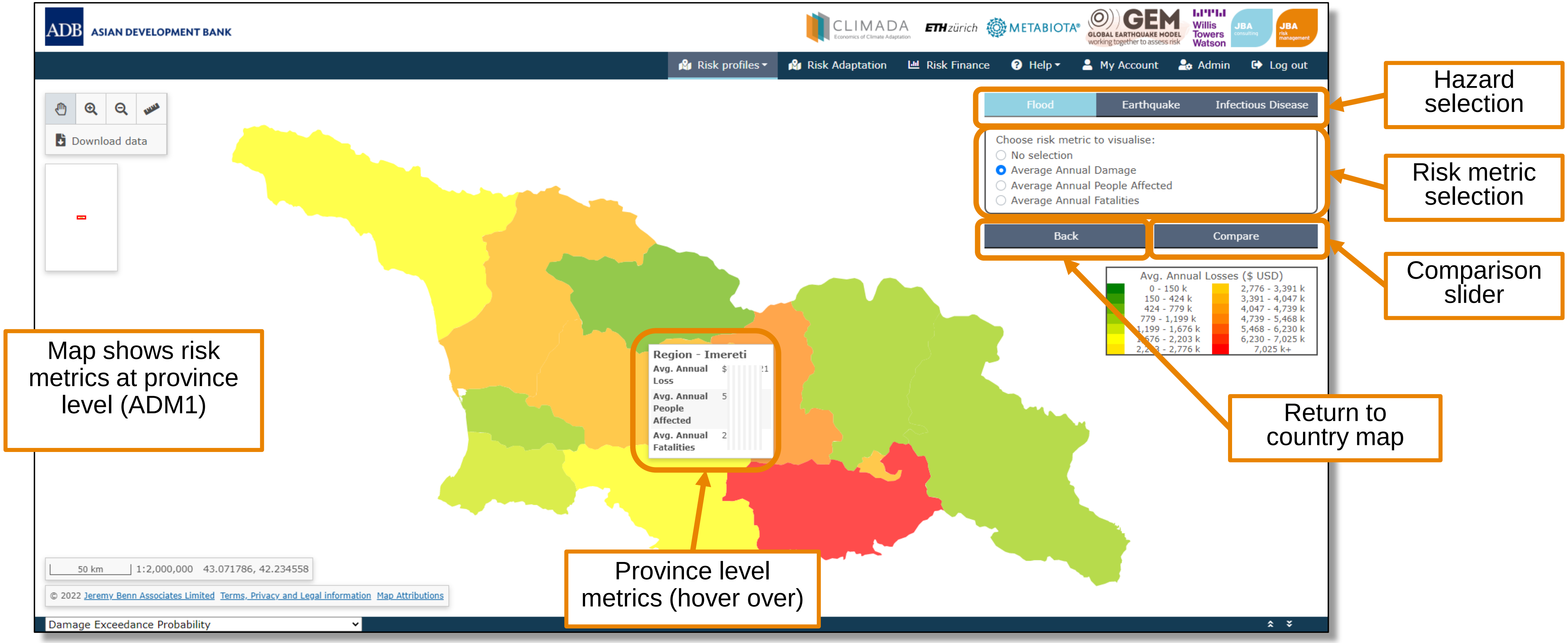
4. Risk Profiles - Probabilistic

Province Map



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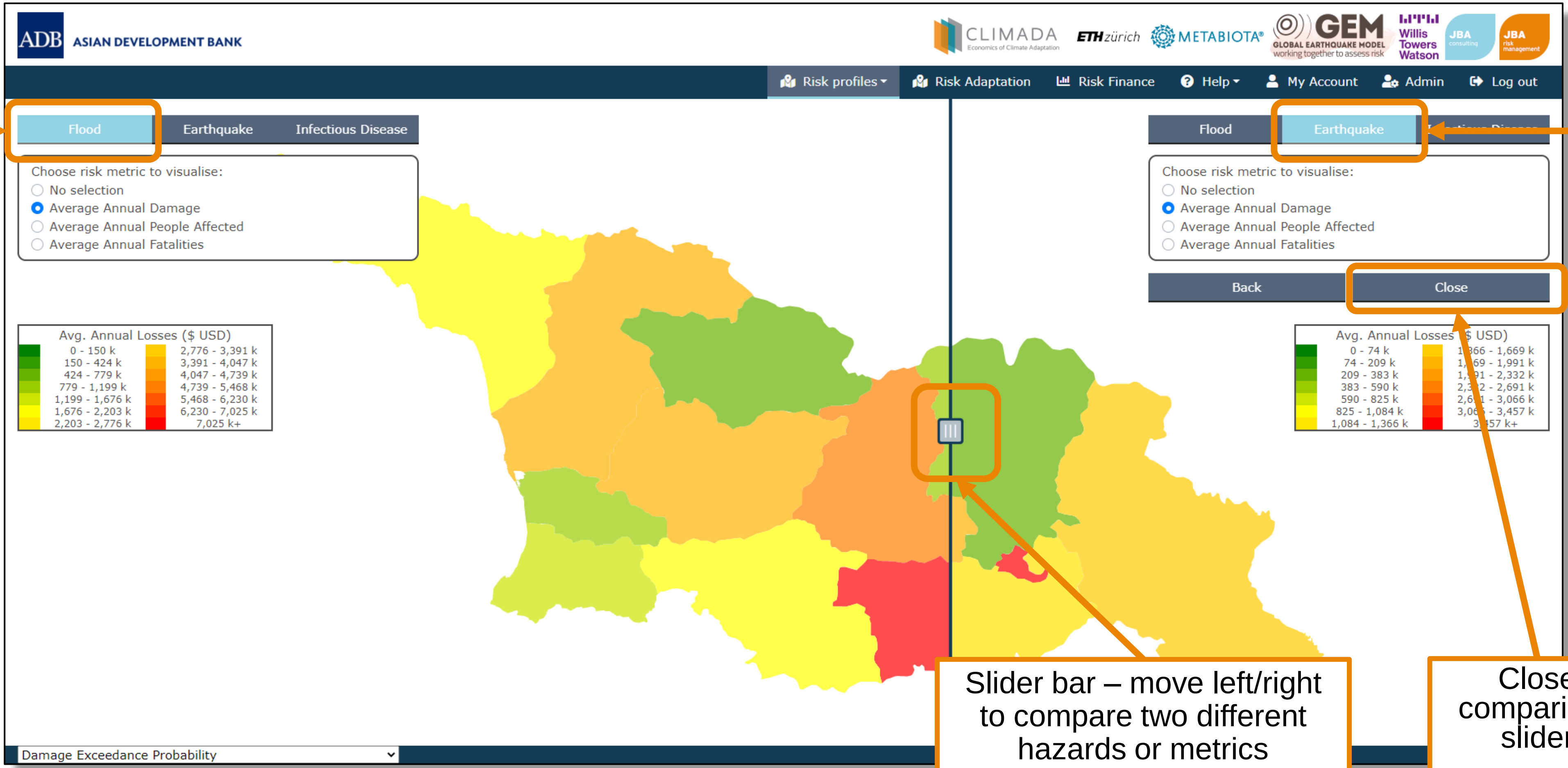
4. Risk Profiles - Probabilistic

Comparison Slider



Flood damage: province level

Earthquake damage: province level

Slider bar – move left/right to compare two different hazards or metrics

Close comparison slider

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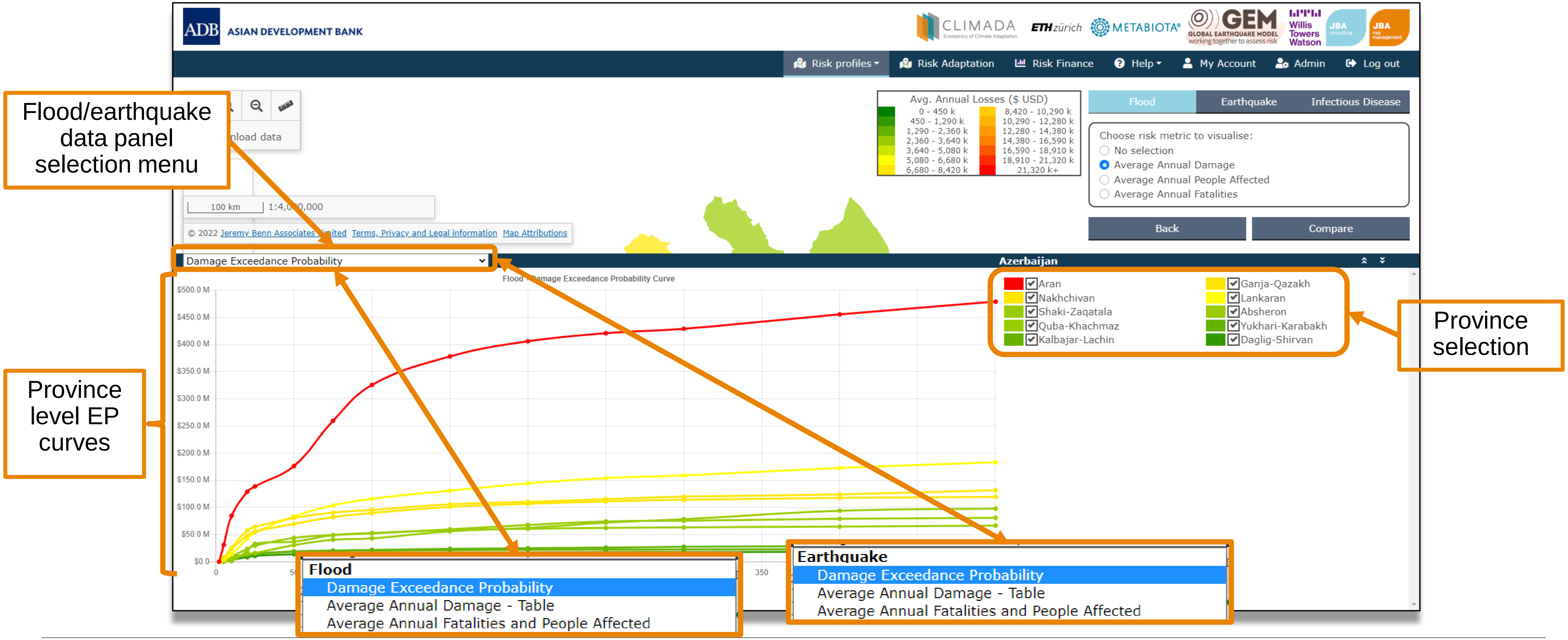
4. Risk Profiles - Probabilistic

Data Panel – Exceedance Probability curves



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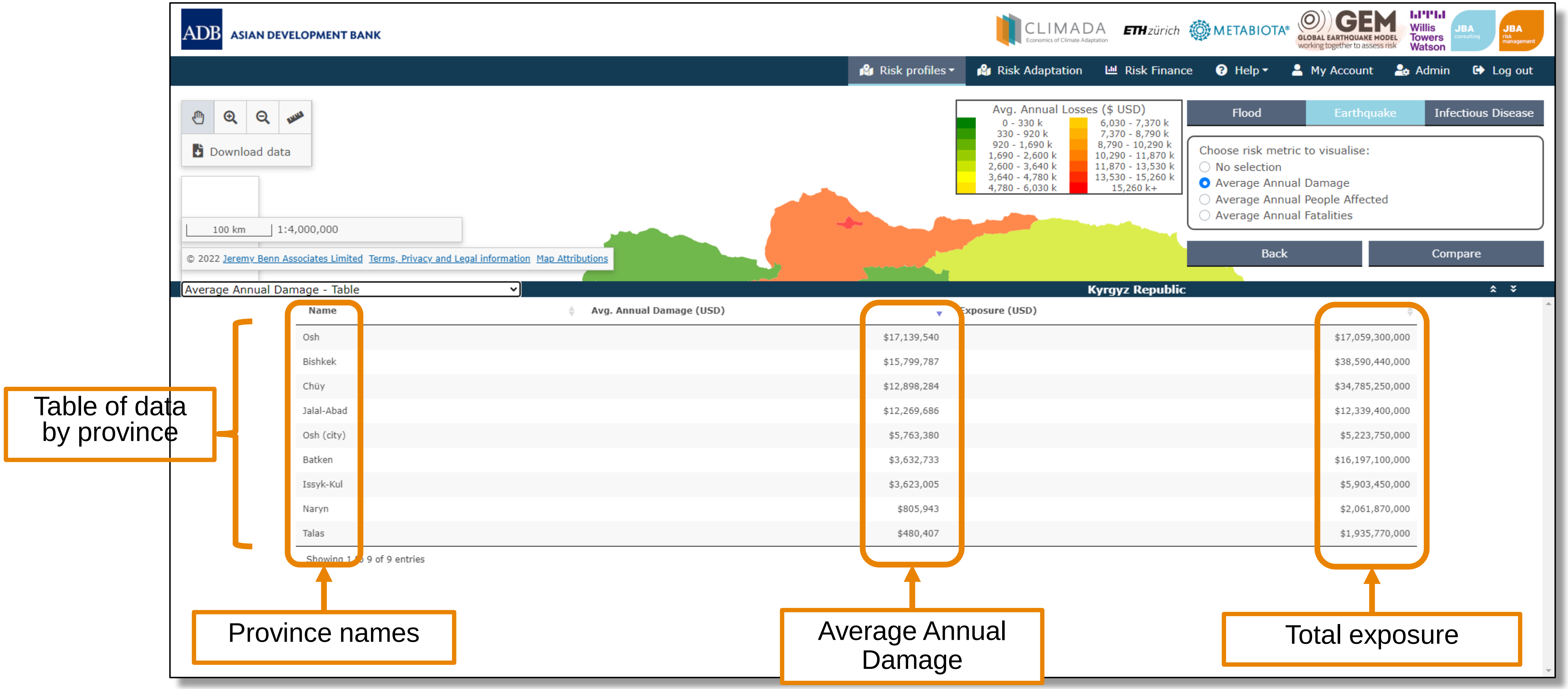
4. Risk Profiles - Probabilistic

Data Panel – Average Annual Loss tables



Name	Avg. Annual Damage (USD)	Exposure (USD)
Osh	$17,139,540	$17,059,300,000
Bishkek	$15,799,787	$38,590,440,000
Chüy	$12,898,284	$34,785,250,000
Jalal-Abad	$12,269,686	$12,339,400,000
Osh (city)	$5,763,380	$5,223,750,000
Batken	$3,632,733	$16,197,100,000
Issyk-Kul	$3,623,005	$5,903,450,000
Naryn	$805,943	$2,061,870,000
Talas	$480,407	$1,935,770,000

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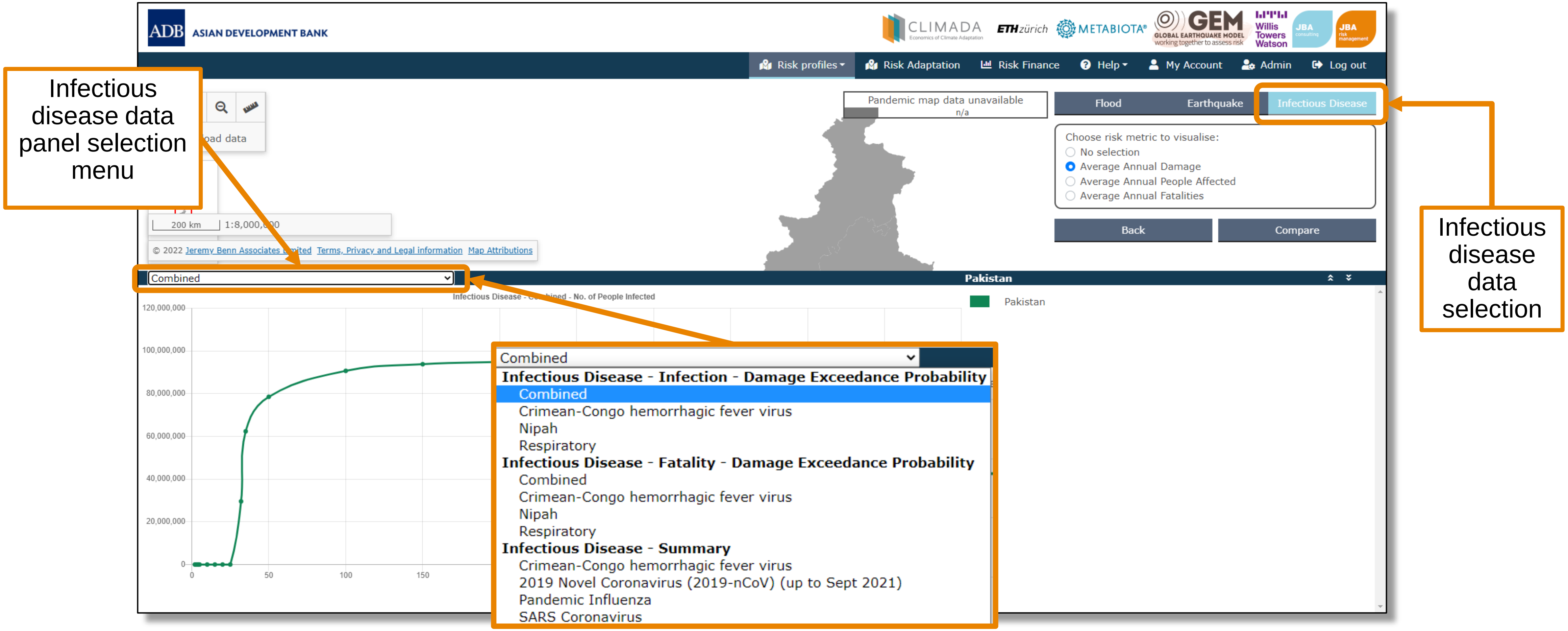
4. Risk Profiles - Probabilistic

Infectious Disease

- Given the nature of infectious disease risk, information is presented on a national, rather than province, level.



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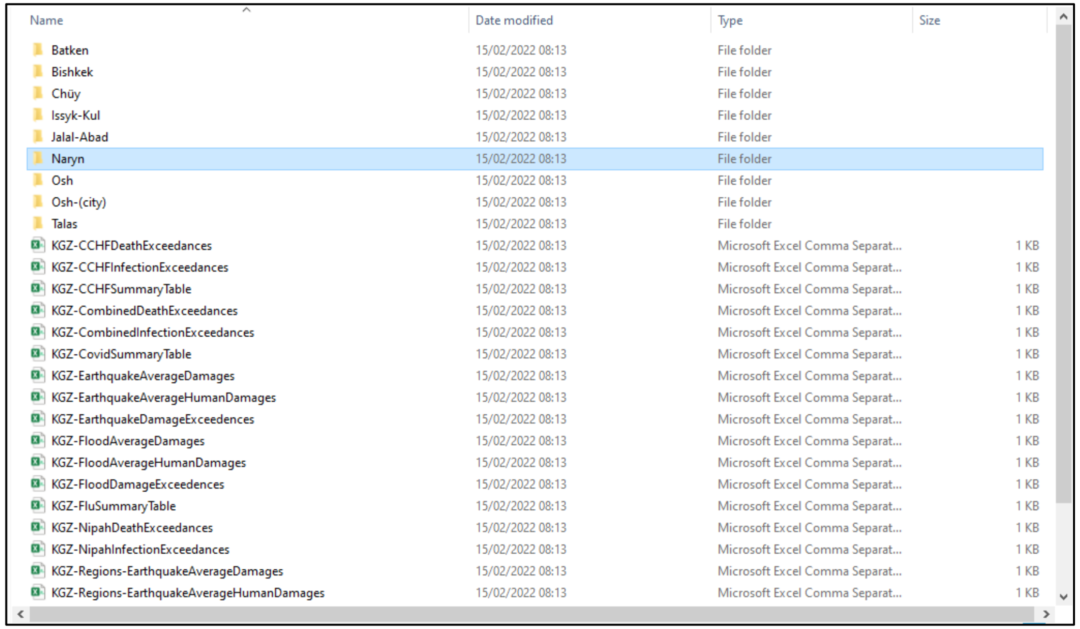
4. Risk Profiles - Probabilistic

Data download

- From the button on the top left of the screen data can be downloaded in csv format
- Download zip file contains
  - Country level flood, earthquake and infectious disease data
  - Average annual metrics and exceedance probabilities
  - Metrics for damage, people affected and fatalities
  - Flood and earthquake outputs at province level (ADM1)



5. Risk Profiles - Deterministic Scenarios

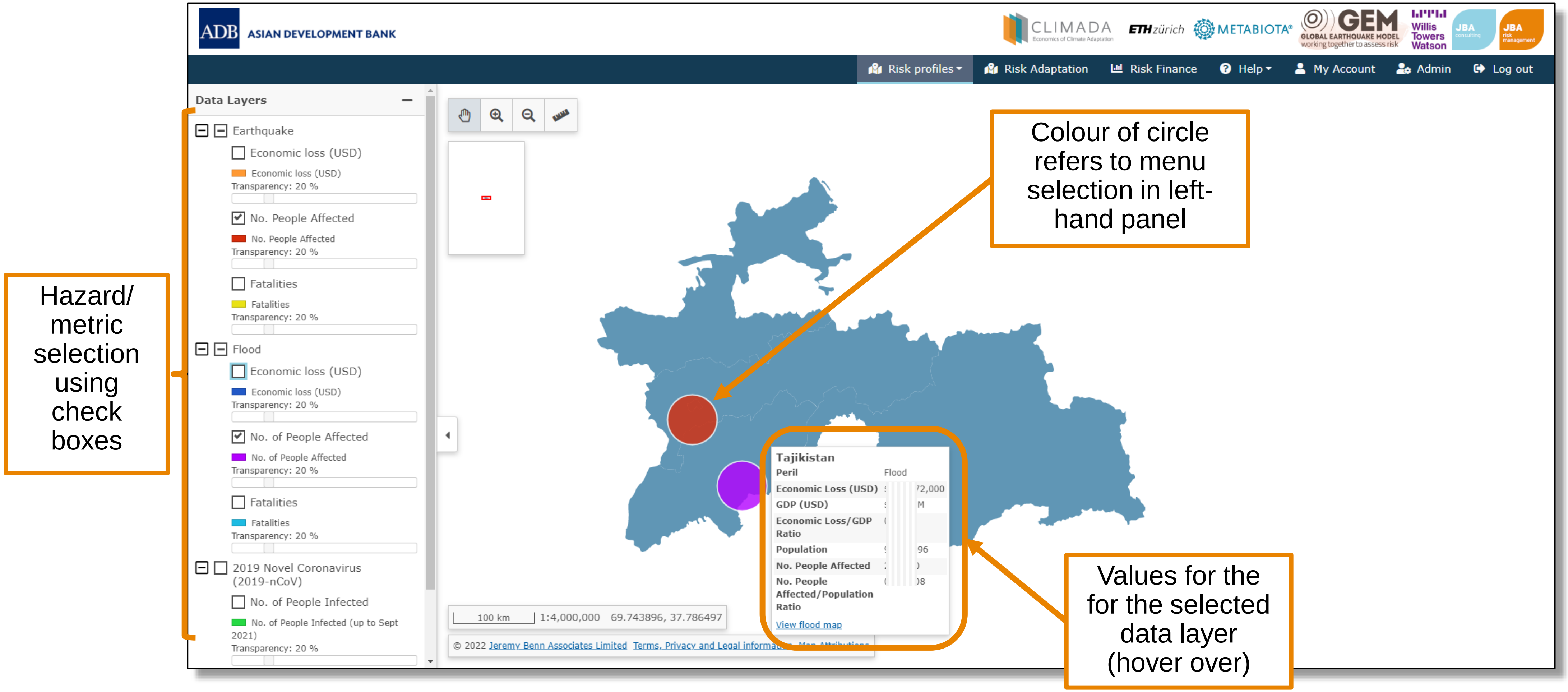
- As a supplement to the probabilistic model outputs, and to help better understand the level of risk from extreme events, the deterministic section displays impact values (damage, fatalities and people affected) based on analysis of a specific simulated event for each country

- Displayed events represent the probability of occurrence of 0.5%, or a return period of 1-in-200-years

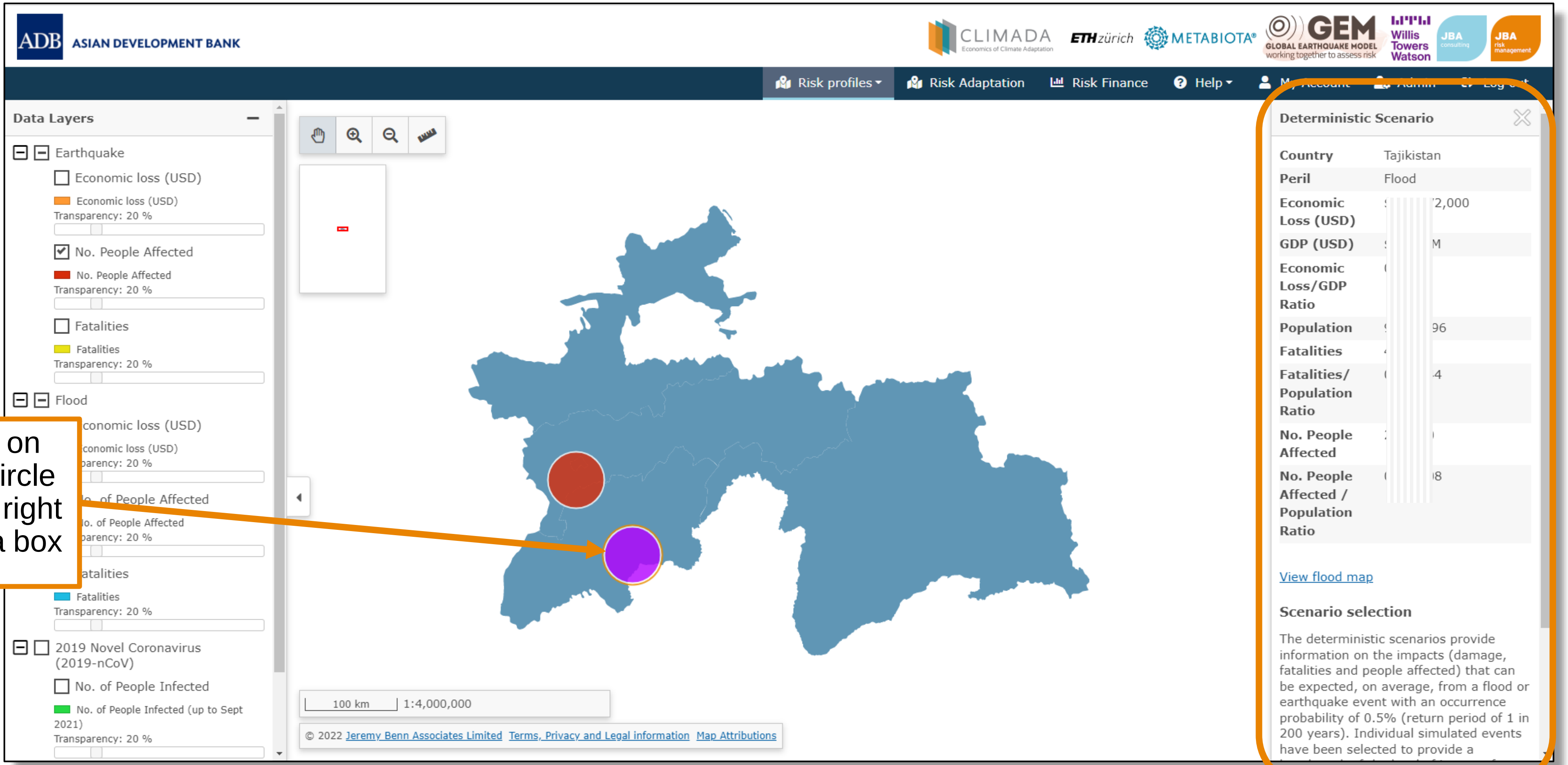
- The intention is to illustrate potential impacts for an event of this magnitude, to inform planning for a plausible, extreme event. It is important to note there is a range of uncertainty around these values that cannot be represented by an individual event analysis

- More information is available in the Risk Modelling Technical Note

5. Risk Profiles - Deterministic Scenarios



5. Risk Profiles - Deterministic Scenarios



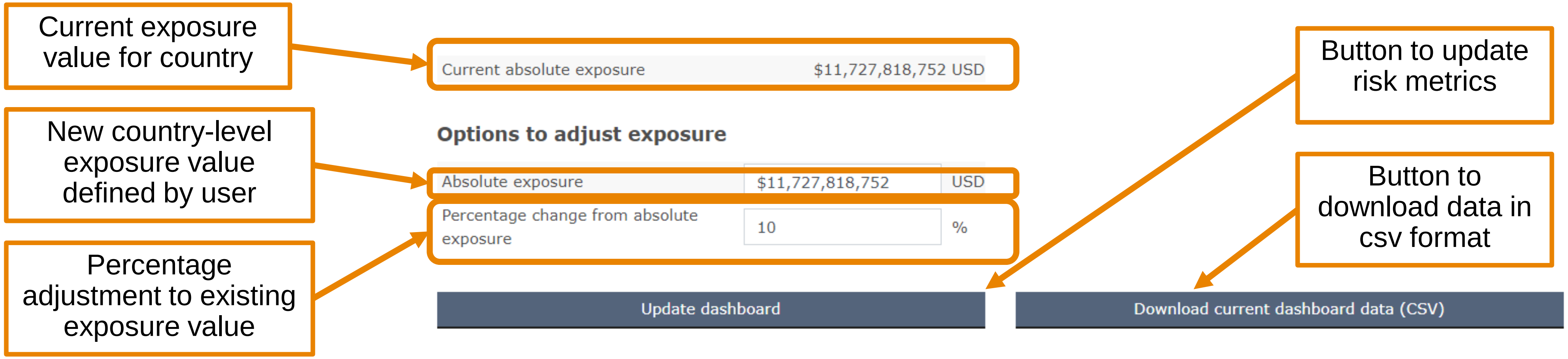
Clicking on country circle brings up right hand data box

Data box containing more country risk information

DISCLAIMER: Image shown is indicative of the display. When accessing the interface, users will be presented a display of their own country of interest.

6. Risk Profiles - Exposure Risk Calculator

- Based on flood and earthquake probabilistic model outputs
- Allows an alternative value of country level exposure to be applied to the risk metrics (Average Annual Loss, Aggregate and Exceedance Probabilities) for flood and earthquake individually or combined
- Current and updated values are displayed side by side and downloadable in csv format



6. Risk Profiles - Exposure Risk Calculator

Calculator Outputs

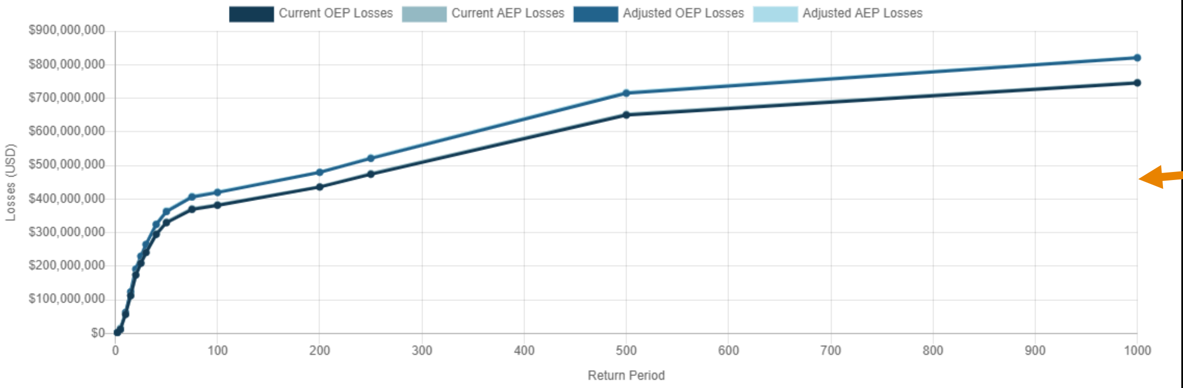
Current country Average Annual Loss

Current Occurrence Exceedance Probability (OEP) – the modelled value of loss that would be incurred from the single largest event at the given return period

Current Aggregate Exceedance Probability (AEP) – the modelled value of loss that would be incurred from the whole year at the given return period

Current Average Annual Loss (USD)	$23,946,032	Adjusted Average Annual Loss (USD)	$26,340,636

Return Period	Current OEP Losses	Current AEP Losses	Adjusted OEP Losses	Adjusted AEP Losses
2	$2,686,777	$3,692,303	$2,955,455	$4,061,534
5	$12,020,962	$15,263,674	$13,223,058	$16,790,042
10	$56,647,659	$57,405,859	$62,312,425	$63,146,445
15	$112,305,710	$113,085,416	$123,536,281	$124,393,958
20	$173,807,660	$175,602,852	$191,188,426	$193,163,137
25	$208,697,916	$210,117,535	$229,567,707	$231,129,289
30	$240,717,707	$241,405,587	$264,789,478	$265,546,146
40	$294,873,082	$296,337,817	$324,360,390	$325,971,599
50	$329,524,793	$332,275,436	$362,477,273	$365,502,979
75	$368,98[illegible],648	$371,850,216	$405,885,313	$409,035,237
100	$381,239,608	$383,556,957	$419,363,569	$421,912,653
200	$435,573,271	$436,771,532	$479,130,598	$480,448,686
250	$473,432,470	$476,348,921	$520,775,717	$523,983,813
500	$649,672,819	$652,591,439	$714,640,101	$717,850,583
1000	$745,422,065	$747,330,255	$819,964,271	$822,063,280



Country Average Annual Loss calculated using an updated exposure value

OEP calculated using an updated exposure value

AEP calculated using an updated exposure value

Graph of Current and Adjusted AEPs and OEPs

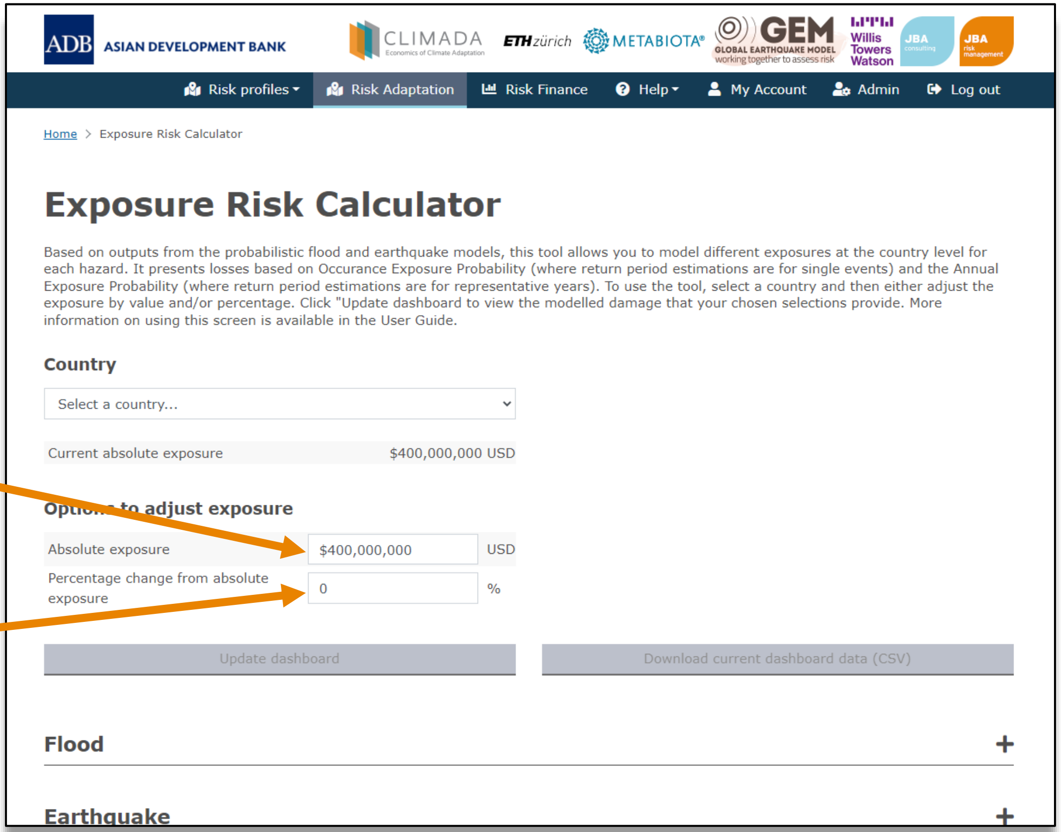
6. Risk Profiles - Exposure Risk Calculator

Example use of the Exposure Risk Calculator for calculating future risk

Say that the chosen country has an absolute exposure value of $400bn, the user can generate an estimate of future Average Annual Loss and Aggregate Exceedance Probability based on a future exposure projection that might account for economic and population growth. This can be done in two ways:

1. If the absolute future exposure value is known, this can be entered, e.g. $440bn
2. If the user has a percentage increase in exposure, this can be entered in the second box, e.g. +10%

Multiple estimates can be made to assess the range of potential outcomes.

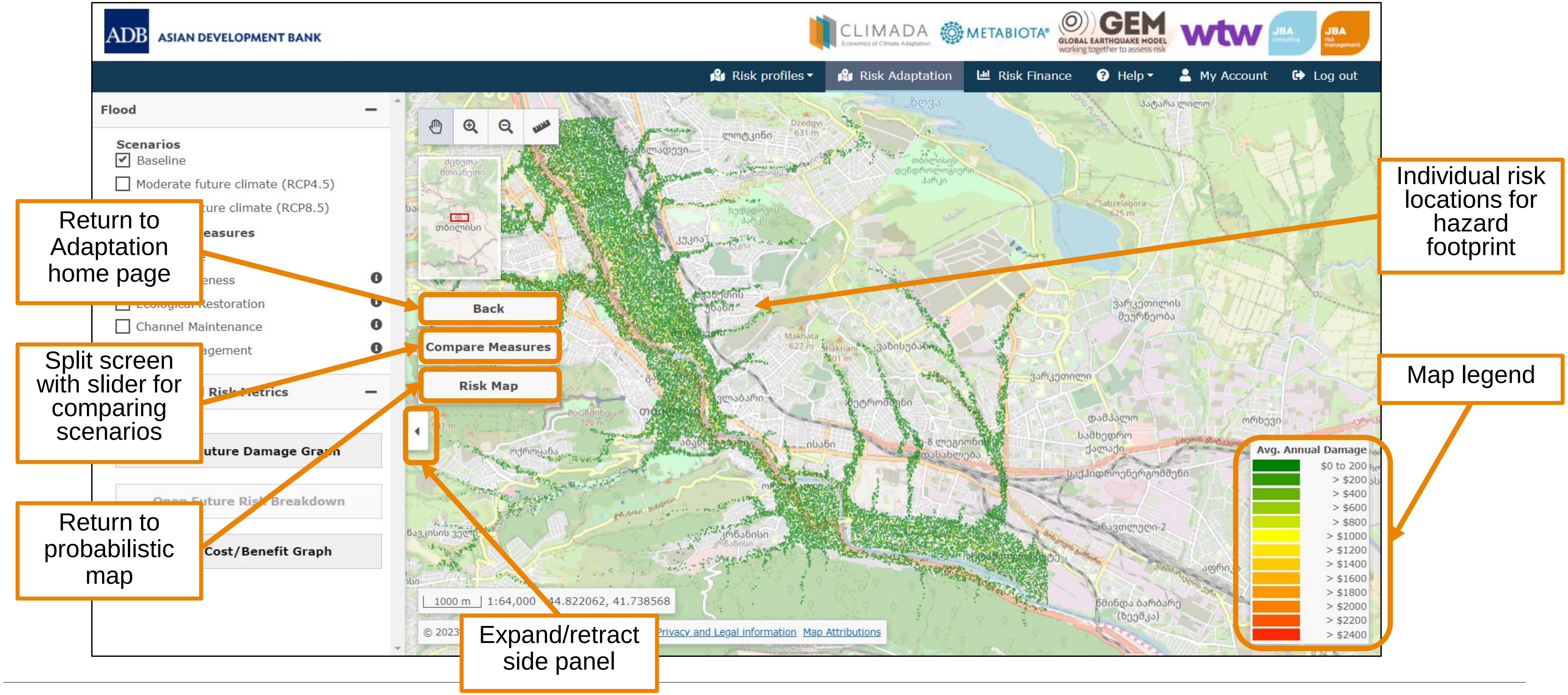


7. Risk Adaptation

- The adaptation scenarios are designed to inform on the potential costs and benefits of implementing different adaptation measures
- The same flood and earthquake modeling in the probabilistic section was input into the CLIMADA modeling framework to generate estimates of cost and benefit for the current (baseline) climate, two future climate scenarios (one moderate and one severe) and one economic growth scenario.
- Only the larger cities were modelled, to account for the large proportion of people, livelihoods and assets at risk. A high level of uncertainty would otherwise have been associated with country-level modeling. The largest city in each CAREC member state was selected. Different cities were selected within the same member state where appropriate to the flood and/or earthquake risk profile.
- These scenarios can inform decision-making on upfront investment in risk reduction measures by estimating future risk averted and comparing them to the cost of the measure itself.
- A folder containing all the data needed to rerun the scenarios in CLIMADA can be downloaded from the Adaptation entry screen. More information is available in the Risk Modelling Technical Note.

7. Risk Adaptation

City Risk Map



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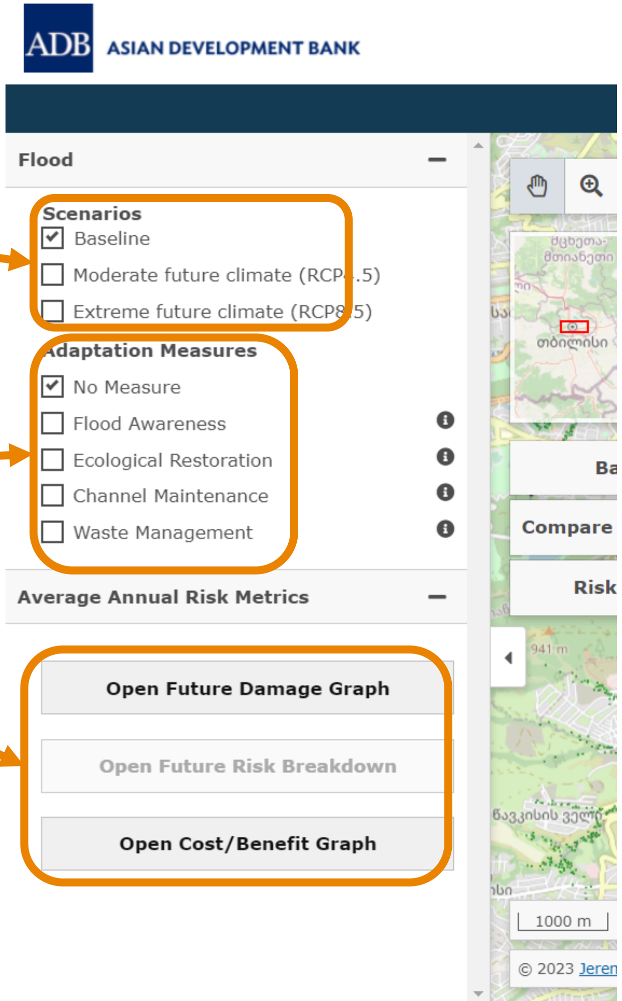
7. Risk Adaptation

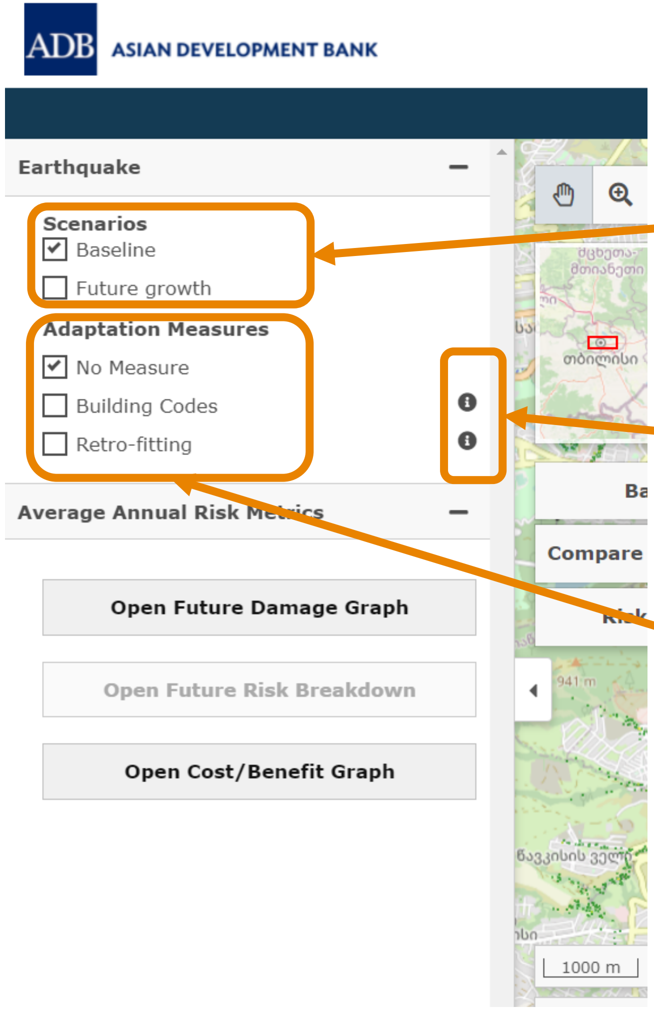
City Risk Map – menu options

Climate scenario selection

Flood adaptation measures selection

Cost/benefit visualisations





Population/ economic scenario selection

Information on adaptation measures

Earthquake adaptation measures selection

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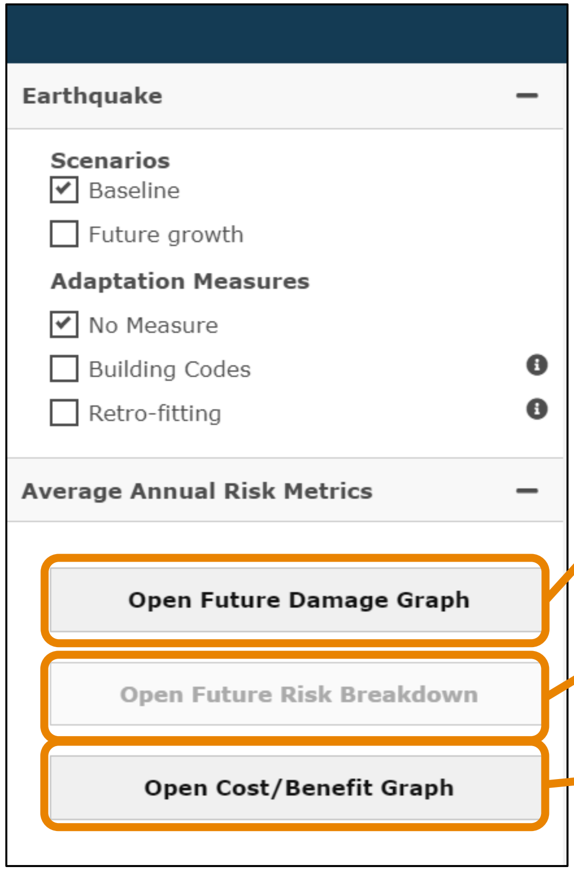
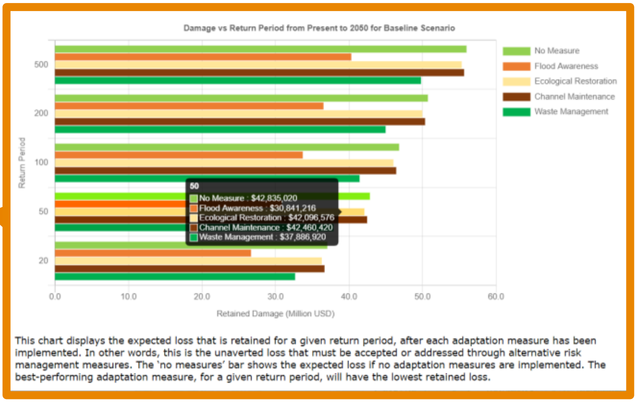
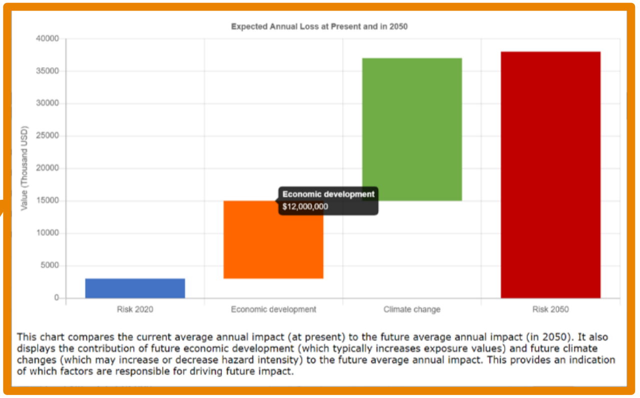
7. Risk Adaptation

Adaptation Plots

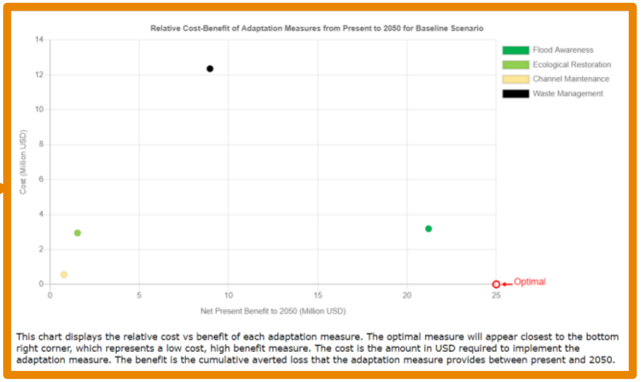




Retained Loss - shows retained loss ($) for all adaptation measures for different return period events



Future Risk Breakdown – shows how the climate and economic growth components relate current loss to future (2050) loss



Cost/Benefit Graph – shows how cost and benefit are related for each adaptation measures – bottom right is optimum of cost/benefit

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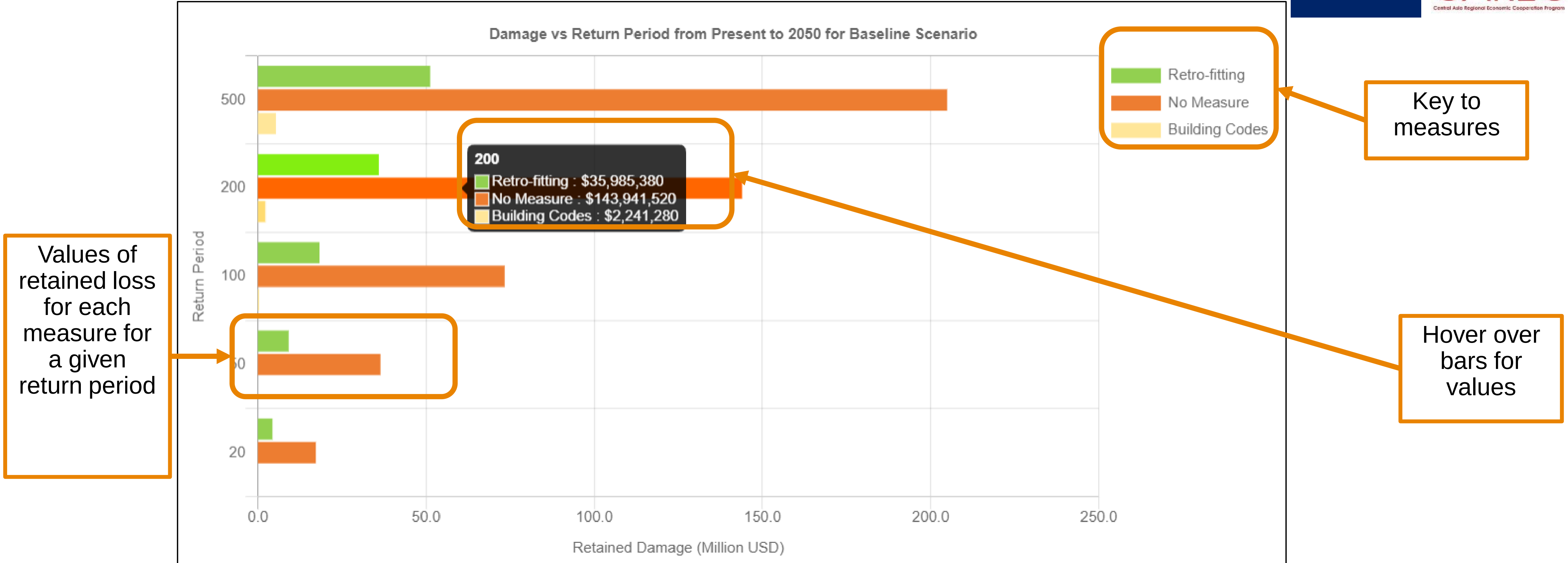
7. Risk Adaptation

Future Loss Graph



This chart displays the expected loss that is retained for a given return period, after each adaptation measure has been implemented. In other words, this is the unaverted loss that must be accepted or addressed through alternative risk management measures. The 'no measures' bar shows the expected loss if no adaptation measures are implemented. The best-performing adaptation measure, for a given return period, will have the lowest retained loss.

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7. Risk Adaptation

Future Risk Breakdown

Values of annual loss for baseline scenario and contributions to future risk estimate

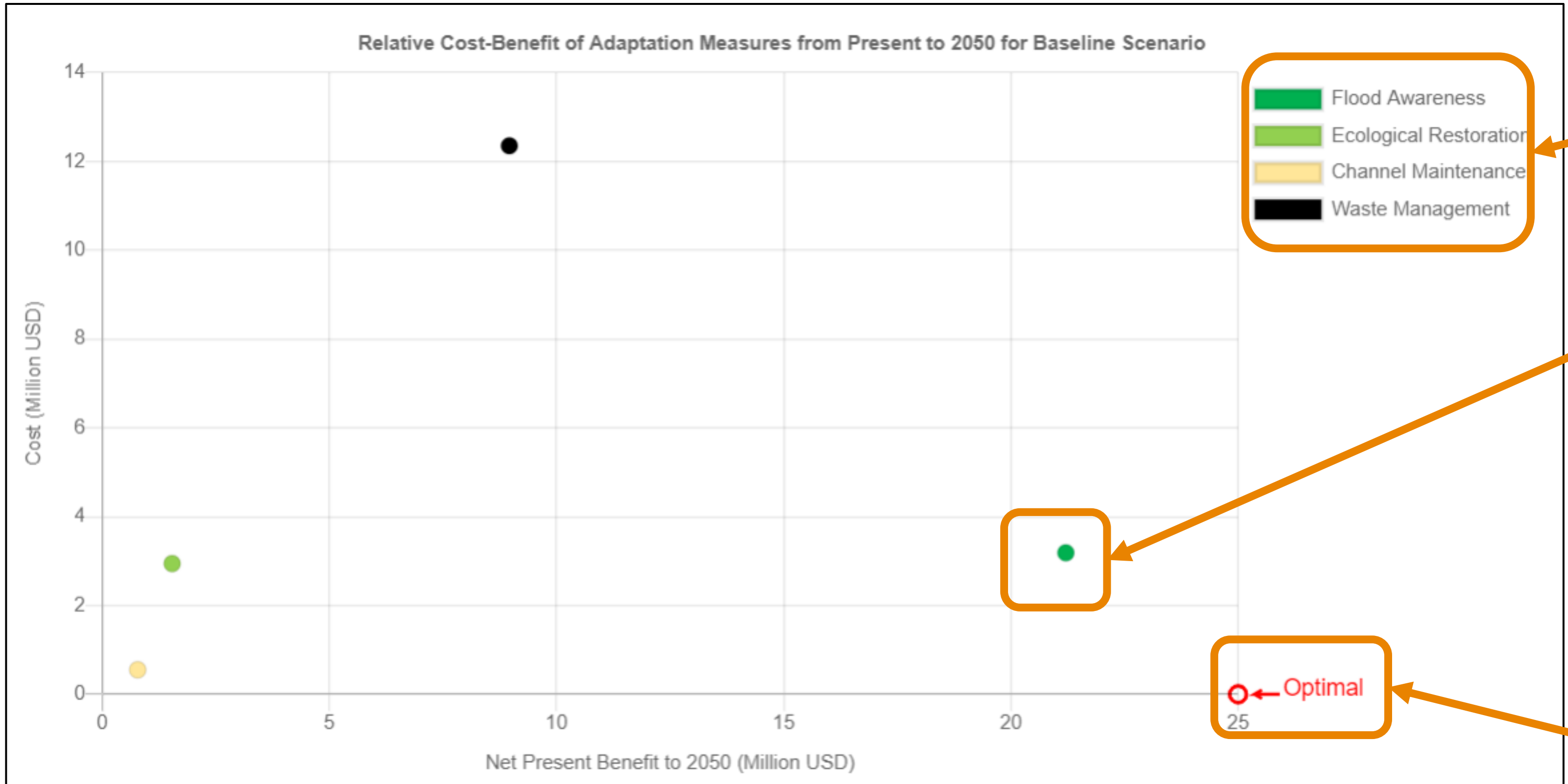
This chart compares the current average annual impact (at present) to the future average annual impact (in 2050). It also displays the contribution of future economic development (which typically increases exposure values) and future climate changes (which may increase or decrease hazard intensity) to the future average annual impact. This provides an indication of which factors are responsible for driving future impact.

Hover over bars for values

7. Risk Adaptation

Cost / Benefit Graph

Costs and benefits for each adaptation measure for the given scenario. Bottom right hand corner is optimal combination of low cost and high benefit



This chart displays the relative cost vs benefit of each adaptation measure. The optimal measure will appear closest to the bottom right corner, which represents a low cost, high benefit measure. The cost is the amount in USD required to implement the adaptation measure. The benefit is the cumulative averted loss that the adaptation measure provides between present and 2050.

Key to measures

Points represent cost-benefit of each adaptation measure

Optimal cost/benefit to the bottom right of the plot

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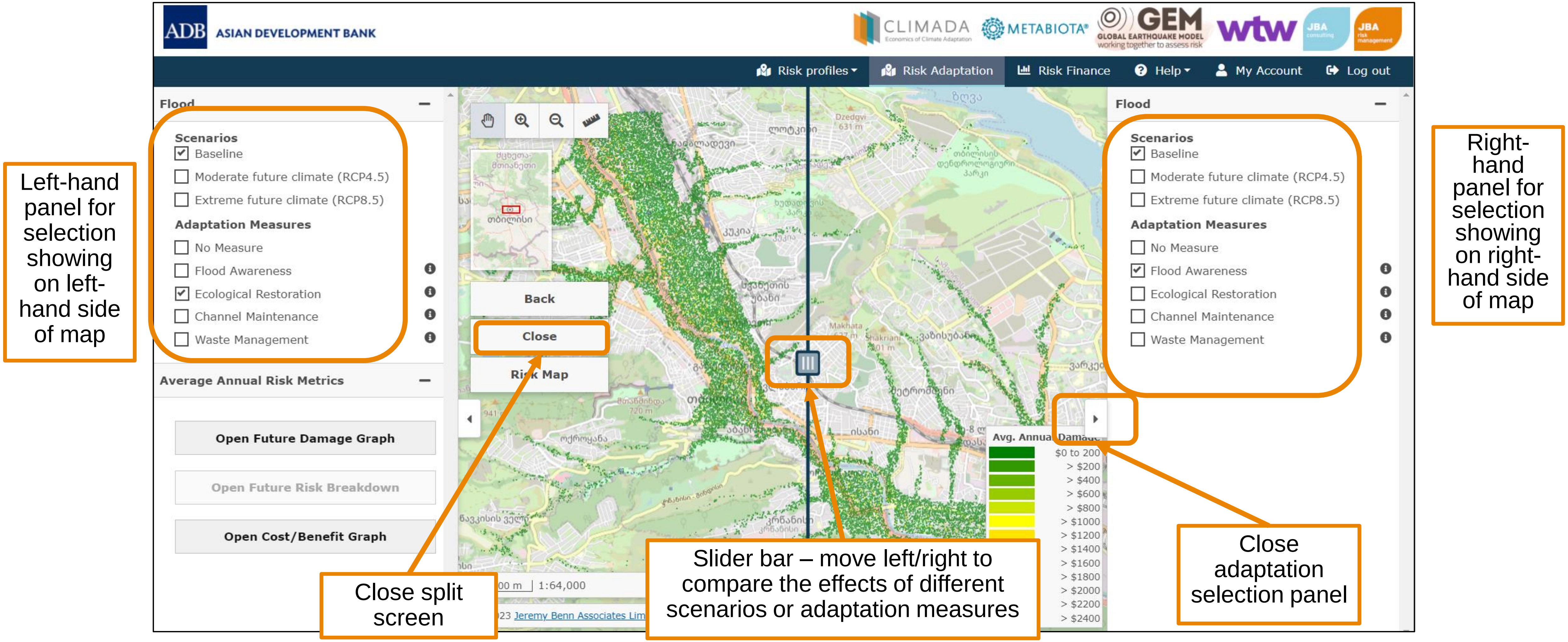
7. Risk Adaptation

Comparison Slider



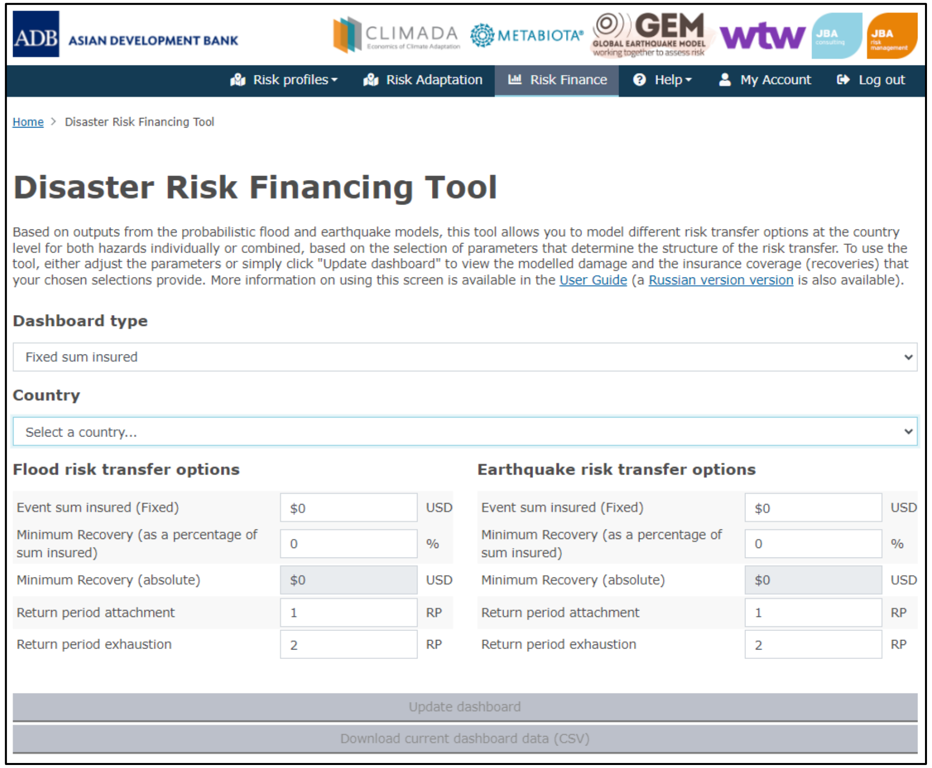
8. Risk Finance

- Allows different parametric insurance options at a country level for flood and earthquake individually or combined

- Dashboard type allows to fix the sum insured, or fix the premium

- Based on the selection of fundamental parameters that determine the structure of the risk transfer

- Selections include:
  - Event sum insured
  - Minimum recovery (minimum pay-out)
  - Return period attachment (start of cover)
  - Return period exhaustion (end of cover)
  - Number of reinstatements (number of pay-outs)



- This builds familiarity with the key parameters for parametric insurance and allows testing to understand how premium prices may respond to different levels of cover, building on the probabilistic section

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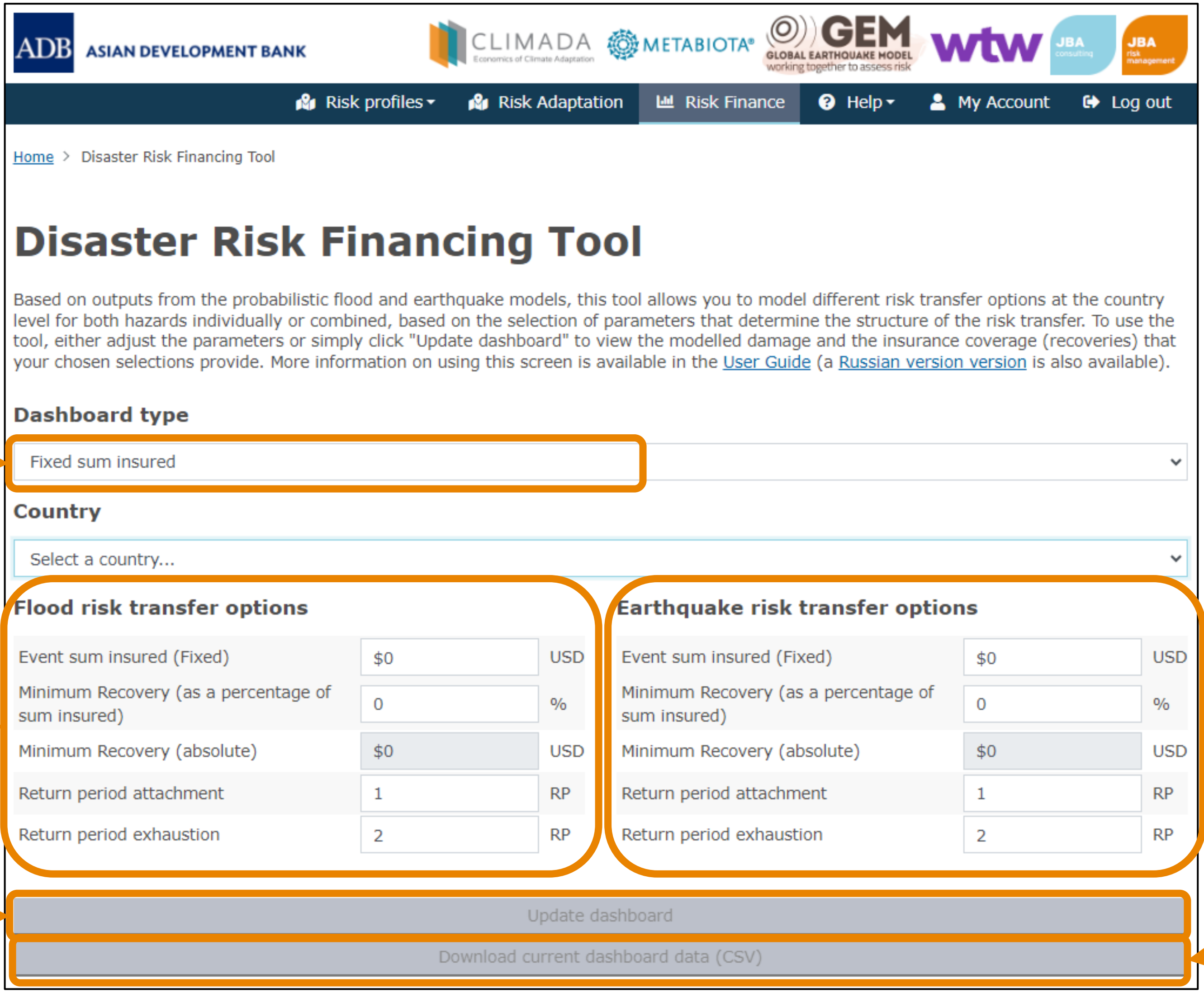
8. Risk Finance



Select dashboard type

Flood risk transfer parameters

Update results

Earthquake risk transfer parameters

Download results in csv format

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8. Risk Finance

Example 1 - Use of the ‘Fixed sum insured’ dashboard for estimating parametric insurance

Let’s say that the average annual loss of the country of interest is $75m for a specific hazard, the estimated losses for a 1 in 10-year event are $200m and $750m for a 1 in 200-year event (these numbers can be found in the Probabilistic Modeling):

- If you wish to cover losses up to the 1 in 200-year level, then **Event Sum Insured** should be set to $750m
- If it is expected that half of losses from frequent events (e.g. 1 in 10-years) are to be covered by insurance, then the **Minimum Recovery** could be set to this level (e.g. $100m)
- Given we have set the Minimum Recovery at the 1 in 10-year level, the **Return Period Attachment** should be set to 10 years
- If we want to cover some of the losses above the Event Sum Insured, then the Return Period Exhaustion could be set higher, e.g. 500 years
- If we only expect the scheme to pay once per policy, then **Number of Reinstatements** is 1

8. Risk Finance

Example 1 - Use of the 'Fixed sum insured' dashboard for estimating parametric insurance

The results of our example are:

- Average Annual Premium of $50m (against an average annual loss of $75m)
- The cover would pay out between $150m and $750m on a linear scale between a 1 in 10-year event and a 1 in 500-year event, then payments are capped at that level
- In this example, results show that the event losses almost exactly match the cover up to 1 in 200 years

If the Average annual premium is deemed too high, then a cover starting at the 1 in 25-year level ($400m) would have an annual premium of $25m.

Alternative risk financing options could then be considered for the remaining gap.

8. Risk Finance

Dashboard Outputs

Average Annual Premium and Average Annual Loss for the selected parameters

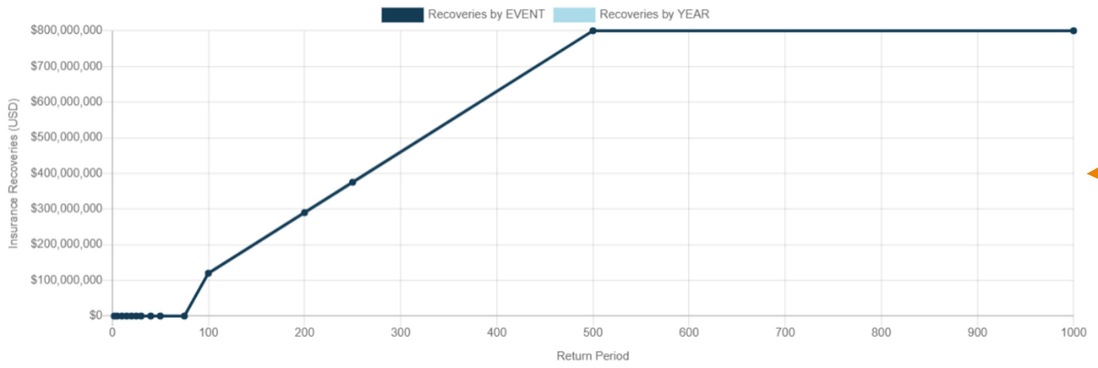
Occurrence Exceedance Probability (OEP) – the modelled value of loss that would be incurred from the single largest event at the given return period

Aggregate Exceedance Probability (AEP) – the modelled value of loss that would be incurred from the whole year at the given return period

Combined

Average Annual Premium (USD)	$5,260,100
Average Annual Loss (USD)	$205,853,100

Return Period	Economic loss (OEP)	Economic loss (AEP)	Recoveries by EVENT	Recoveries by YEAR
2	$60,362,338	$60,880,200	$0	$0
5	$261,507,070	$261,796,342	$0	$0
10	$511,792,652	$515,108,198	$0	$0
15	$789,077,136	$793,800,143	$0	$0
20	$1,017,383,513	$1,028,243,540	$0	$0
25	$1,215,231,856	$1,241,234,730	$0	[illegible]
30	$1,386,126,970	$1,397,209,253	$0	$0
40	$1,685,994,746	$1,688,325,101	$0	$0
50	$1,896,451,827	$1,896,509,535	$0	$0
75	$2,407,7[illegible],191	$2,417,765,776	$0	$0
100	$[illegible],812,235,695	$2,840,051,882	$120,000,000	$120,000,000
200	$3,968,899,572	$4,002,861,896	$290,000,000	$290,000,000
250	$4,334,779,837	$4,507,758,642	$375,000,000	$375,000,000
500	$6,087,639,497	$6,191,711,186	$800,000,000	$800,000,000
1000	$10,524,900,988	$10,524,924,626	$800,000,000	$800,000,000



Recoveries by **event** – the cover provided by the parametric scheme for an event of given return period

Recoveries by **year** – the cover provided by the parametric scheme for an event of given return period

Graph of event and year recoveries against return period

DISCLAIMER: Image shown is indicative of the display. When accessing the interface, users will be presented a display of their own country of interest.

8. Risk Finance

Example 2 - Use of the ‘Fixed premium’ dashboard for estimating parametric insurance

Let’s say that the average annual loss of the country of interest is $75m for a specific hazard, the estimated losses for a 1 in 10-year event are $200m and $750m for a 1 in 200-year event (these numbers can be found in the Probabilistic Modeling):

- If you wish to fix your premium at a known level, then **Average annual premium** should be set to $5m
- If it is expected that half of losses from frequent events (e.g. 1 in 10-years) are to be covered by insurance, then the **Minimum Recovery** could be set to this level (e.g. 50%)
- Given we have set the Minimum Recovery at the 1 in 10-year level, the **Return Period Attachment** should be set to 10 years
- If we want to cover some of the losses above the Event Sum Insured, then the Return Period Exhaustion could be set higher, e.g. 500 years
- If we only expect the scheme to pay once per policy, then **Number of Reinstatements** is 1

8. Risk Finance

Example 2 - Use of the ‘Fixed premium’ dashboard for estimating parametric insurance

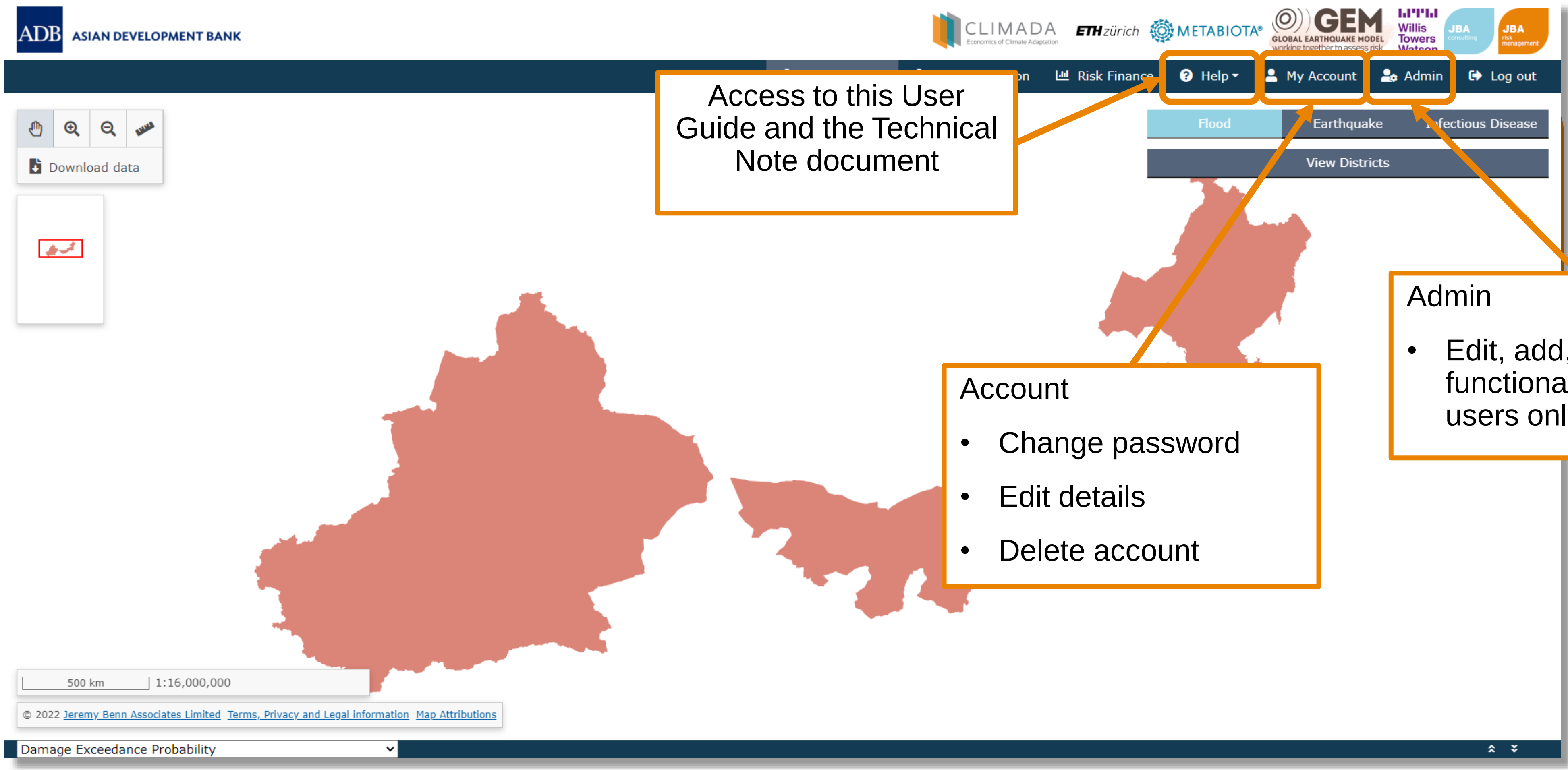
The results of our example are:

- Event Sum Insured of $121m (against an average annual loss of $75m)
- The cover would pay out between $60m and $120m on a linear scale between a 1 in 10-year event and a 1 in 500-year event, then payments are capped at that level
- In this example, results show that the event losses almost exactly match the cover up to 1 in 200 years

If the Event sum insured is deemed too high, then a lower Annual average premium of $2m would provide a $50m maximum of Event sum Insured

Alternative risk financing options could then be considered for the remaining gap.

9. DRMI Administration



Access to this User Guide and the Technical Note document

Account

- Change password
- Edit details
- Delete account

Admin

- Edit, add, delete user functionality for admin users only

DISCLAIMER: Image shown is indicative of the display. When accessing the interface, users will be presented a display of their own country of interest.