

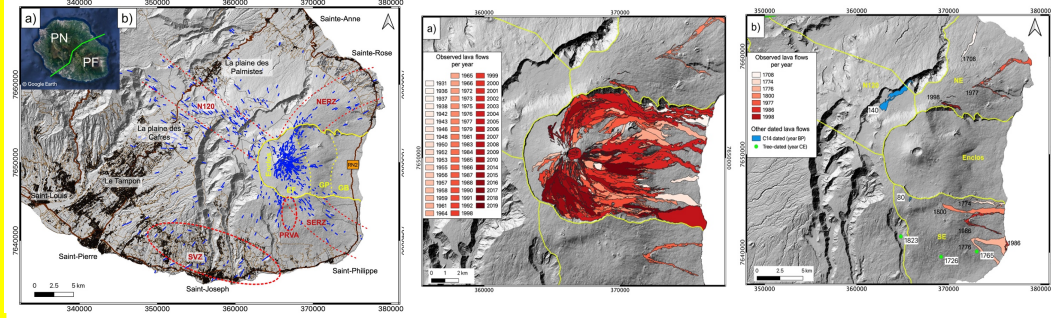
LAVA FLOW HAZARD MAP OF PITON DE LA FOURNAISE VOLCANO

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GEOLOGICAL SETTING

- One of the most active volcano worldwide
- 2 eruptions per year since creation of OVPF (1979)
- Effusive eruption, fissures feeding fountains and lava flows
- 97 % of eruptions are in the Enclos 100,000 visitors / year
- Since 1950, the road was cut 10 times
- Occurrence of lava flows in inhabited area (1977, 1986, 1998)



BUILDING THE HAZARD MAP : METHODS AND DATA

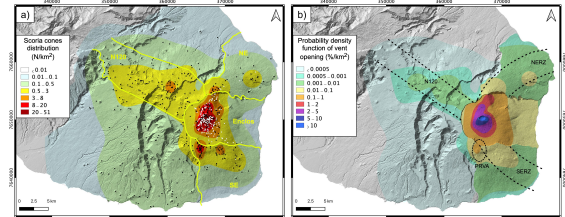
The hazard at any pixel i , with a given size Δx and Δy , that will be inundated by lava is defined as the probability H_i (Favalli et al., 2012):

$$H_i = \sum_j \rho_{Vj} \Delta x \Delta y \cdot P_{ij} \cdot P_{Lij}$$

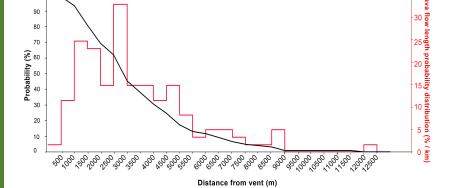
Lava flow inventory and lava flow recurrence times

Region	N. lava flows	Time interval (years)	Recurrence time (year)	N. lava flows per year (year ⁻¹)	Relative occurrence probability (%)
Summit craters	47	88	1.9	0.53	23.6
Enclos w/out craters*	148	88	0.6	1.68	74.2
Inside Enclos**	195		0.5 [5.4 months]	2.22	97.9
SE	9	290	32.2	0.03	1.4
NE	5	311	62.2	0.02	0.7
N120	1	209	209.0	0.005	0.2
Hors Enclos***	15		20.7	0.05	2.1
Total	210			2.3	100.0

Vents distribution and lava flow recurrence times are used to produce the probability density function of vent opening at location i (ρ_{Vj})



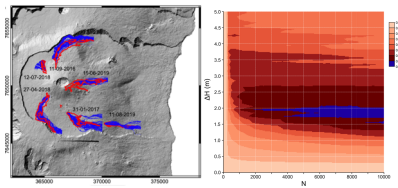
Statistics of lava flow lengths: the probability (in % / km) that a lava flow originating from vent j reaches pixel i along the calculated flow path (P_{Lij})



Database of simulations using DOWNFLOW : a matrix of probabilities where pixel $i=1$ if inundated by a lava flow originating from vent location j and $i=0$ otherwise .

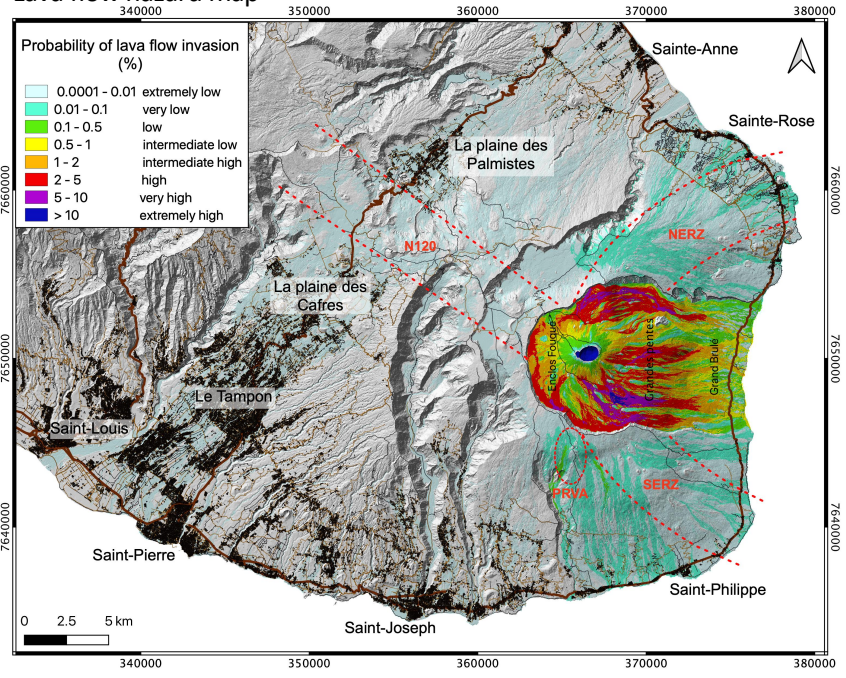
Calibration of DOWNFLOW to find the best fit parameters (N , Δh)

$$\mu = \frac{A_s \cap A_R}{A_s \cup A_R}$$

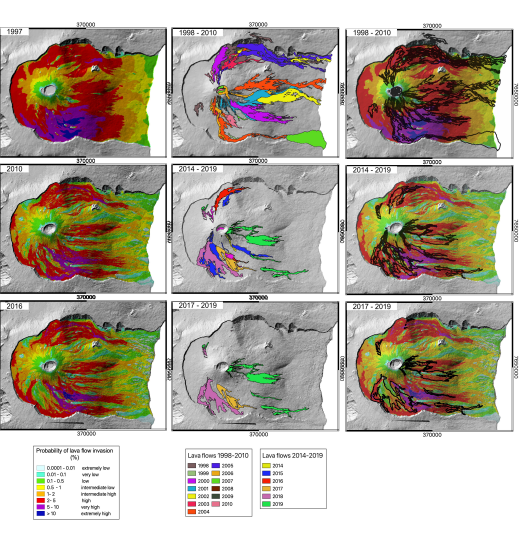


RESULTS

Lava flow hazard map



Evolution of lava flow hazard in the Enclos



CONCLUSION

Hazard assessment :

The map presented here is reliable and trustworthy for long term hazard assessment, land use planning and management. This framework also allows to produce short term (near real time) lava flow hazard assessment (by updating the input data DEMs, vent locations, flow properties).

Data base

195 lava flows in the Enclos since 1931 (2/year)
15 lava flows outside of the Enclos since 1708 (1/21 years)
726 vents over the entire volcano edifice.

For the next eruption:

At 98 % it will be inside the Enclos where areas have probabilities of 12 % .
Probability outside the Enclos is 2 %, with areas of 0.5 % along the well-defined rift zones above inhabited areas

Chevrel M.O, Favalli M., Villeneuve N., Harris A., Fornaciari A., Richter N., Derrien A., Boissier P., Di Muro A. and A. Peltier (2021)
Lava flow hazard map of Piton de la Fournaise volcano.
Submitted in Natural Hazards in Earth System Sciences