GLADE
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A slippery slope

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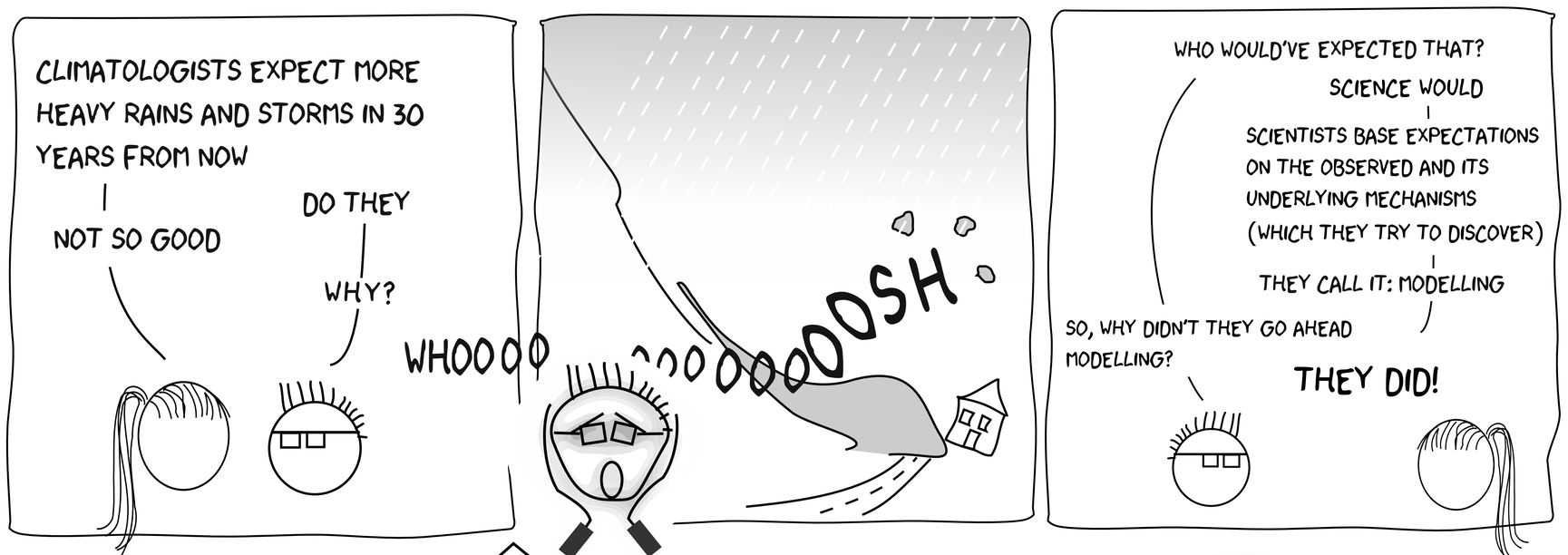
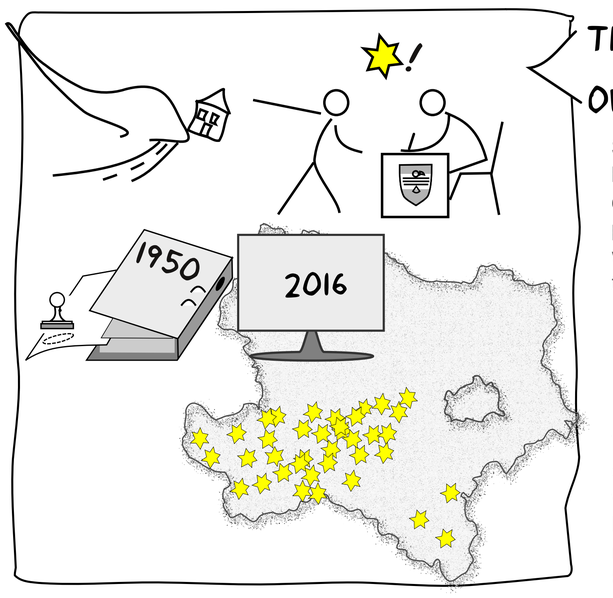
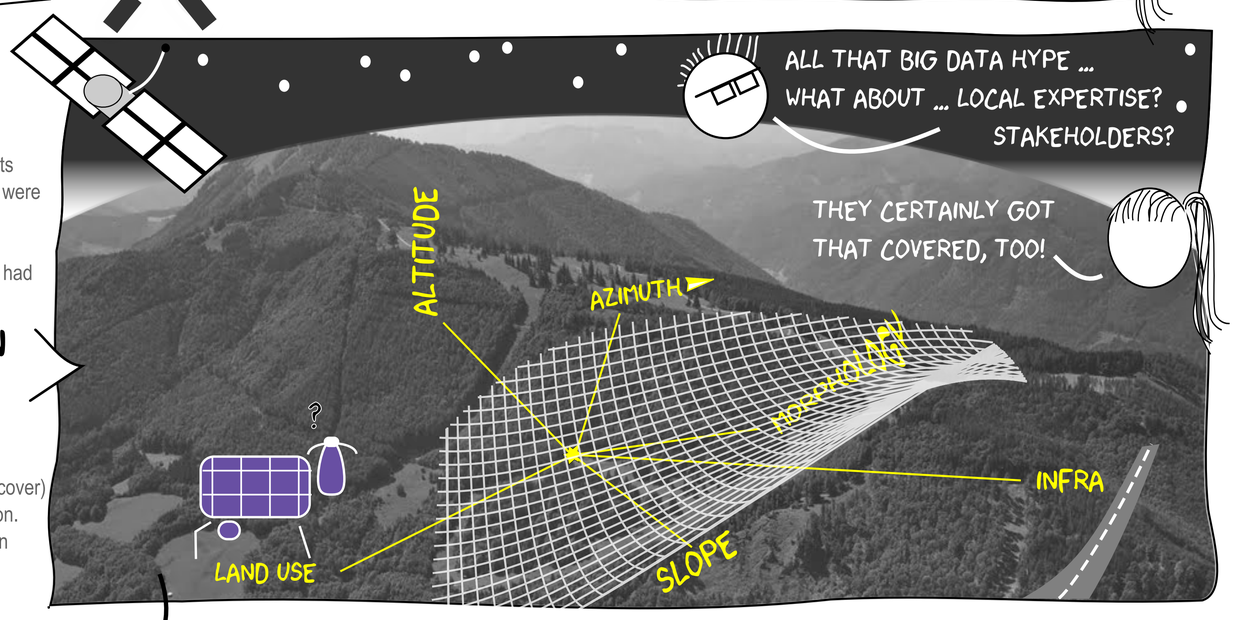
FUNDED THROUGH THE AUSTRIAN CLIMATE RESEARCH PROGRAMME





THEY COLLECTED EVIDENCE ON LANDSLIDES (TEDIOUS!)...

Such evidence is surprisingly hard to come by, because events have to be accurately located **and** dated. An example source were damage claims from Lower Austria (a type of souce which is prone to bias, though). For this and other sources extensive validations - **including individual verification with aerials** - had to be run.

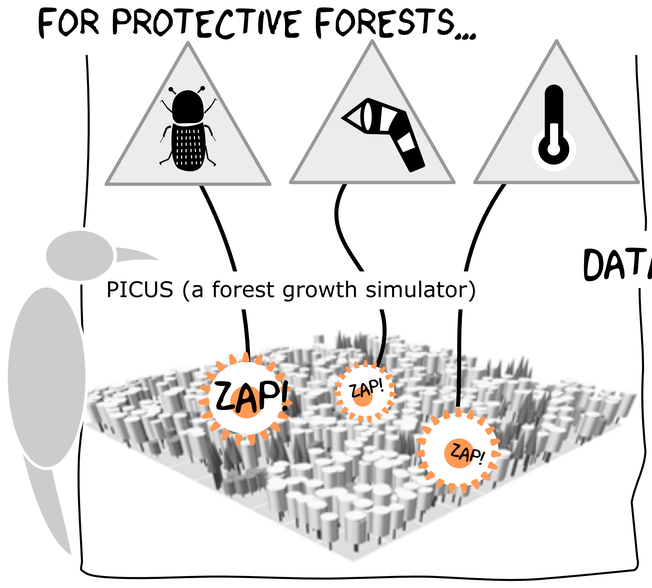


... AND GATHERED DATA ON THE CIRUMSTANCES

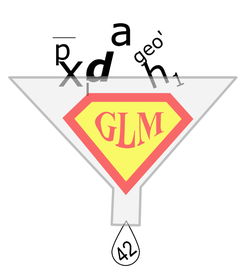
To predict something (e.g. landslides), you need a choice of independent factors (e.g. slope, geology, protective forest cover) which the probability of the "something" turns out to depend on. Luckily, those data are rather easily obtained - the effort lies in merging and handling massive amounts of data.
Consider a nationwide bulk of 840 mio grid cells.

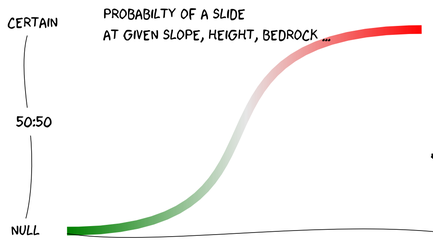
DATA

THEY MODELLED CLIMATE-RELATED HAZARDS FOR PROTECTIVE FORESTS...



DATA →



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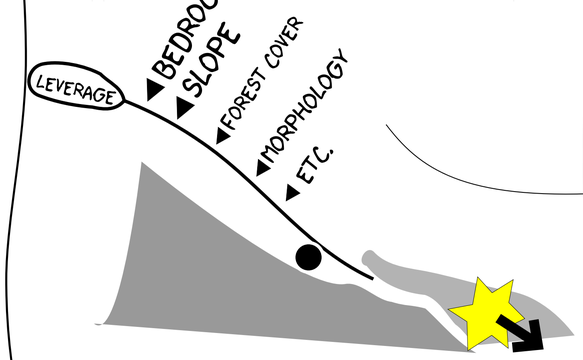
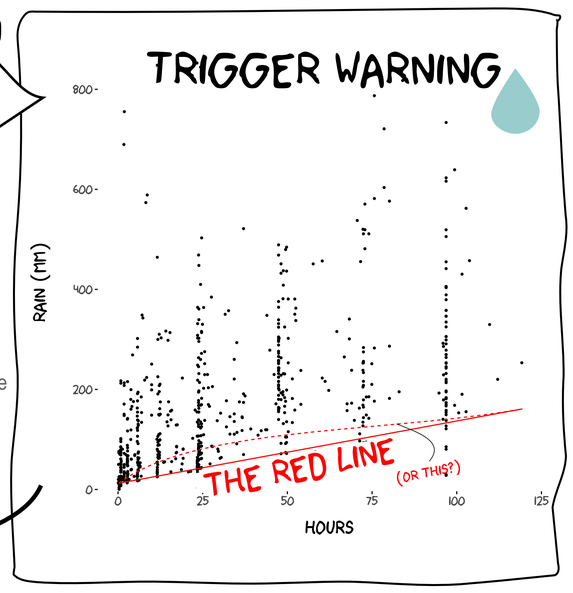
Call:
glm(formula = slide ~ geo2 + slope + alt + forest + I(slope^2) +
    geo2:I(slope^2) + alt:I(slope^2) + forest:I(slope^2), family
    data = tmp)

Deviance Residuals:
      Min         1Q     Median         3Q        Max
-2.09806  -0.15774  -0.03519  -0.01494   3.02573

Coefficients:
                    Estimate Std. Error z value Pr(>|z|)
(Intercept)       -1.110e+01  1.667e+00  -6.659 2.75e-11 ***
geo2               1.713e+00  4.344e-01   3.943 8.05e-05 ***
slope              6.141e-01  1.281e-01   4.793 1.64e-06 ***
alt               -1.606e-03  1.693e-03  -0.948  0.34293
```



THEY MODELLED PRECIPITATION TRESHOLDS BEYOND WHICH MOST SLIDES ARE TRIGGERED



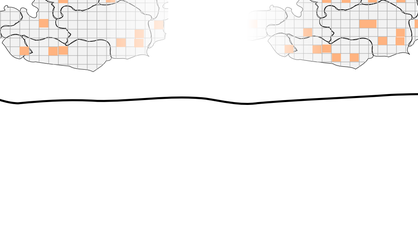
ALL THESE COMPONENTS WERE FED INTO THE BIG MODEL: "TO SLIDE OR NOT TO SLIDE"

Modelling was done with GAMs and GLMs: these are multiple regression on steroids. To be deployed whenever "classical" regression falls short: e.g. when a YES/NO response is required or dependencies grow non-linear.

DATA

LANDSLIDE, CLASSIC
INGREDIENTS:
45 % GEOLOGY
28 % SLOPE
15 % FOREST
3 % AZIMUTH
9 % RANDOM ERROR
PREPARATION:
ALLOW FOR INTERACTION
ADD 100 MM RAIN
DONE AFTER 72 HOURS

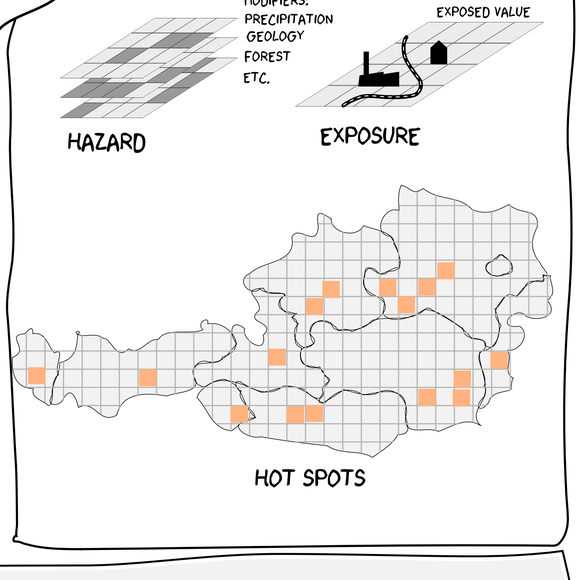
WITH ALL THAT MODELLING IN THEIR PACKS THEY RETURNED TO VALIDATING THEIR FINDINGS WITH THE STAKEHOLDERS ...

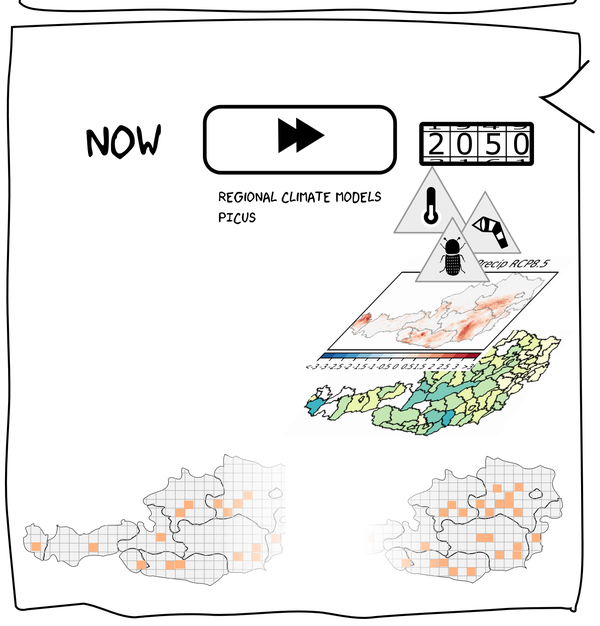


OVERLAYING HAZARDS AND EXPOSED VALUES REVEALS HOTSPOTS OF INCREASED RISK...

Once the weight of each hazard (and their interactions) has been modelled, one can calculate the combined effect at each of an areas grid cells from the local data. It's the algebraic equivalent to overlaying thematic maps of varying opacity. Adding charts of infrastructure and other exposed value results in hotspot maps.

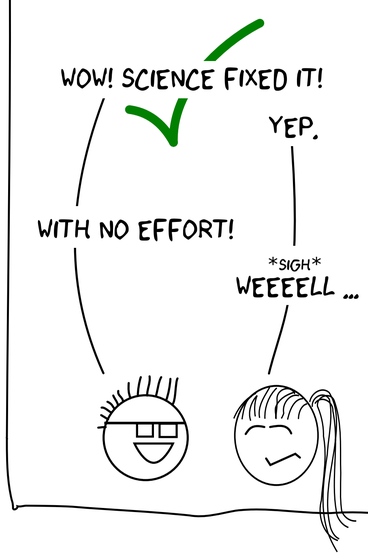
\+ Bonus: a numerical estimate of how much each hazard (or protective factor) contributes to the probability of a landslide





WITH THE NEW INSIGHTS INTO THE COMPONENTS OF LANDSLIDE RISK THEY CAST FUTURE SCENARIOS OF THE SINGLE COMPONENTS -
AND THEIR COMBINED EFFECT.

... YIELDING LANDSLIDE HOTSPOT MAPS FOR PLANNING AND PREVENTION



Actually, lots of efforts went into this project. But data science became much easier thanks to a multitude of open data and open source software (and the communities behind those). Our work greatly benefitted from, i.a.,
high resolution digital elevation models (obtained from **www.data.gv.at**)
lhigh resolution landuse info from SENTINEL-2 data (opendata portal at **www.umweltbundesamt.at**)
infrastructure layers from **openstreetmap.org**
landslide inventories at **geoland.at**
... and opensource GIS and statistic packages like **GRASS**, **QQIS** and **R** (including package xkcd)
...last not least **Inkscape** which this cartoon was produced with.

Design and font were heavily inspired by **Randall Munroe,** the grand visual narrator of complicated science: **xkcd.com**, **what-if.xkcd.com**

RECOMMENDED!
XKCD ON GLOBAL WARMING
https://xkcd.com/1732/