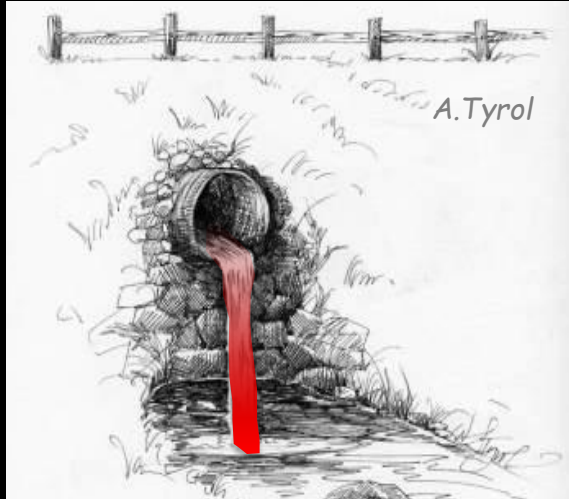


Death by a million pipes



an overview of culverts in Europe

Carlos Garcia de Leaniz &
AMBER Consortium

Rivers are meant to flow.....





**But
most
don't...**

99.9%



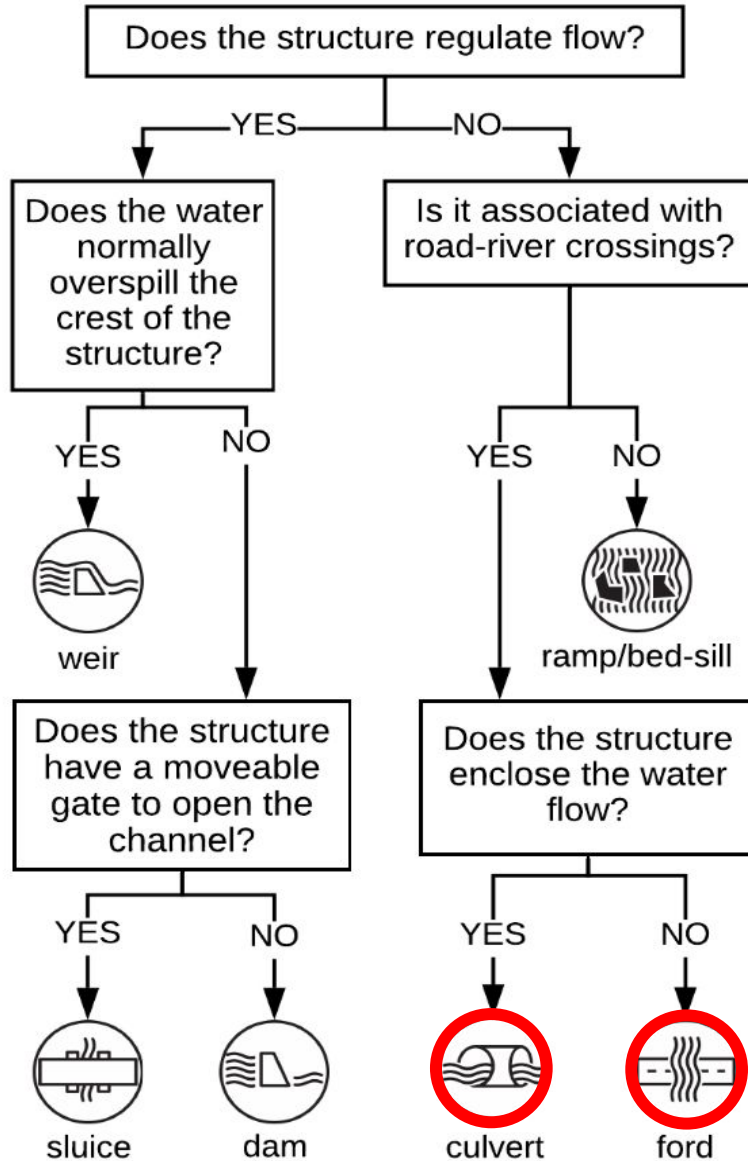
0.1%



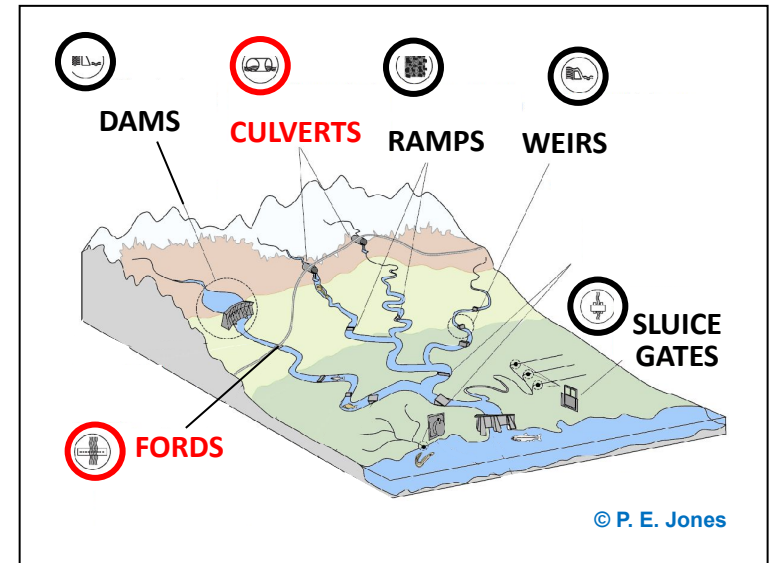
and large dams are not
the biggest problem....
it might be culverts

Barrier typology: what is a culvert

Ponding
Store water



Non-ponding
Don't store water



**Non-ponding structures at
river-road crossings**

How many
[hidden]

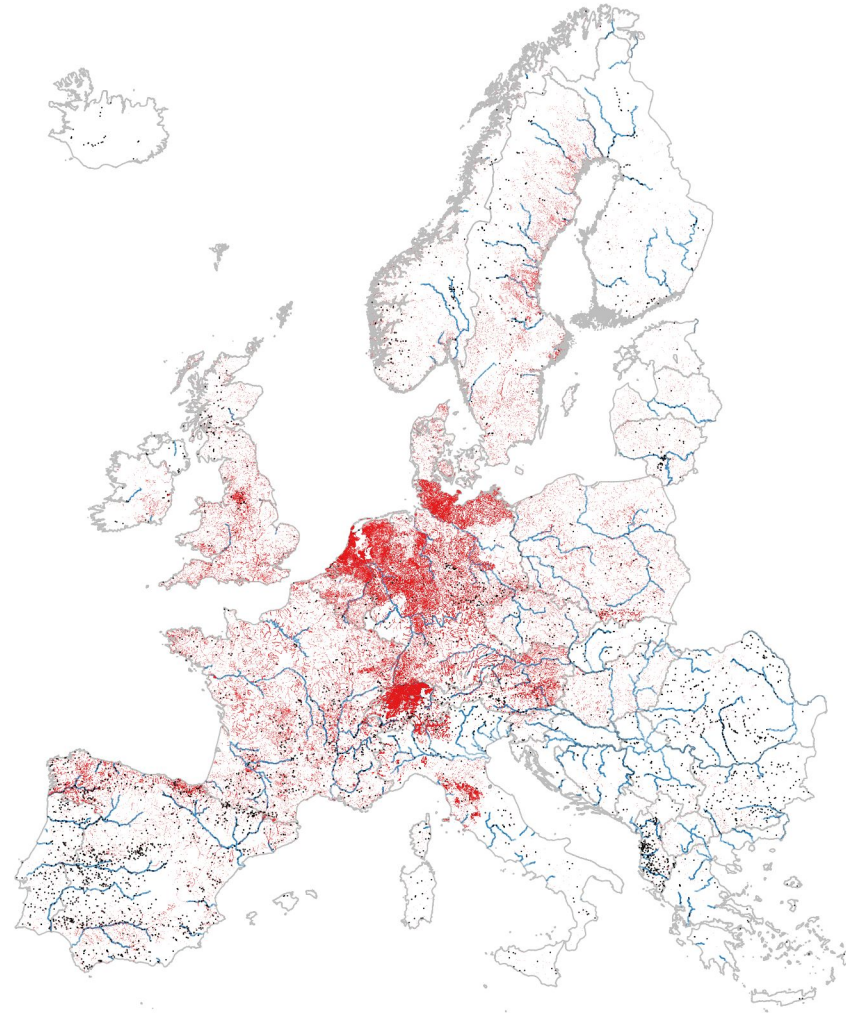
culverts are in
Europe



What we do know (sort of...)

**+1.2M
barriers**
but.. could be
as high as

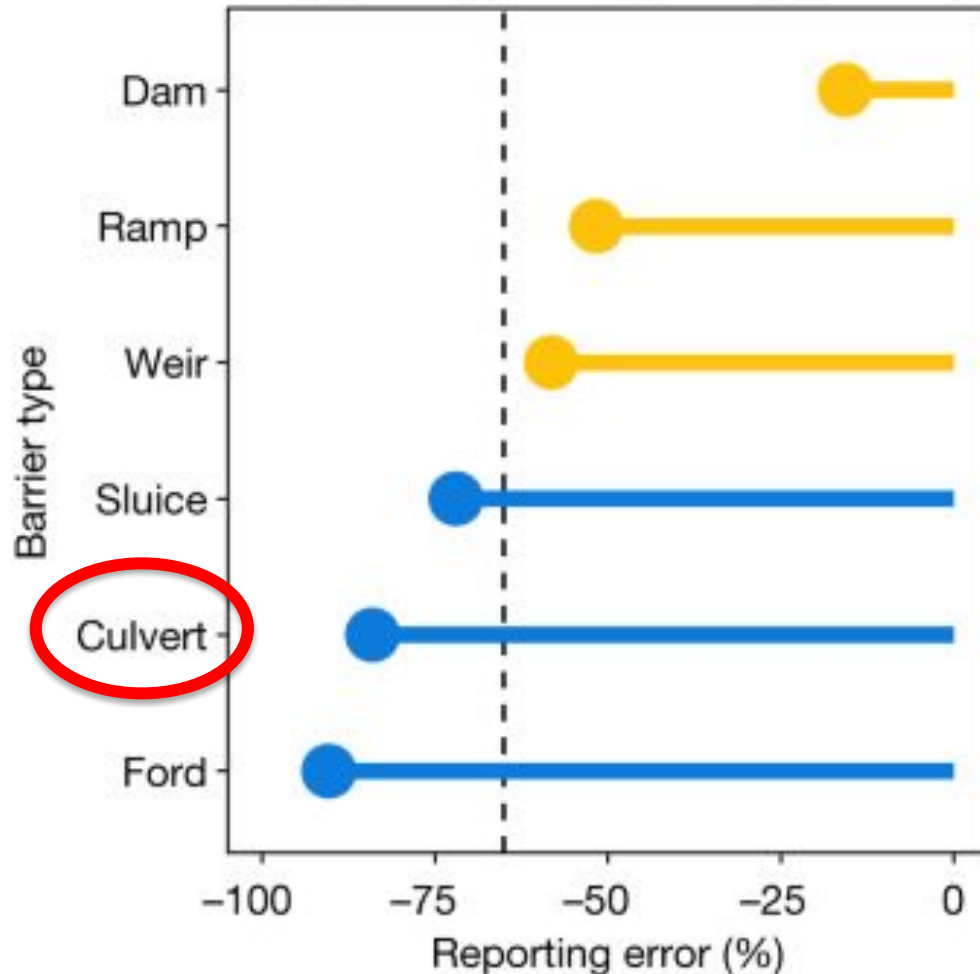
**3.7M
barriers**



Belletti et al (2020) *Nature*

Culverts are under-reported...

Belletti et al (2020)

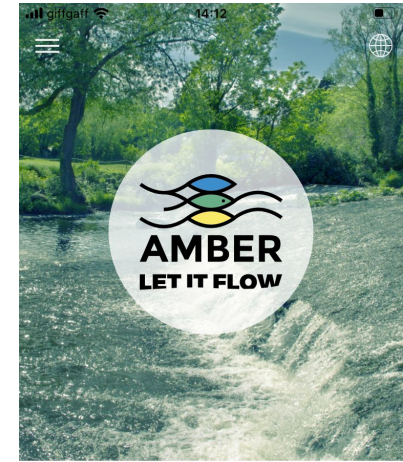
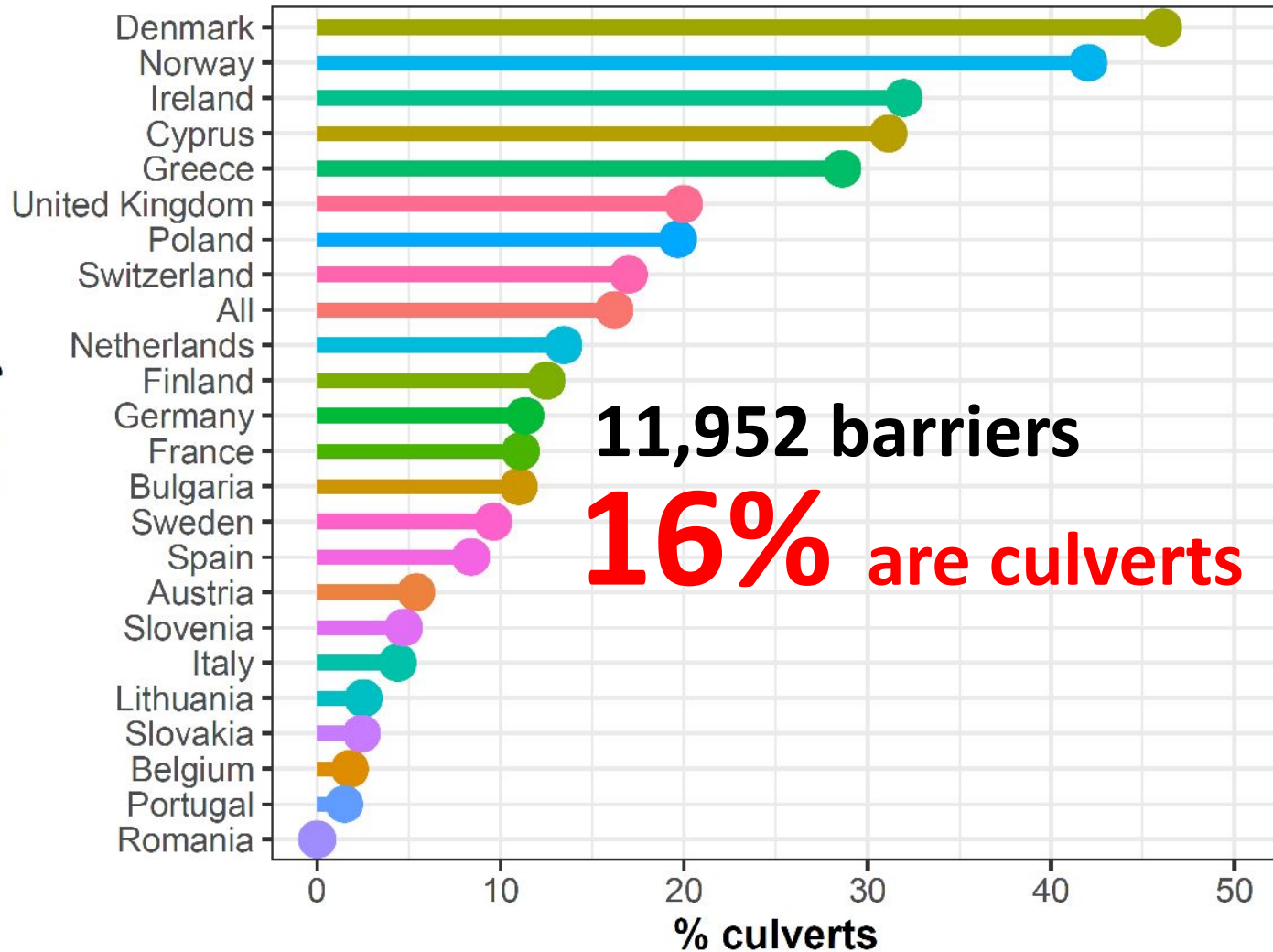


Atlas = 111K
culverts

but...

- 84%
error

Citizens are finding culverts everywhere..

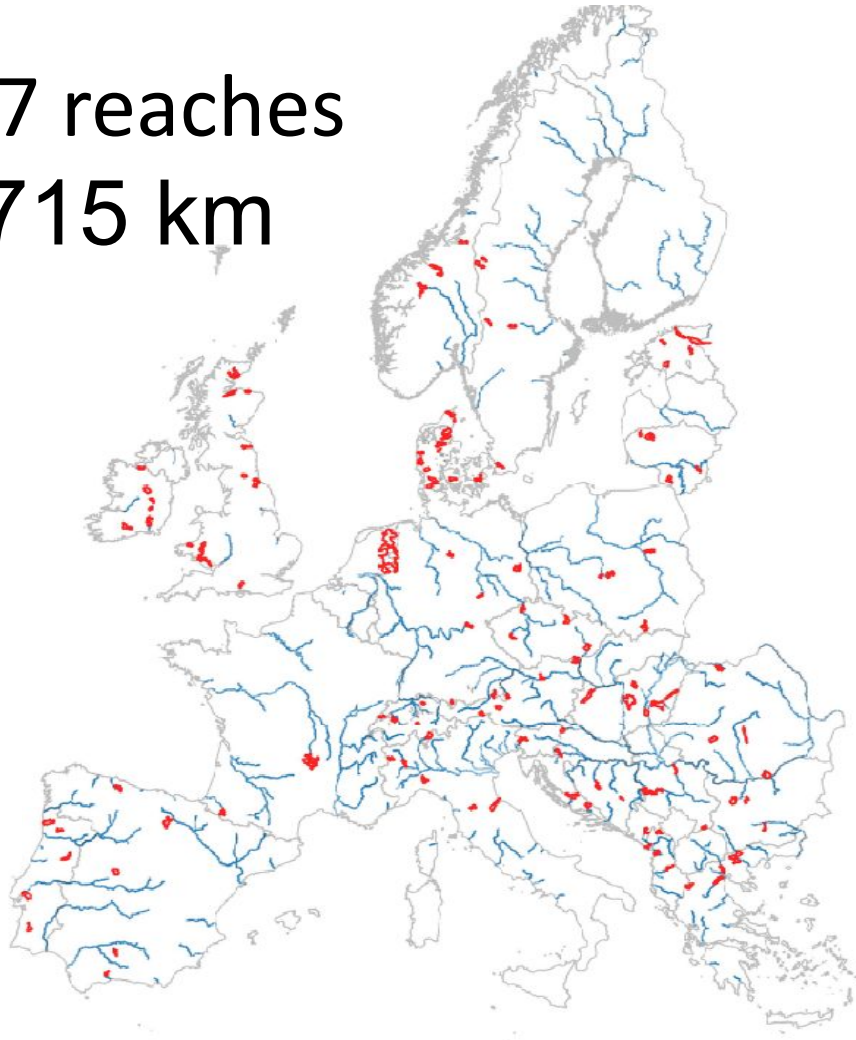


Record a New Obstacle

View Map

But culverts aren't randomly distributed...

147 reaches
2,715 km



1,583 barriers

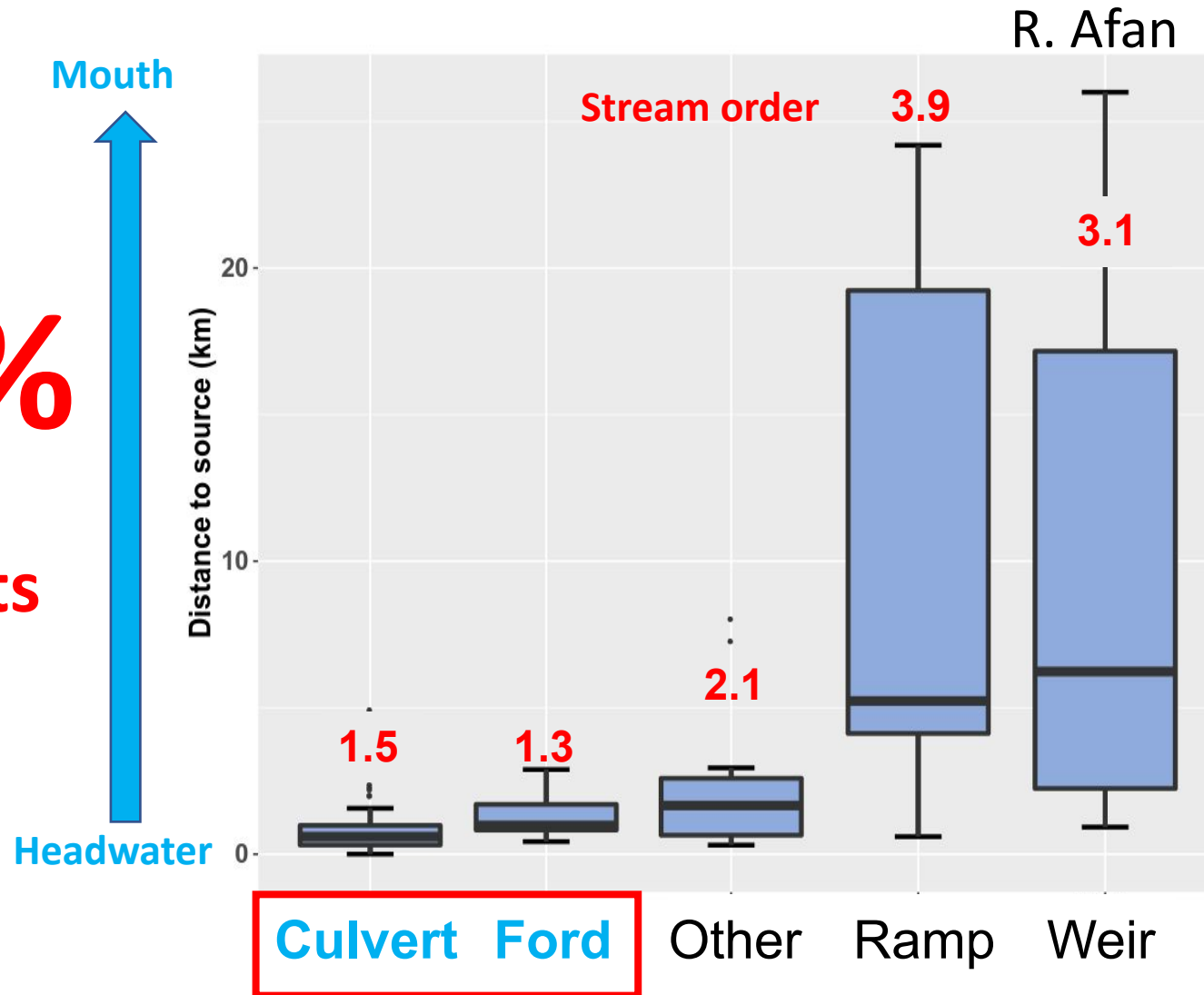
4% are
culverts

But... if consider only
1st-2nd order streams

49% are
culverts!

Culverts dominate low order stream

51%
are
culverts



But can we estimate their number

$$N = \frac{n}{l} * L$$

No. culverts = *culvert dens.* * *River network*



BIG, BIG

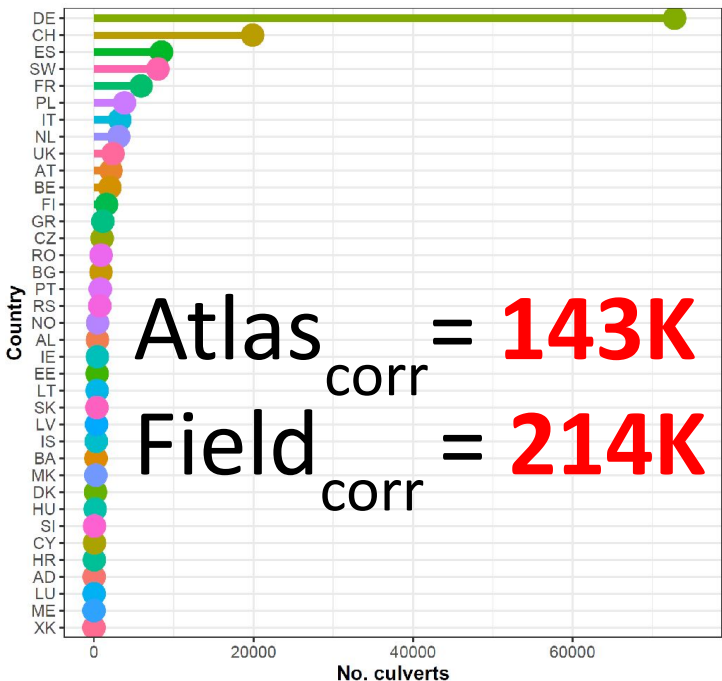
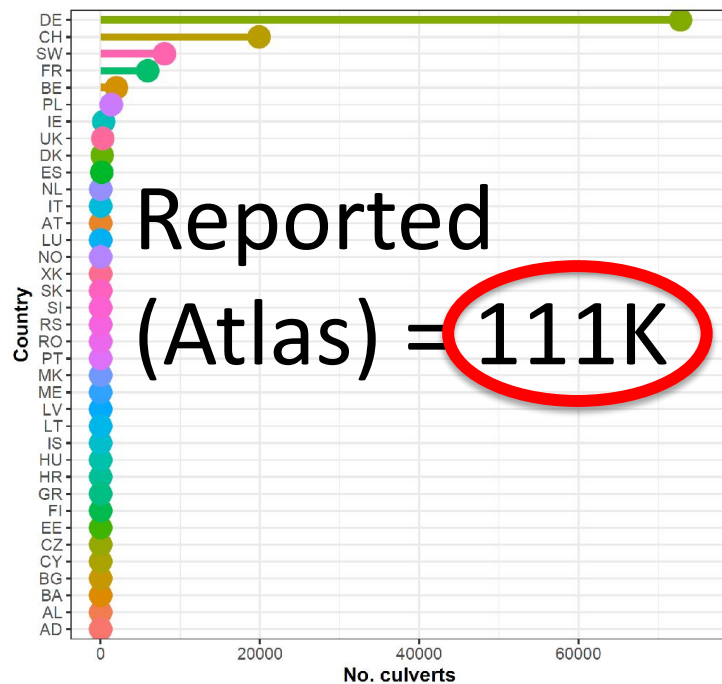
uncertainty



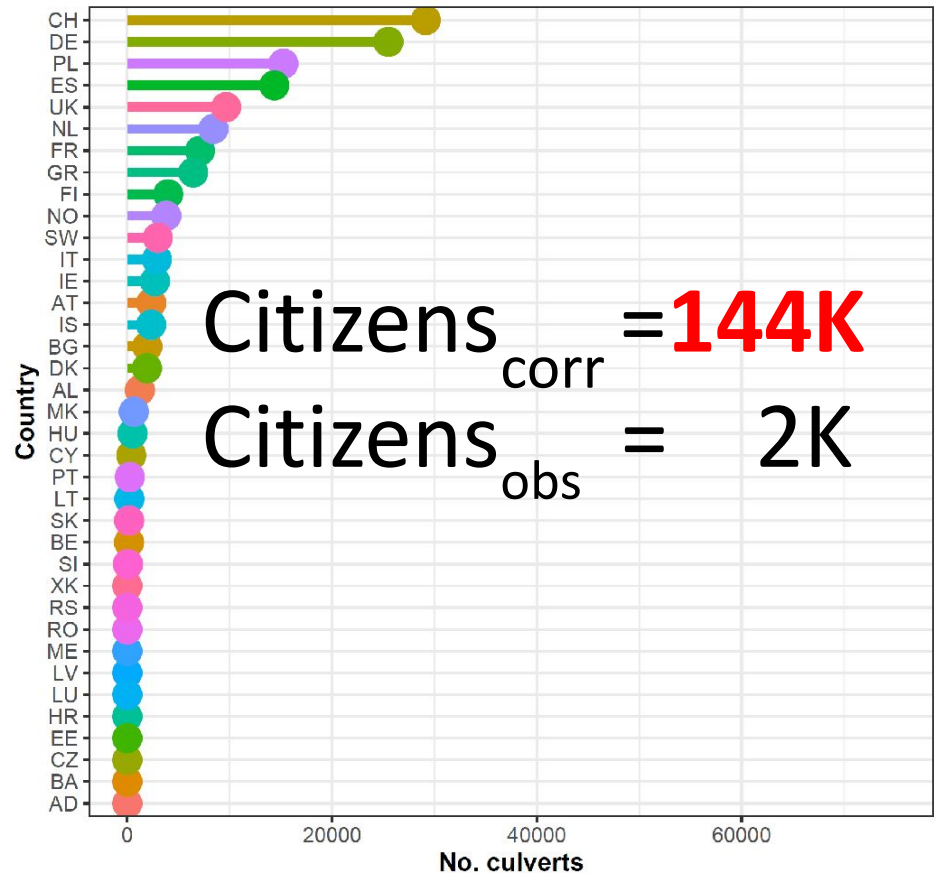
BIG error



BIG error



We can try...



But culverts are only
found in small streams..
hence easy to miss

Estimates based on small streams

No. culverts = *culvert dens.* * *River network*



0.125 culverts/km
in 1st-2nd order
streams¹



80% of 5M km
are 1st-2nd order
streams²

$$0.125 \times 0.8 \times 5 \times 10^6 = 0.5M \text{ culverts?}$$

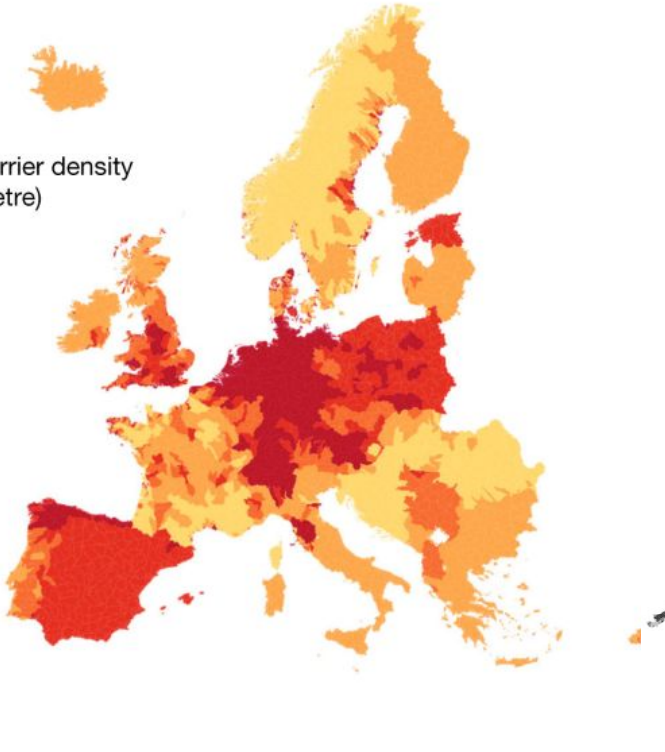
[This would be more than double our
previous 200K estimate!]

¹Belletti et al 2020; ²Kristensen & Globovnik 2014

Another approach: using road crossings

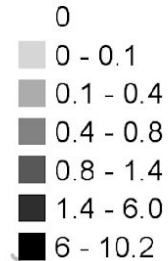
b

Field-estimated barrier density
(barriers per kilometre)



c)

Road
crossings
density
(No./km²)



Belletti et al (2020)

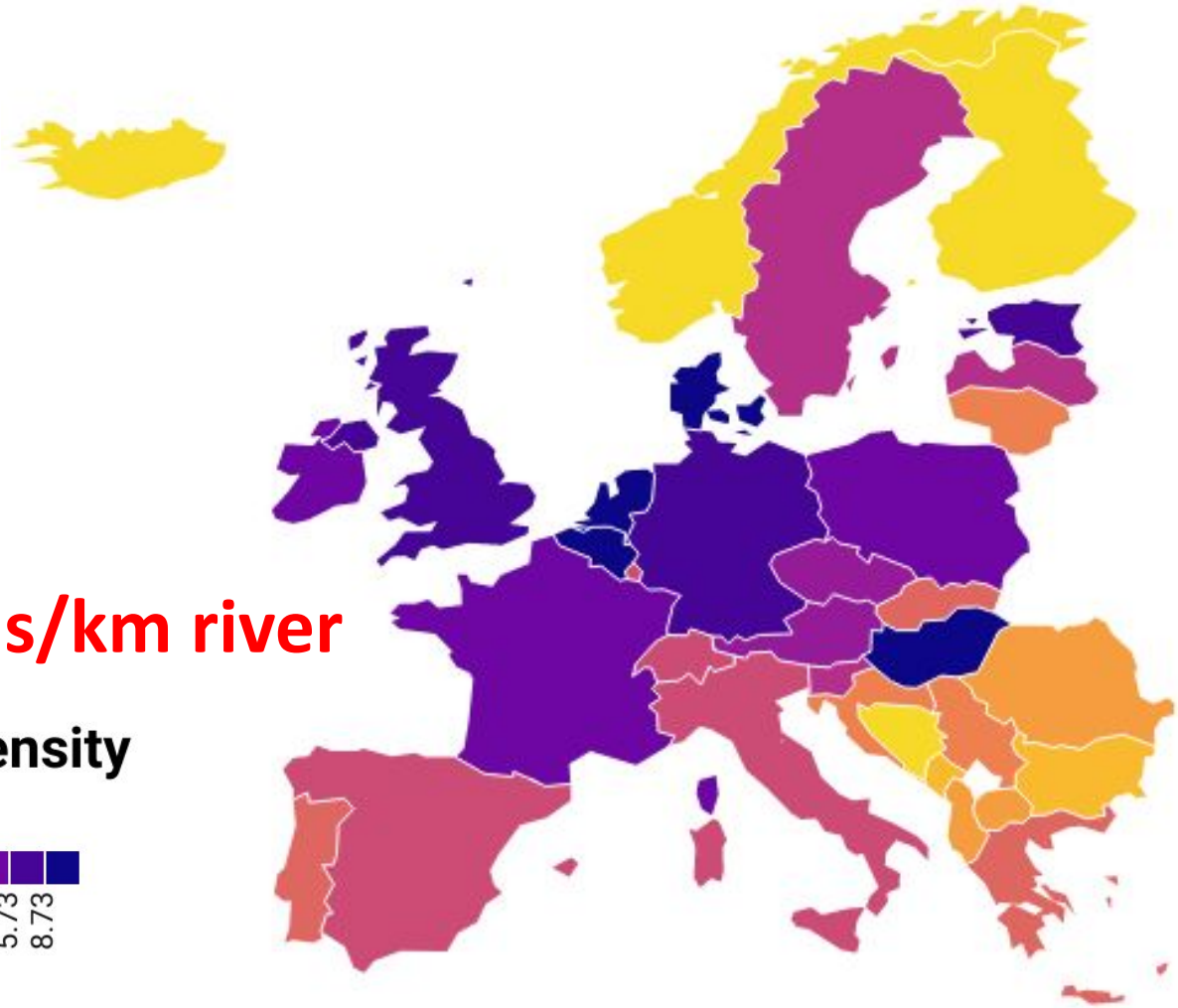
River road crossings are a good predictor of
barrier density

Road-river density

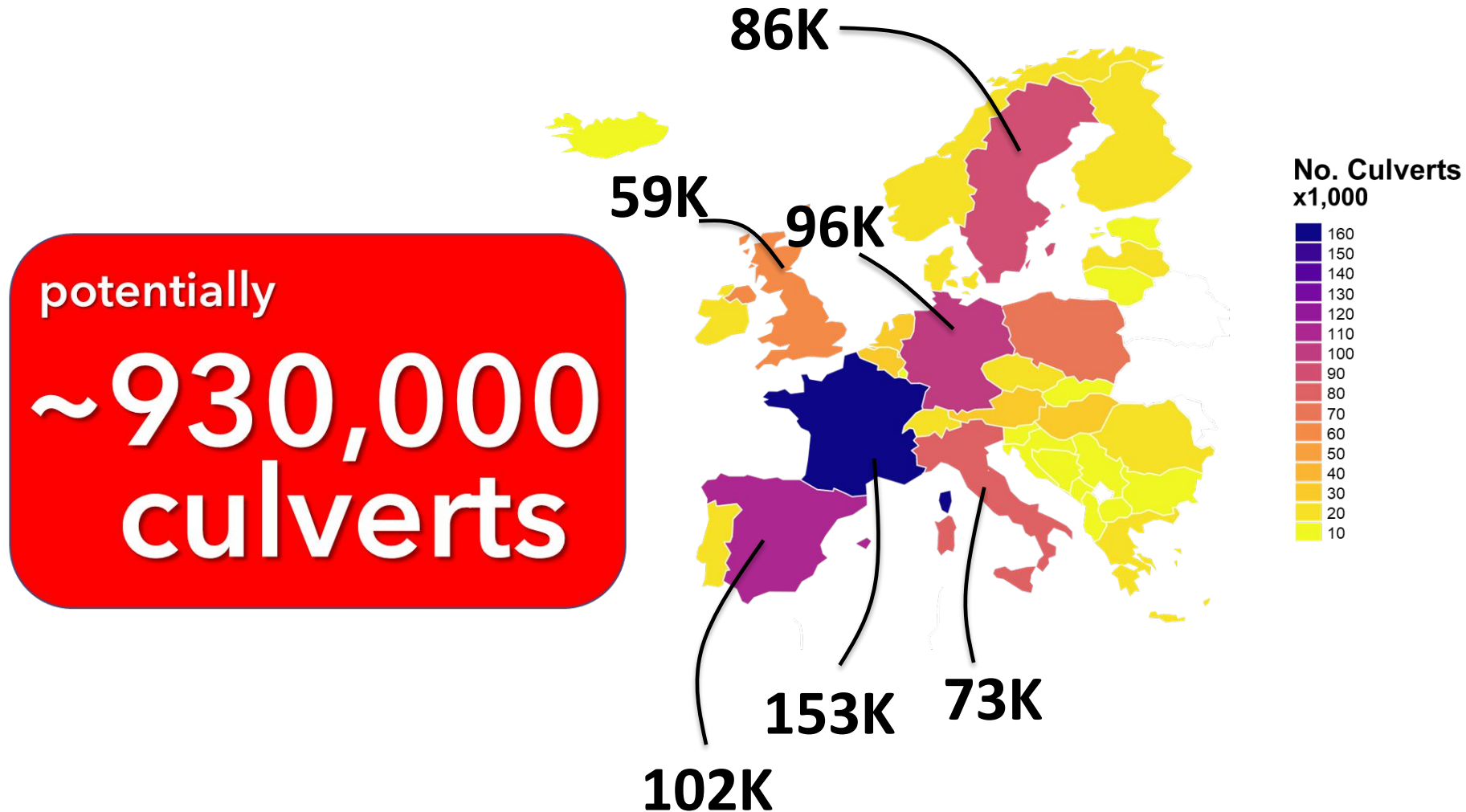
3.8 km roads/km river

Road/River density

km road/km river



Very rough potential culvert estima

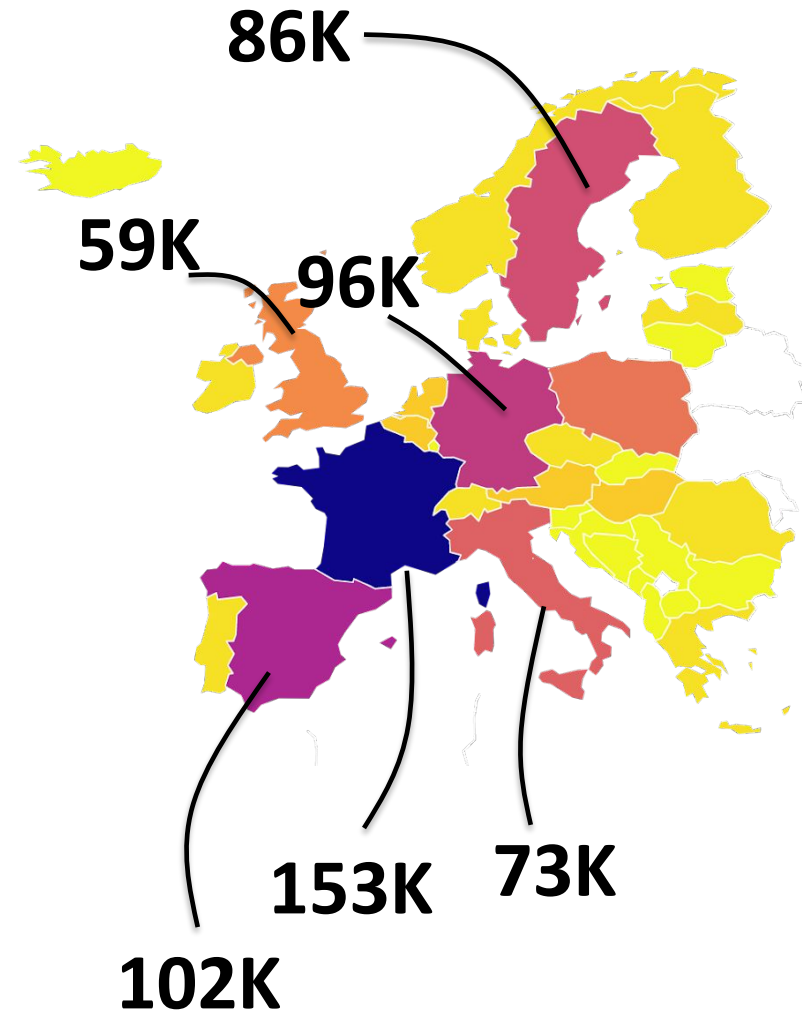


* Scaling up number of river-road crossings from density of river and road networks

Are 930K culverts conceivably possible?

Some comparative data

- GB = 50K culverts (Steph), we predict 59K
- Great Lakes (+20 times smaller) has 250K culverts
- Germany has 51K bridges, we predict 96K culverts
- France has 200-250K bridges, we predict 153K culverts



so...culvert
s

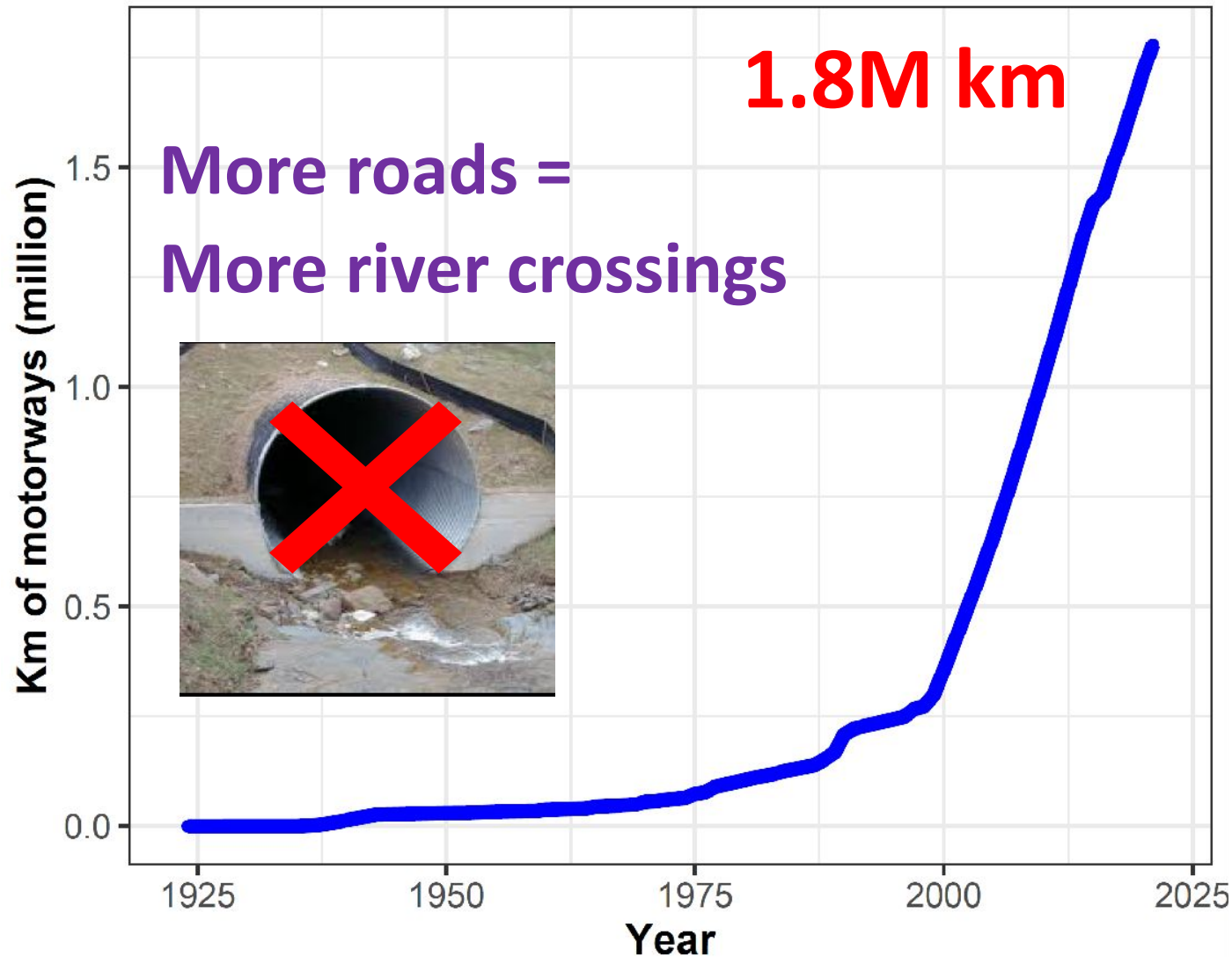
abound,

(other than move & net profit -> next talk
what

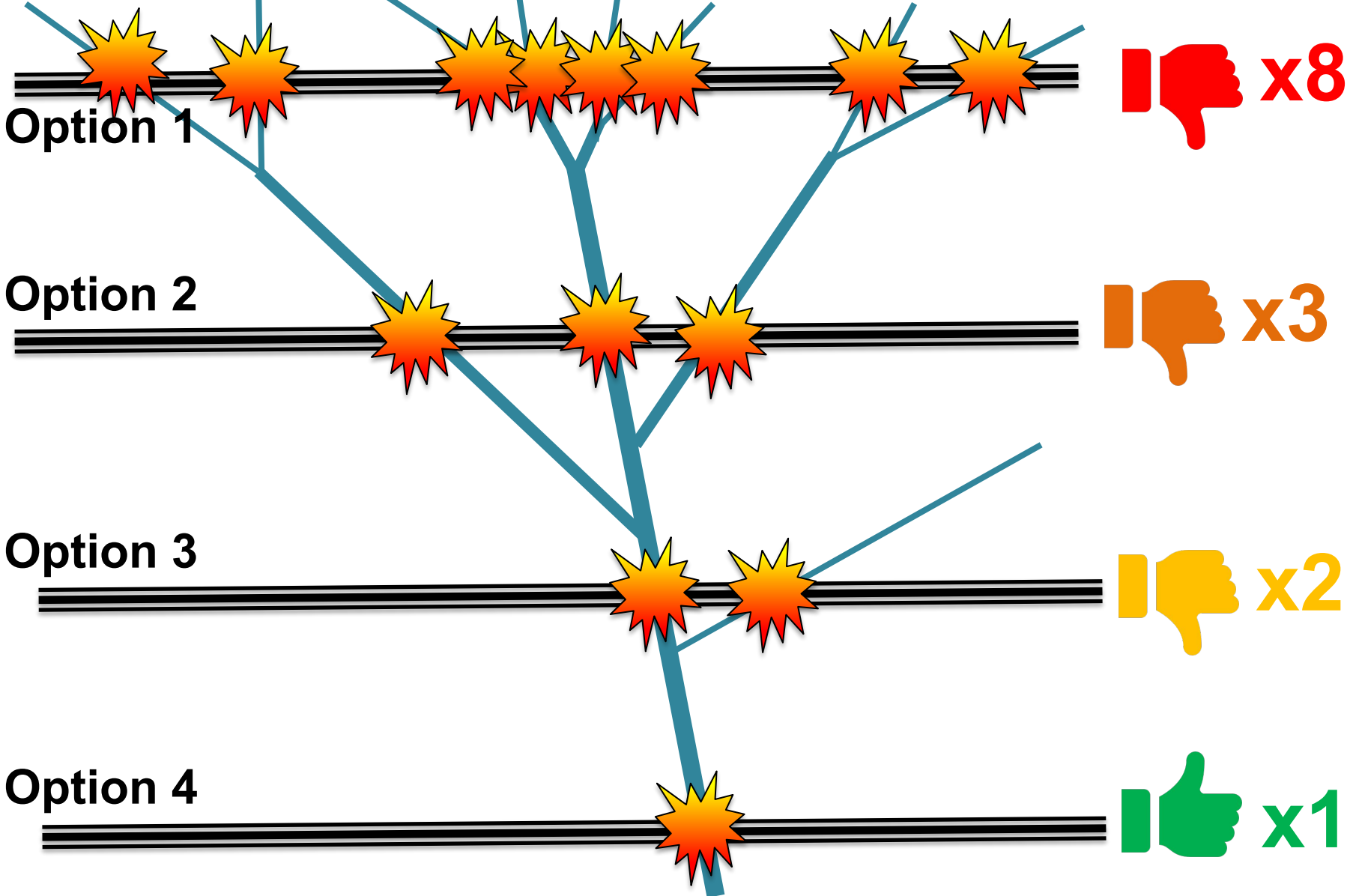
10

1. Plan future roads to reduce river crossings

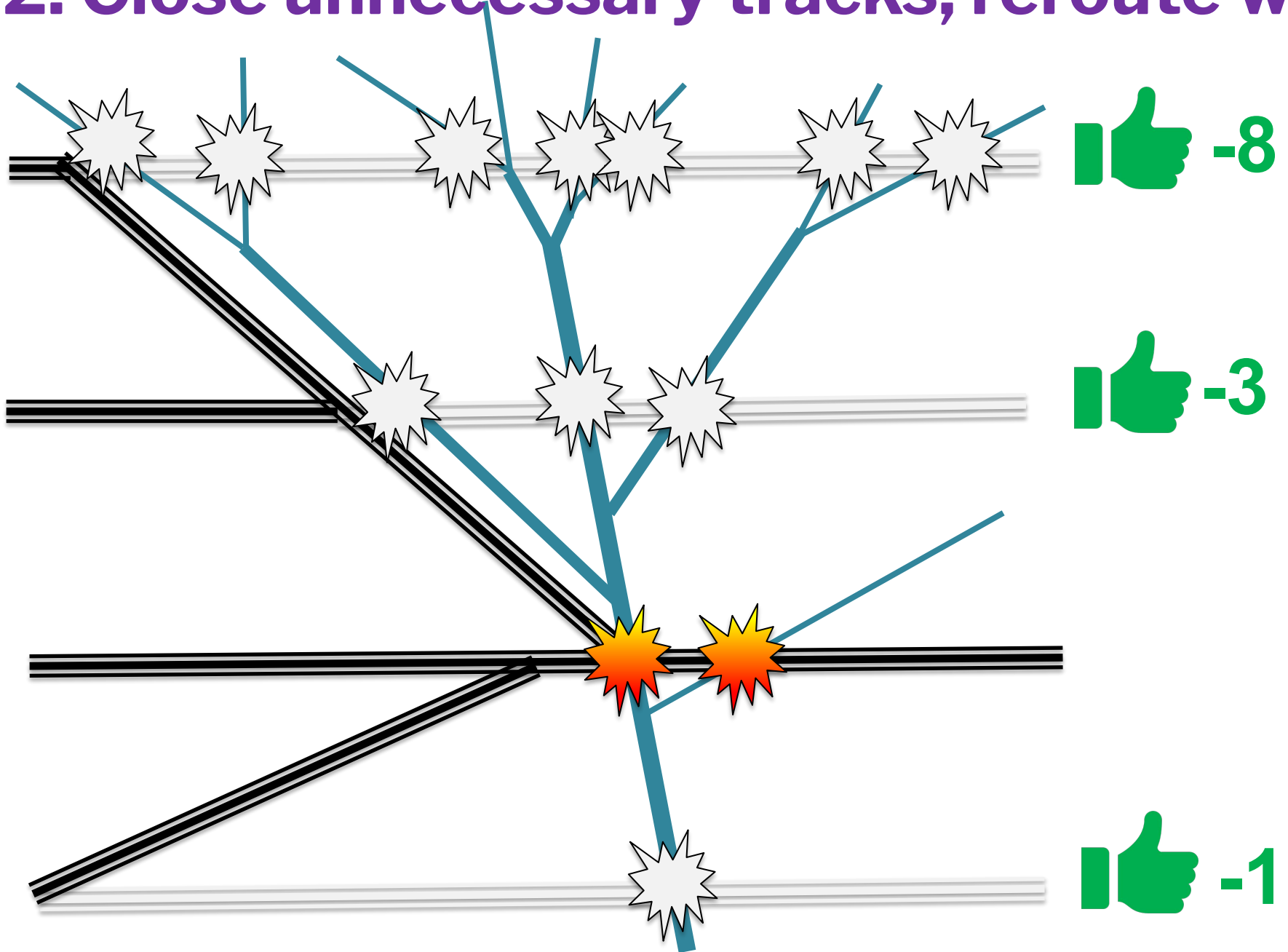
Motorways in Europe



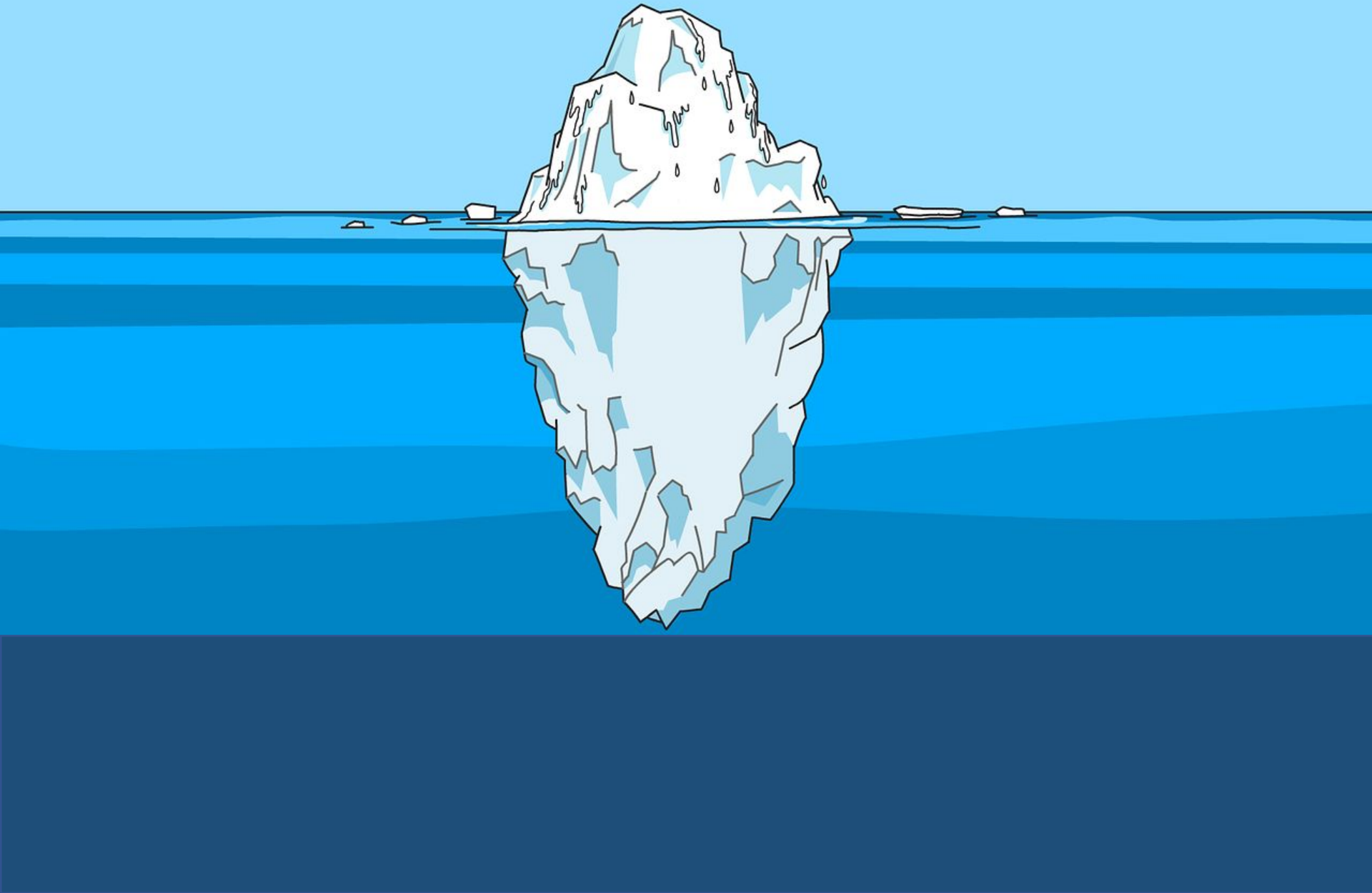
1. Plan future roads to reduce river crossings



2. Close unnecessary tracks, reroute wise



3. Raise awareness



3. Change their name

Culbergs



Thank
you

90% invisible..
yet lethal💧