

The spreadsheet developed at Middlesex University's Flood Hazard Research Centre



To begin your analysis please complete all relevant white cells

A. Enter the number of future floods that you will analyse
Between 4 and 7 floods need to be entered

B. Enter the return
(e.g. starting at 5 years)
These must be between 1 and 100 years


C. The number and type of interventions that require analysis
Please enter a brief description of the intervention

D. Enter the discount rate
This should be between 0 and 10%

Interventions
NB: To enter a value in a cell, click on the cell and type the value

| |
|---------------------|
| 0 |
| 1 Closing road and |
| 2 Closing road and |
| 3 Closing gaps, enh |
| 4 |
| 5 |
| 6 |

* These estimates need to be the estimated total costs of all interventions considered



fhrc
Flood Hazard Research Centre

Lavara,
Greece

The “menu” of basic data inputs

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B. Enter the return
(e.g. starting at 5 years)
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C. The number and type of interventions that require analysis
Please enter a brief description of the intervention

D. Enter the discount rate
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Interventions
NB: To enter a value, click on the cell and type the value

| |
|---------------------|
| 0 |
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| 4 |
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The “menu” of basic data inputs

To begin your analysis please complete all relevant white cells

A. Enter the number of future floods that you will analyse

Between 4 and 7 floods need to be entered

Possible interventions and their costs

| # | Description (e.g. Bank raising to 2m) NB: To examine combinations of interventions enter as one line | Estimated Capital costs (£ or selected currency)* | Estimated annual maintenance costs (£ or selected currency)* | Life of scheme (in years) (select from 25, 50, 75 or 100 years) | Approximate total discounted cost (£ or selected currency) |
|---|---|---|--|---|--|
| 0 | Current flood situation | 0 | 0 | 100 | 0 |
| 1 | Closing road and rail gaps | 300,000 | 3,000 | 100 | 385,966 |
| 2 | Closing road and rail gaps and enhanced bypass channel | 1,000,000 | 10,000 | 100 | 1,286,554 |
| 3 | Closing gaps, enhanced bypass channel and enhanced main embankments | 1,300,000 | 13,000 | 100 | 1,672,521 |
| 4 | | | | | |
| 5 | | | | | |
| 6 | | | | | |

* These estimates need to be the estimated total costs of all interventions considered

that require analysis (you may enter up to 6 interventions):

Please enter a brief description of the risk reducing interventions and their approximate estimated costs (in €):

D. Enter the discount rate to be applied:

 %

This should be entered as a % between 0 and 10% (with 0.5% increments)

The current flood situation: data inputs



The current flooding situation (i.e. no new interventions)

Users are required to complete the white cells in the tables below

Flood Hazard Research Cent

| Return period of the future flood (years) | Residential Damages | | | | Non-residential Damages | | | | Agricultural Losses | | | | Any other possible losses? | TOTAL | | | |
|---|--------------------------------------|---|------------------|-------------------|--|---|---|---------------|---------------------|---|---------------------------------|------------------|----------------------------|------------------|---------------------|---------------------|--|
| | Residential properties at risk (No.) | Mean depth of flooding inside properties (cm) | Damage per house | Total Damage | Non-Residential Properties at risk (No.) | Mean depth of flooding inside properties (cm) | MCM2013; p163 and Non-Residential Guidance Tab) | Damage per m2 | Total Damage | Type of Agriculture affected (select from list) | Agricultural losses per hectare | hectares flooded | | | Agricultural Losses | | |
| 2 | 20 | 40 | 24,334 | 436,683 | 5 | 40 | 200 | 390 | 390,004 | Extensive arable | 359 | 50 | 17,337 | | 306,623 | | |
| 7 | 250 | 100 | 28,351 | 7,237,861 | 40 | 100 | 200 | 703 | 5,620,806 | Extensive arable | 359 | 277 | 39,371 | | 12,358,039 | | |
| 8 | 300 | 120 | 30,083 | 9,024,318 | 40 | 120 | 200 | 801 | 6,404,210 | Extensive arable | 359 | 1200 | 430,438 | | 15,859,616 | | |
| 9 | 380 | 140 | 31,880 | 12,114,433 | 60 | 140 | 200 | 878 | 10,531,734 | Extensive arable | 359 | 1240 | 444,836 | | 23,031,125 | | |
| 10 | 380 | 160 | 33,566 | 12,755,212 | 60 | 160 | 200 | 964 | 11,571,049 | Extensive arable | 359 | 1380 | 495,061 | | 24,821,322 | | |
| TOTAL RESIDENTIAL DAMAGES | | | | 41,631,172 | TOTAL NON-RESIDENTIAL DAMAGES | | | | 34,517,864 | TOTAL AGRICULTURAL LOSSES | | | | 1,487,635 | TOTAL OTHER | TOTAL LOSSES | |
| | | | | | | | | | | | | | | | | 77,636,730 | |

Loss-probability calculation

| Return Period | Exceedance Probability | Damages | Internal probability | Mean Damage | Internal Damage | Cumulative annual damages | Discounted Annual average Damages |
|-----------------------------|------------------------|------------|----------------------|-------------|-----------------|---------------------------|-----------------------------------|
| 2 | 0.500 | 306,623 | | | | | |
| | | | 0.450 | 6,332,334 | 3,119,550 | 3,119,550 | 83,392,041 |
| 20 | 0.050 | 12,358,039 | | | | | |
| | | | 0.030 | 14,408,827 | 432,265 | 3,551,815 | 101,778,773 |
| 50 | 0.020 | 15,859,616 | | | | | |
| | | | 0.010 | 19,475,370 | 194,754 | 3,746,569 | 107,359,523 |
| 100 | 0.010 | 23,031,125 | | | | | |
| | | | 0.009 | 23,356,223 | 215,606 | 3,362,175 | 113,537,805 |
| 1000 | 0.001 | 24,821,322 | | | | | |
| TOTAL ANNUAL DAMAGES | | | | | | 3,362,175 | |

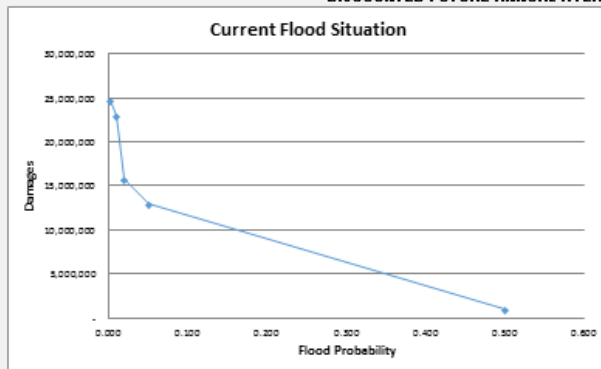
DISCOUNTED FUTURE ANNUAL AVERAGE DAMAGES: 113,537,805

Discounting

| | | |
|-----------------|-------|-------|
| Scheme Life | 100 | years |
| Discount rate | 3.5 | % |
| Discount factor | 28.66 | |

Intervention costs

| | |
|------------------------------------|--|
| Capital costs | |
| Annual Maintenance costs | |
| Total discounted maintenance costs | |
| Total | |



The current flood situation: data inputs



The current flooding situation (i.e. no new interventions)

Users are required to complete the white cells in the tables below

Floods

| Return period of the future flood (years) | Residential Damages | | | | Non-residential Damages | | | | | |
|---|--------------------------------------|---|------------------|-------------------|--|---|---|---------------|--------------|-------------------|
| | Residential properties at risk (No.) | Mean depth of flooding inside properties (cm) | Damage per house | Total Damage | Non-Residential properties at risk (No.) | Mean depth of flooding inside properties (cm) | Average sq. m. (see MCM2013; p163 and Non-Residential Guidance Tab) | Damage per m2 | Total Damage | |
| 2 | 20 | 40 | 24,934 | 498,688 | 5 | 40 | 200 | 390 | 390,004 | |
| 10 | 250 | 100 | 28,951 | 7,237,867 | 40 | 100 | 200 | 703 | 5,620,806 | |
| 50 | 300 | 120 | 30,083 | 9,024,918 | 40 | 120 | 200 | 801 | 6,404,210 | |
| 100 | 380 | 140 | 31,880 | 12,114,493 | 60 | 140 | 200 | 878 | 10,531,794 | |
| 1000 | 380 | 160 | 33,566 | 12,755,212 | 60 | 160 | 200 | 964 | 11,571,049 | |
| TOTAL RESIDENTIAL DAMAGES | | | | 41,631,172 | TOTAL NON-RESIDENTIAL DAMAGES | | | | | 34,517,864 |

Loss-probability calculation

| Return Period | Exceedance Probability | Damages | Interval probability | Mean Damage | Interval Damage | Cumulative annual damages | Discounted Annual average Damages |
|---|------------------------|------------|----------------------|-------------|-----------------|---------------------------|-----------------------------------|
| 2 | 0.500 | 906,629 | | | | | |
| | | | 0.450 | 6,332,334 | 3,119,550 | 3,119,550 | 89,392,041 |
| 20 | 0.050 | 12,958,039 | | | | | |
| | | | 0.030 | 14,408,827 | 432,265 | 3,551,815 | 101,778,773 |
| 50 | 0.020 | 15,859,616 | | | | | |
| | | | 0.010 | 19,475,370 | 194,754 | 3,746,569 | 107,359,523 |
| 100 | 0.010 | 23,031,125 | | | | | |
| | | | 0.009 | 23,956,223 | 215,606 | 3,962,175 | 113,537,805 |
| 1000 | 0.001 | 24,821,322 | | | | | |
| TOTAL ANNUAL DAMAGES | | | | | | 3,962,175 | |
| DISCOUNTED FUTURE ANNUAL AVERAGE DAMAGES | | | | | | | 113,537,805 |

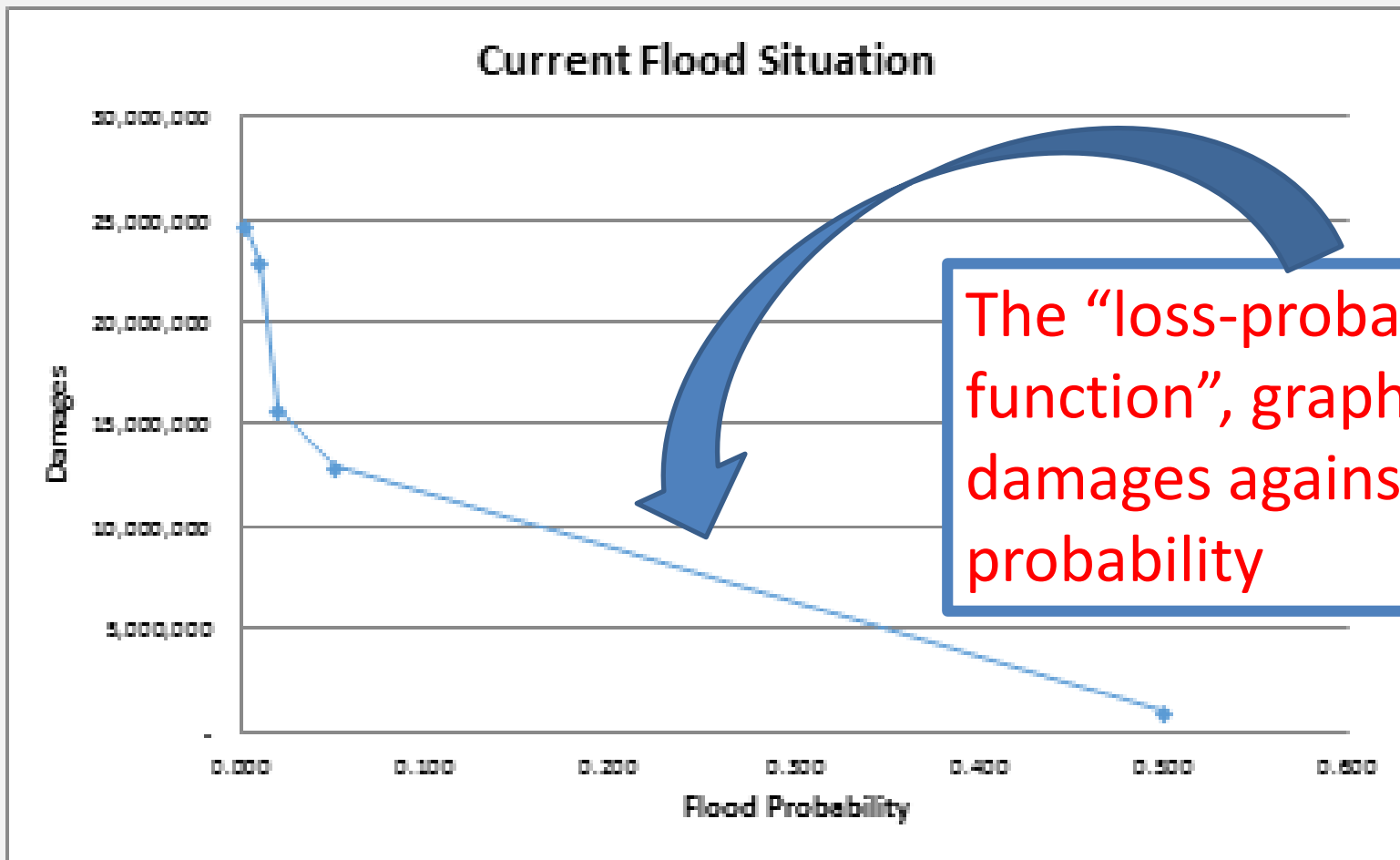
The current flood situation: the result

TOTAL ANNUAL DAMAGES

3,962,175

DISCOUNTED FUTURE ANNUAL AVERAGE DAMAGES

Current Flood Situation



The “loss-probability function”, graphing damages against flood probability

Intervention No. 2: data inputs

Agricultural land still at risk

fhrc Flood Hazard Research Centre

Intervention 2

Users are required to complete the white cells in the tables below

How to choose interventions
 Many different approaches are available for the reduction of flood risk, both structural (engineering) and non-structural. Within a spreadsheet system it is recommended that the first intervention analysed is quite minor in scope and scale, such as increased maintenance of the drainage system to reduce flood risk just a little for the properties likely to be affected. The second and subsequent interventions should be more ambitious, up to the point where the analyst thinks that the benefits are unlikely to be exceeded by the costs. This creates a "ladder" of interventions of increasing complexity and cost. This spreadsheet is designed to analyse...

| Return period of the event (years) | Residential Damages | | | | Non-residential Damages | | | | Agricultural Losses | | | | Any other possible losses | TOTAL | | |
|------------------------------------|--|---|------------------|--------------|--|---|---------------|--------------|---|----------------------------------|----------------------------|---------------------|--------------------------------|---------|---|---------|
| | Residential properties STILL at risk (No.) | Mean depth of flooding inside properties (cm) | Damage per house | Total Damage | Non-Residential Properties STILL at risk (No.) | Mean depth of flooding inside properties (cm) | Damage per m2 | Total Damage | Type of Agriculture affected (select from list) | Agriculture losses per hectare | Number of hectares flooded | Agricultural Losses | | | | |
| 2 | 0 | 0 | 2,381 | - | 0 | 0 | 35 | - | Extensive arable | 359 | 50 | 17,337 | - | 17,337 | | |
| 20 | 0 | 0 | 2,381 | - | 0 | 0 | 35 | - | Extensive arable | 359 | 160 | 57,398 | - | 57,398 | | |
| 50 | 0 | 0 | 2,381 | - | 0 | 0 | 35 | - | Extensive arable | 359 | 680 | 243,343 | - | 243,343 | | |
| 100 | 0 | 0 | 2,381 | - | 0 | 0 | 35 | - | Extensive arable | 359 | 700 | 251,118 | - | 251,118 | | |
| 1000 | 0 | 0 | 2,381 | - | 0 | 0 | 35 | - | Extensive arable | 359 | 882 | 316,409 | - | 316,409 | | |
| TOTAL RESIDENTIAL DAMAGES | | | | - | TOTAL NON-RESIDENTIAL DAMAGES | | | | - | TOTAL AGRICULTURAL LOSSES | | | | 886,805 | - | 886,805 |
| | | | | | | | | | | | | | TOTAL OTHER DTAL LOSSES | | | |

Loss-probability calculation

| Return Period | Annual Exceedance Probability | Damages | Interval Probability | Mean Damage | Interval Damage | Cumulative annual damages | Discounted Annual average Damages |
|---------------|-------------------------------|---------|----------------------|-------------|-----------------|---------------------------|-----------------------------------|
| 2 | 0.500 | 17,337 | 0.450 | 37,668 | 16,350 | 16,350 | 485,723 |
| 20 | 0.050 | 57,398 | | 150,671 | 4,520 | 21,471 | 615,243 |
| 50 | 0.020 | 243,343 | | 247,531 | 2,475 | 23,346 | 686,180 |
| 100 | 0.010 | 251,118 | | 283,763 | 2,554 | 26,500 | 759,362 |
| 1000 | 0.001 | 316,409 | | | | | |

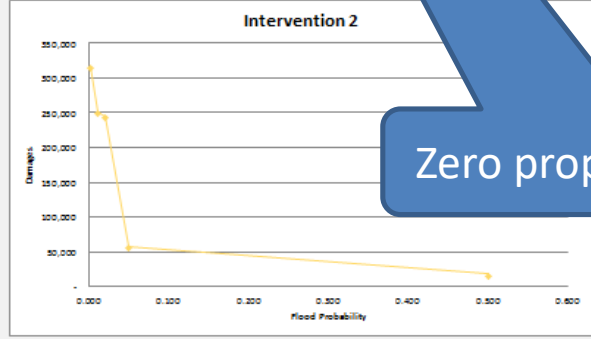
Discounting

| | |
|-----------------|-----------|
| Scheme Life | 100 years |
| Discount rate | 3.5 % |
| Discount factor | 28.66 |

Intervention costs

| | |
|------------------------------------|------------------|
| Capital costs | 1,000,000 |
| Annual Maintenance costs | 10,000 |
| Total discounted maintenance costs | 286,554 |
| Total | 1,286,554 |

DISCOUNTED FLOOD RISK AVERAGE DAMAGES 759,362

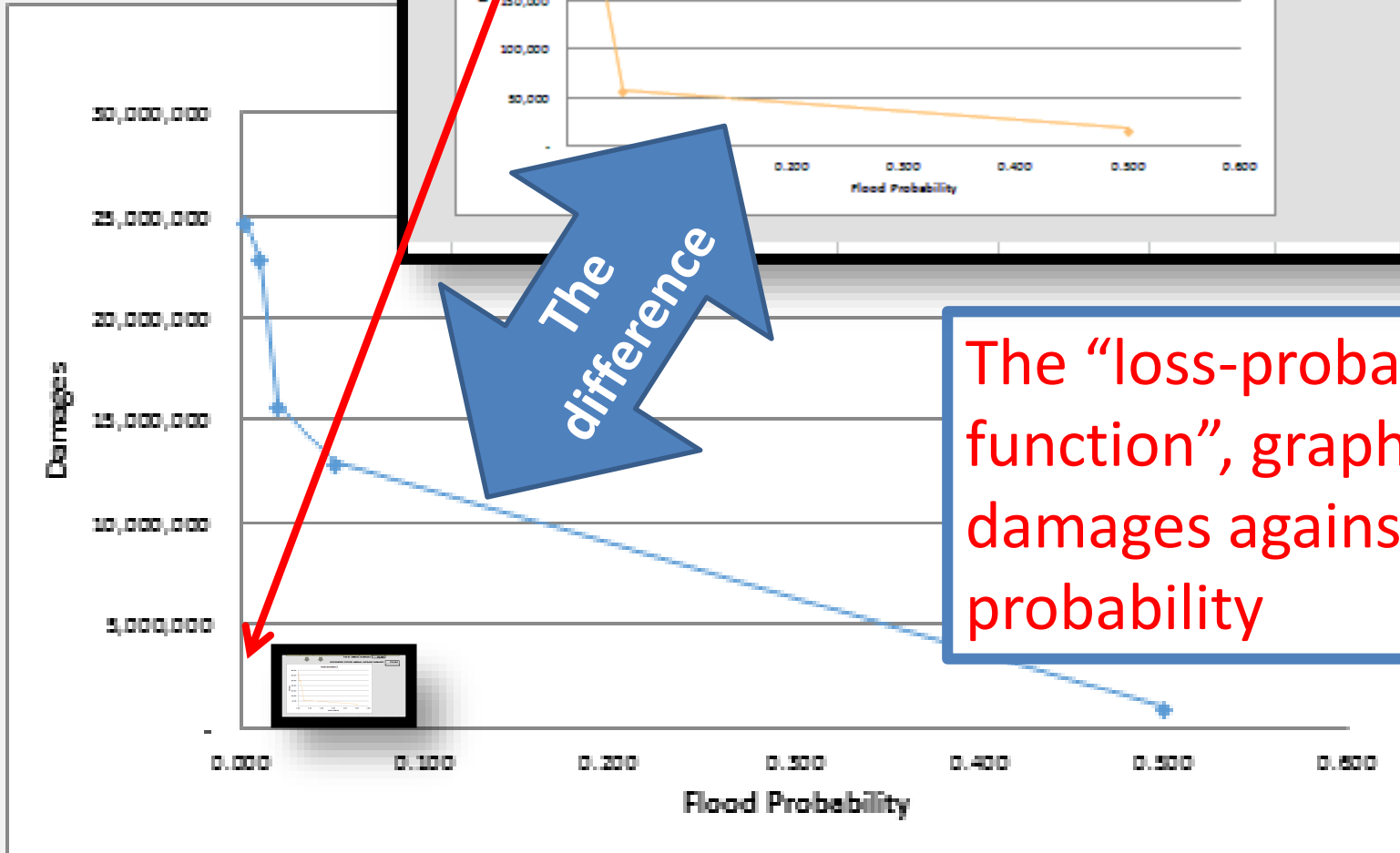
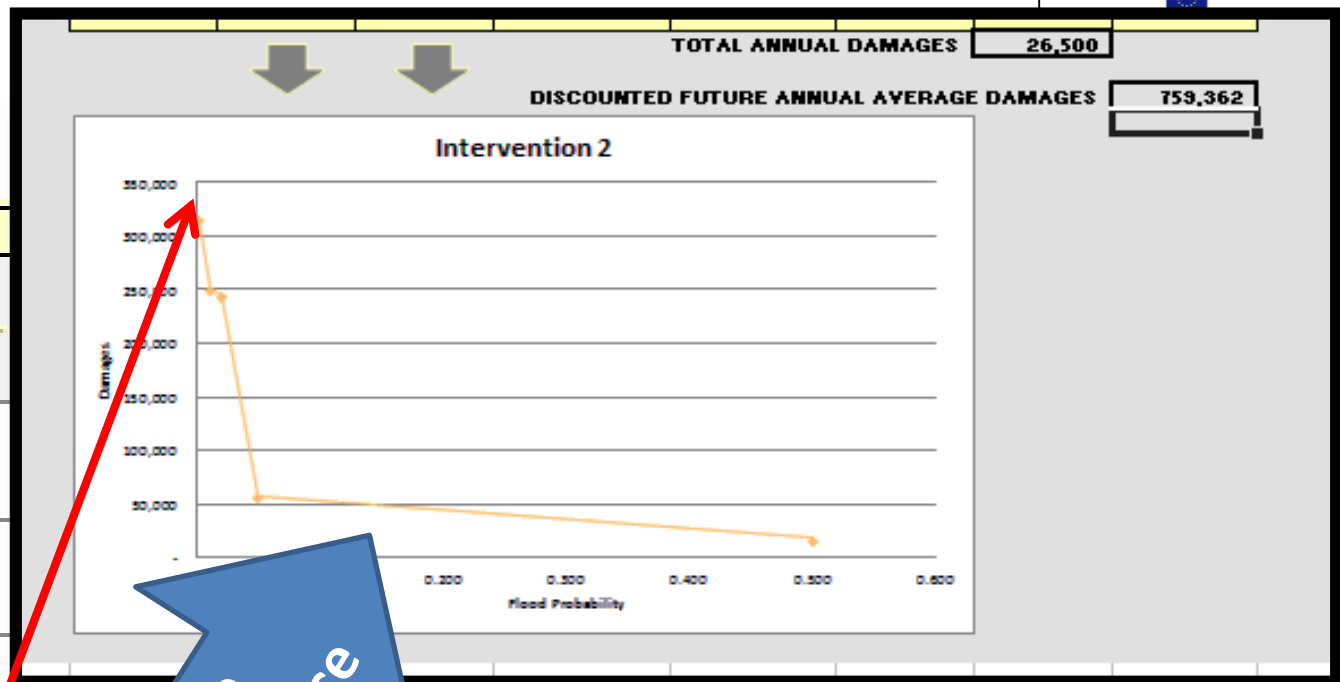


Zero properties now at risk





The two graphs



The difference

The "loss-probability function", graphing damages against flood probability

Summary results

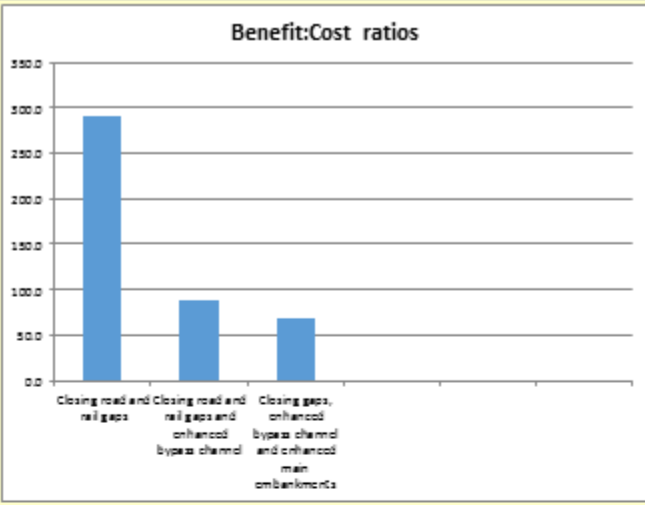
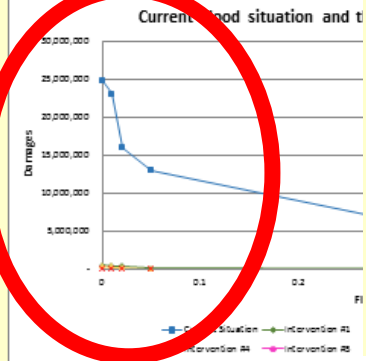
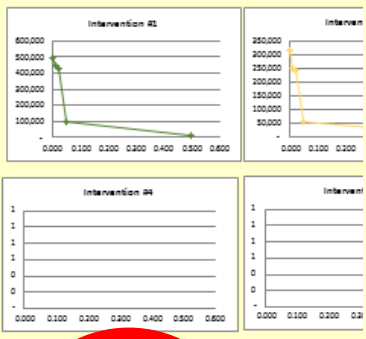
fhrcc
Flood Hazard
Research Centre

Summary

CURRENT FLOODING SITUATION
Discounted future potential losses 113,537,805

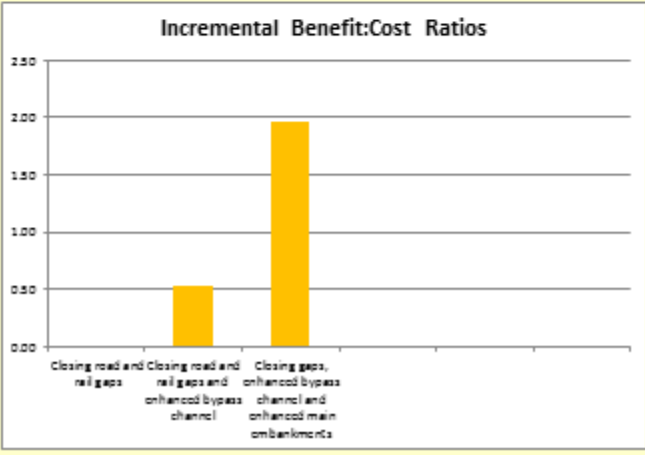
| INTERVENTIONS | | |
|--|------------------------------------|---------|
| Option(s) | discounted future potential losses | Benefit |
| #1 Closing road and rail gaps | 1,230,703 | 112,30 |
| #2 Closing road and rail gaps and enhanced bypass channel | 753,362 | 112,778 |
| #3 Closing gaps, enhanced bypass channel and enhanced main embankments | - | 113,537 |
| #4 | | |
| #5 | | |
| #6 | | |

*The current situation discounted losses minus the post-interven



The incremental benefit:cost ratio

This statistic is an important one when evaluating the standard of protection provided by a particular flood risk reduction intervention. It assesses the extra benefits over and above the previous intervention, by flood return period standard, in relation to the extra costs that this more ambitious intervention requires. So an incremental benefit: cost ratio above 1.0 indicates that that intervention is superior to the previous one analysed in that it's costs do not exceed the extra benefits obtained. Other things being equal the analyst should pursue those interventions where the incremental benefit: cost ratio exceeds 1.0.



ntios

standard of protection provided by a the extra benefits over and above dard, in relation to the extra costs that mental benefit: cost ratio above 1.0 ious one analysed in that it's costs do being equal the analyst should pursue st ratio exceeds 1.0.

ost Ratios

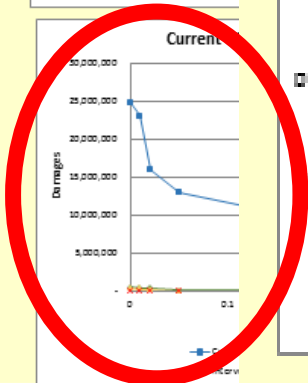
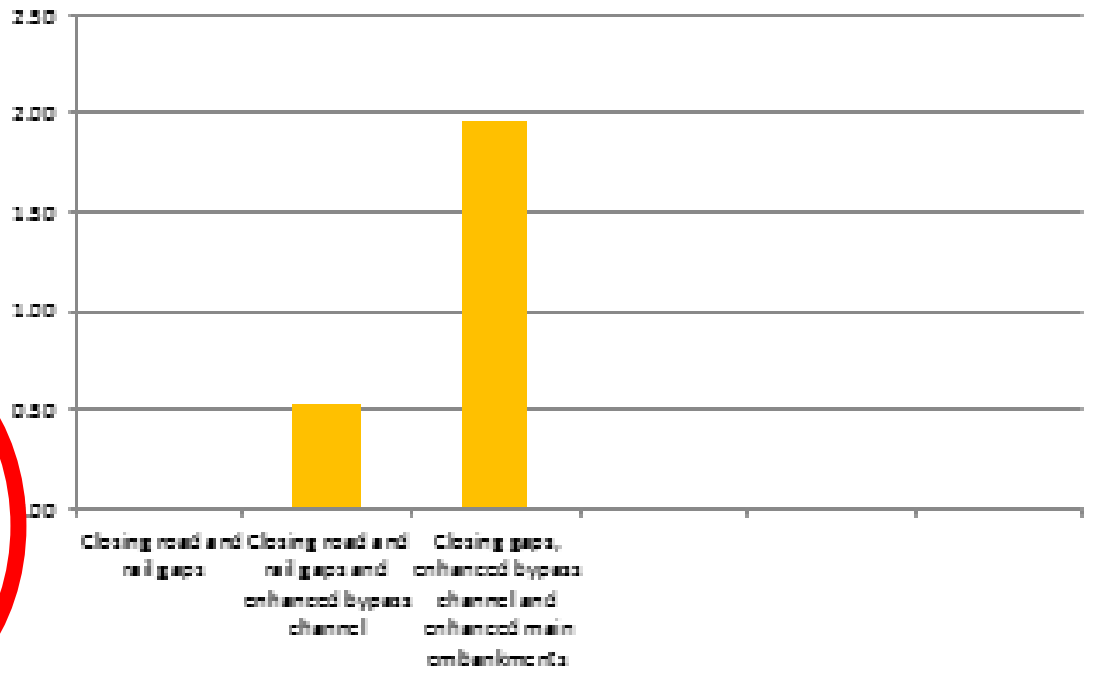
Summary results

| A | B |
|----|--|
| 1 | fhrc |
| 2 | Flood Hazard Research Centre |
| 3 | |
| 4 | |
| 5 | CURRENT FLOODING SITUATION |
| 6 | Discounted future potential losses |
| 7 | |
| 8 | |
| 9 | INTERVENTIONS |
| 10 | Option(s) |
| 11 | #1 Closing road and rail gaps |
| 12 | #2 Closing road and rail gaps and enhanced bypass channel |
| 13 | #3 Closing gaps, enhanced bypass channel and enhanced main embankments |
| 14 | #4 |
| 15 | #5 |
| 16 | #6 |
| 17 | *The current situation discounted to: |
| 18 | |
| 19 | |
| 20 | |
| 21 | |
| 22 | |
| 23 | |
| 24 | |
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| 65 | |
| 66 | |
| 67 | |

The incremental benefit:cost ratio

This statistic is an important one when evaluating the standard of protection provided by a particular flood risk reduction intervention. It assesses the extra benefits over and above the previous intervention, by flood return period standard, in relation to the extra costs that this more ambitious intervention requires. So an incremental benefit: cost ratio above 1.0 indicates that that intervention is superior to the previous one analysed in that it's costs do not exceed the extra benefits obtained. Other things being equal the analyst should pursue those interventions where the incremental benefit: cost ratio exceeds 1.0.

Incremental Benefit:Cost Ratios



Summary results: Sensitivity analysis

The "base case"

| # | Description (e.g. Bank raising to 2m) NB: To examine combinations of interventions enter as one line | Estimated Capital costs (£ or selected currency)* | Estimated annual maintenance costs (£ or selected currency)* | Life of scheme (in years) (select from 25, 50, 75 or 100 years) | Approximate total discounted cost (£ or selected currency) |
|---|---|---|--|---|--|
| 0 | Current flood situation | 0 | 0 | 100 | 0 |
| 1 | Closing road and rail gaps | 300,000 | 3,000 | 100 | 385,966 |
| 2 | Closing road and rail gaps and enhanced bypass channel | 1,000,000 | 10,000 | 100 | 1,286,554 |
| 3 | Closing gaps, enhanced bypass channel and enhanced main embankments | 1,300,000 | 13,000 | 100 | 1,672,521 |
| 4 | | | | | |
| 5 | | | | | |
| 6 | | | | | |

* These estimates need to be the estimated total costs of all interventions considered

The changed assumptions

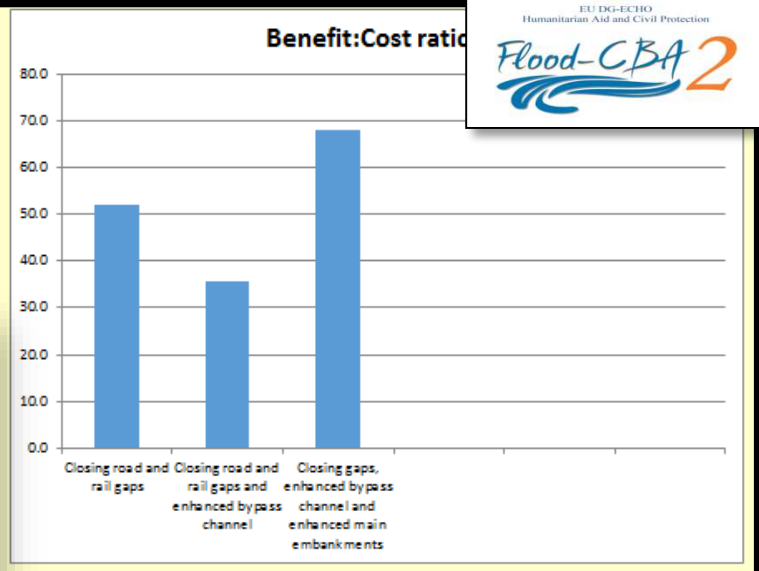
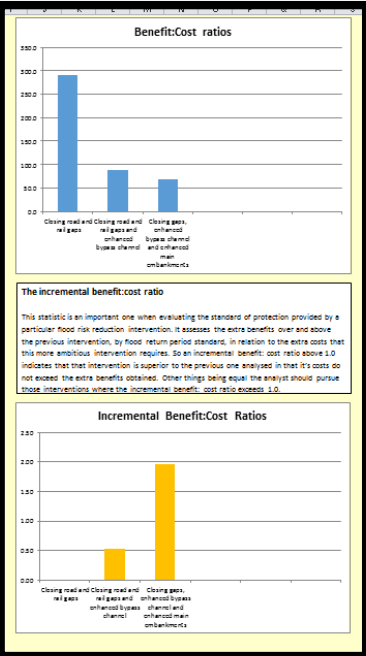
| # | Description (e.g. bank raising to 2m) NB: To examine combinations of interventions enter as one line | Estimated Capital costs (£ or selected currency)* | Estimated annual maintenance costs (£ or selected currency)* | Life of scheme (in years) (select from 25, 50, 75 or 100 years) | Approximate total discounted cost (£ or selected currency) |
|---|---|---|--|---|--|
| 0 | Current flood situation | 0 | 0 | 100 | 0 |
| 1 | Closing road and rail gaps | 850,000 | 75,000 | 25 | |
| 2 | Closing road and rail gaps and enhanced bypass channel | 1,000,000 | 75,000 | 100 | |
| 3 | Closing gaps, enhanced bypass channel and enhanced main embankments | 1,300,000 | 13,000 | 100 | |
| 4 | | | | | |
| 5 | | | | | |
| 6 | | | | | |

* These estimates need to be the estimated total costs of all interventions considered

Summary results: Sensitivity analysis

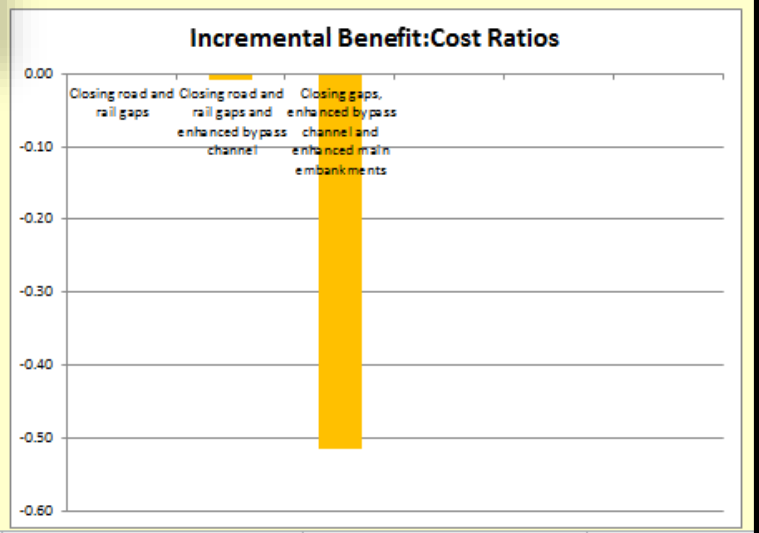
The "base case"

| # | Description (e.g. Bank raising to 2m) |
|---|---|
| 0 | Current flood situation |
| 1 | Closing road and rail gaps |
| 2 | Closing road and rail gaps and enhanced bypass channel |
| 3 | Closing gaps, enhanced bypass channel and enhanced main embankments |
| 4 | |
| 5 | |
| 6 | |



The incremental benefit:cost ratio

This statistic is an important one when evaluating the standard of protection provided by a particular flood risk reduction intervention. It assesses the extra benefits over and above the previous intervention, by flood return period standard, in relation to the extra costs that this more ambitious intervention requires. So an incremental benefit: cost ratio above 1.0 indicates that that intervention is superior to the previous one analysed in that it's costs do not exceed the extra benefits obtained. Other things being equal the analyst should pursue those interventions where the incremental benefit: cost ratio exceeds 1.0.



The changed assumptions

| # | Description (e.g. bank raising to 2m) |
|---|---|
| 0 | Current flood situation |
| 1 | Closing road and rail gaps |
| 2 | Closing road and rail gaps and enhanced bypass channel |
| 3 | Closing gaps, enhanced bypass channel and enhanced main embankments |
| 4 | |
| 5 | |
| 6 | |



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Flood-CBA 2