Introduction

First, we provide additional discussion on the basin resonance (as observed in our simulations; demonstrated in Figure 4 of the main document) using Section S1. Further, in tables, we aim to elucidate the physics-based simulation procedure by demonstrating the characteristics of the utilised crustal domain (Table S1), the distribution of earthquake hypocenters (Table S2) and simulation parameters (Table S3).
In figures, we provide the representation of rupture moment release for $M_w 6$ and $M_w 5$ (Figures S1, S2), map view of the distribution of ruptures (Figure S3), Peak Ground Acceleration (PGA) values obtained from simulations (PGA_{true}) for vertical component (Figure S4) and, $PGA_{\Delta A}$ versus PGA_{true} plotted for the vertical component (Figure S5).

In additionally attached files, we include, movies showing the PGA maps by each earthquake (Movie S1), and simulation videos showing the wavefront evolution for X, Y and Z components (Movies S2, S3 and S4). A compressed repository (Dataset S1) of PGA values resulting out of the simulations is also attached.

Section S1:

It is observed that the basin effects are amplifying the overall spectral content for the stations located in the basin area, i.e., S1, S2, S3, S6 and S7 shown in Figure 4c of the main document. This high amplification in the basin area is the result of basin resonance as widely known. Here we explain the dominant frequencies relevant to our simulations.

Let us start by analysing the shallow basin, which has a maximum depth of approximately 500m (see Figure 2c in the main document), with a minimum shear wave velocity of 250 m/s. To calculate 1D modal basin resonance frequency for fundamental mode (f_{1D}), the following relation from Brissaud et al., 2020 can be used:

$$f_{1D} = \frac{V_{s,basin}}{4 * \ h_{basin}} \qquad (1)$$

Where, $V_{s,basin}$ and h_{basin} are shear wave velocity and depth of the basin, respectively. Based on these parameters f_{1D} can be roughly estimated to be as low as 0.075 Hz. Now, since our simulations are conducted in 3D, we need to consider a suitable approximation for the basin geometry. We can assume that the shallow basin has a predominantly closed curve shape in 2D (East-west and vertical), with the third dimension along North-South being infinite. Therefore, dominant frequency in a 2D shape (f_{2D}) will provide a better representation for the 3D basin resonance as compared to f_{1D}. Given the aspect ratio (depth/width) of the shallow basin, to be approximately 1, f_{2D} can be estimated to be roughly 2.5 times f_{1D} (see Figure 16 in Castellaro & Musinu, 2023). This results in f_{2D} being 0.1875 Hz, which correspond to a 5 second period, approximately.

Please note, because the $V_{s,basin}$ increases with depth and the basin's shape being irregular, compounded with the complexity of having two basins in the crustal domain used, the above equation 1 is just a very generalised representation of basin resonance. However, the resolved range in our simulations account for the periods up to 5s, we infer that a significant representation of basin resonance is included in our analysis (Figure 4c in the main document).

River Channel	**Basin Interior**	**Basin exterior**
Mean V_s at the surface (μ) $[m.s^{-1}]$		
350	550	1800
V_s variation factor (δ)		
100	150	200
V_s profiles $[m.s^{-1}]$		
$\mu + \delta r + 15\sqrt{z}$	$\mu + \delta r + 15\sqrt{z}$	$\mu + \delta r + 20\sqrt{z}$
V_p profiles $[m.s^{-1}]$		
$1.87 * V_s$	$1.87 * V_s$	$V_p = a_0 + a_1 V_s - a_2 V_s^2 + a_3 V_s^3 - a_4 V_s^4$, with $a_0 = 940, a_1 = 2094.7, a_2 = 820.6, a_3 = 268.3, a_4 = 25.1$
Density profiles $[10^3 kgm^{-3}]$		
$(0.00174 * V_p)^{0.025}$	$(0.00174 * V_p)^{0.025}$	$(0.00174 * V_p)^{0.025}$

Table S1: Description of depth-dependent velocity structure of the domain used in earthquake simulations (Adapted from Jenkins et al. 2023). Please note, Brocher, 2005 (equation 9) is used to relate the V_p and V_s for basin exterior. Variation factor δ introduces a fractal spatial correlations in the velocity structure.

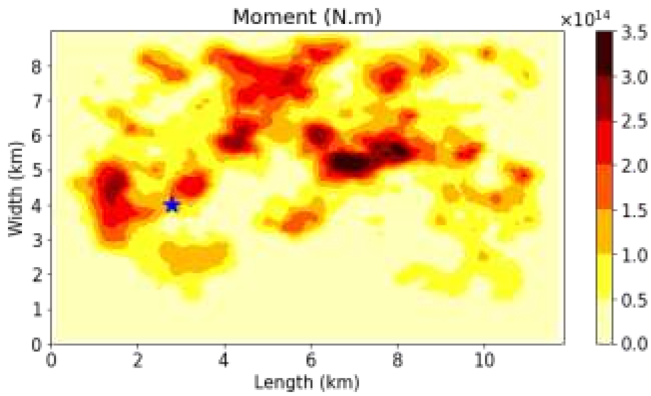
Earthquake ID	X coordinate (m)	Y coordinate (m)	Z coordinate (m)
EQ1	332211.7	3060803	-12000
EQ2	322841	3044649.4	-12000
EQ3	342214.4	3067866.1	-12000
EQ4	341291	3049440	-12000
EQ5	322099	3060560	-12000
EQ6	336988.1	3085360.2	-12000
EQ7	346322.2	3036363.8	-12000
EQ8	351822.4	3054351.2	-12000
EQ9	307161.5	3048208.9	-12000
EQ10	300630.2	3067596.8	-12000
EQ11	315848.3	3034438	-12000
EQ12	350552.3	3067763.3	-12000
EQ13	318537.1	3072944.4	-12000
EQ14	342211.7	3070803	-12000
EQ15	322211.7	3080803	-12000
EQ16	312211.7	3070803	-12000
EQ17	342211.7	3048803	-12000
EQ18	320211.7	3048803	-12000
EQ19	320211.7	3059803	-12000
EQ20	344211.7	3062803	-12000
EQ21	332273.6	3056242.9	-12000
EQ22	328335.4	3064060.1	-12000
EQ23	309888.3	3071958.6	-12000
EQ24	343096.7	3059389.2	-12000
EQ25	336308.5	3048650.2	-12000
EQ26	324548.9	3043107.4	-12000
EQ27	313190.6	3035516.8	-12000
EQ28	342191.9	3082048.4	-12000
EQ29	344556.8	3038639.1	-12000

EQ30	357350.7	3062136.1	-12000
EQ31	344273.6	3066242.9	-12000
EQ32	324273.6	3076242.9	-12000
EQ33	322273.6	3069242.9	-12000
EQ34	333273.6	3045242.9	-12000
EQ35	320273.6	3044242.9	-12000
EQ36	320273.6	3055242.9	-12000
EQ37	336273.6	3072242.9	-12000
EQ38	345273.6	3053242.9	-12000
EQ39	346273.6	3050242.9	-12000
EQ40	318273.6	3048242.9	-12000

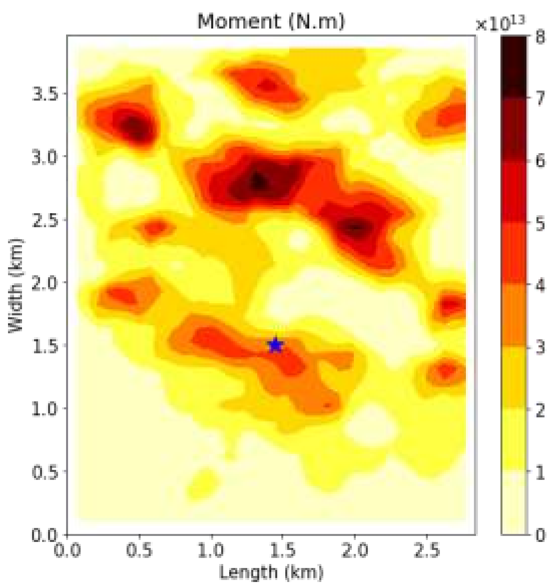
Table S2: Hypocentral coordinates of all 40 earthquakes used in the simulations.

Model parameters and simulation process	
Mesh dimension, $x * y * z$ (km^3)	99.8 * 99.6 * 20
Total number of elements (million)	5.378
Minimum element length (m)	200
Number of GLL nodes (million)	346.73
Simulation time (seconds)	20
Number of time steps	20000
Mesh slices (number of processing cores)	112
Real run time/ wall clock time (hours)	24.2

Table S3. Mesh properties and simulation parameters.



a)



b)

Figure S1. Moment release across the rupture for a) Mw6.0 and b) Mw5.0 scenario events. Hypocenter location is shown using blue star. Please note the same moment distribution is used for all the earthquakes of corresponding magnitude (Adapted from Jenkins et al. 2023).

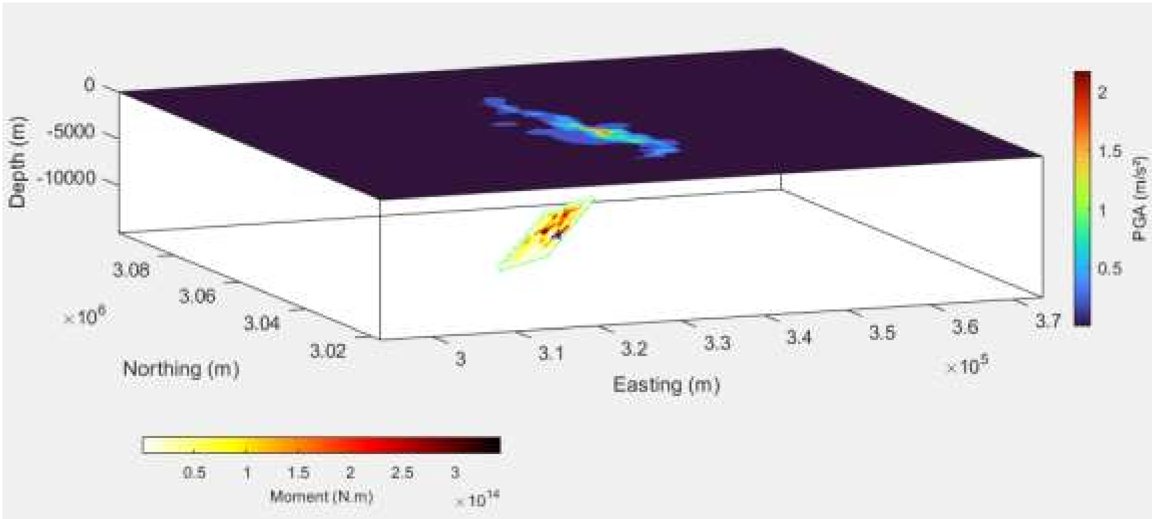


Figure S2. 3D view of the moment distribution across the rupture surface of EQ1 and the Peak Ground Acceleration (PGA) observed on the surface. More detailed distribution of PGA values across the domain surface can be seen in the Movie S4.

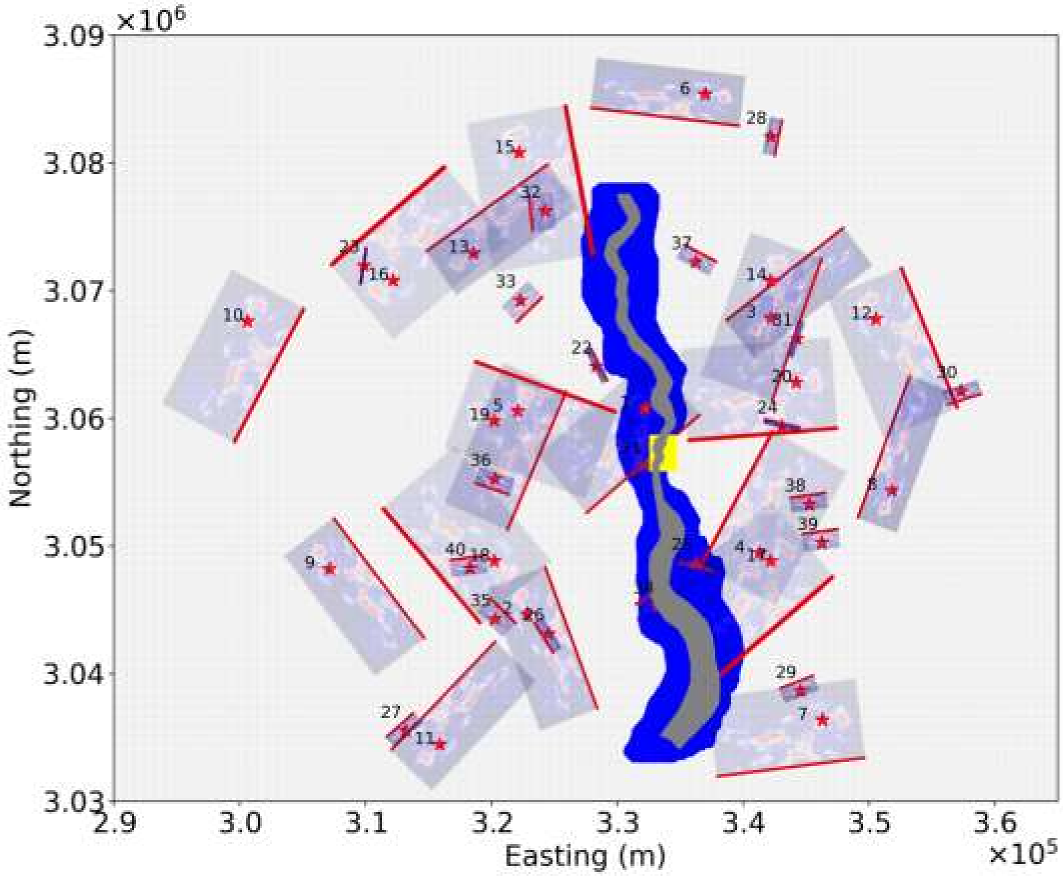


Figure S3. Map view of the distribution of all 40 rupture surfaces across the crustal domain. Top edge of every fault is made solid red for the visualization of fault orientation. Hypocenters are denoted by red stars. Blue and gray channels show deep and shallow basins respectively, Tomorrowville is shown with yellow rectangle in the middle.

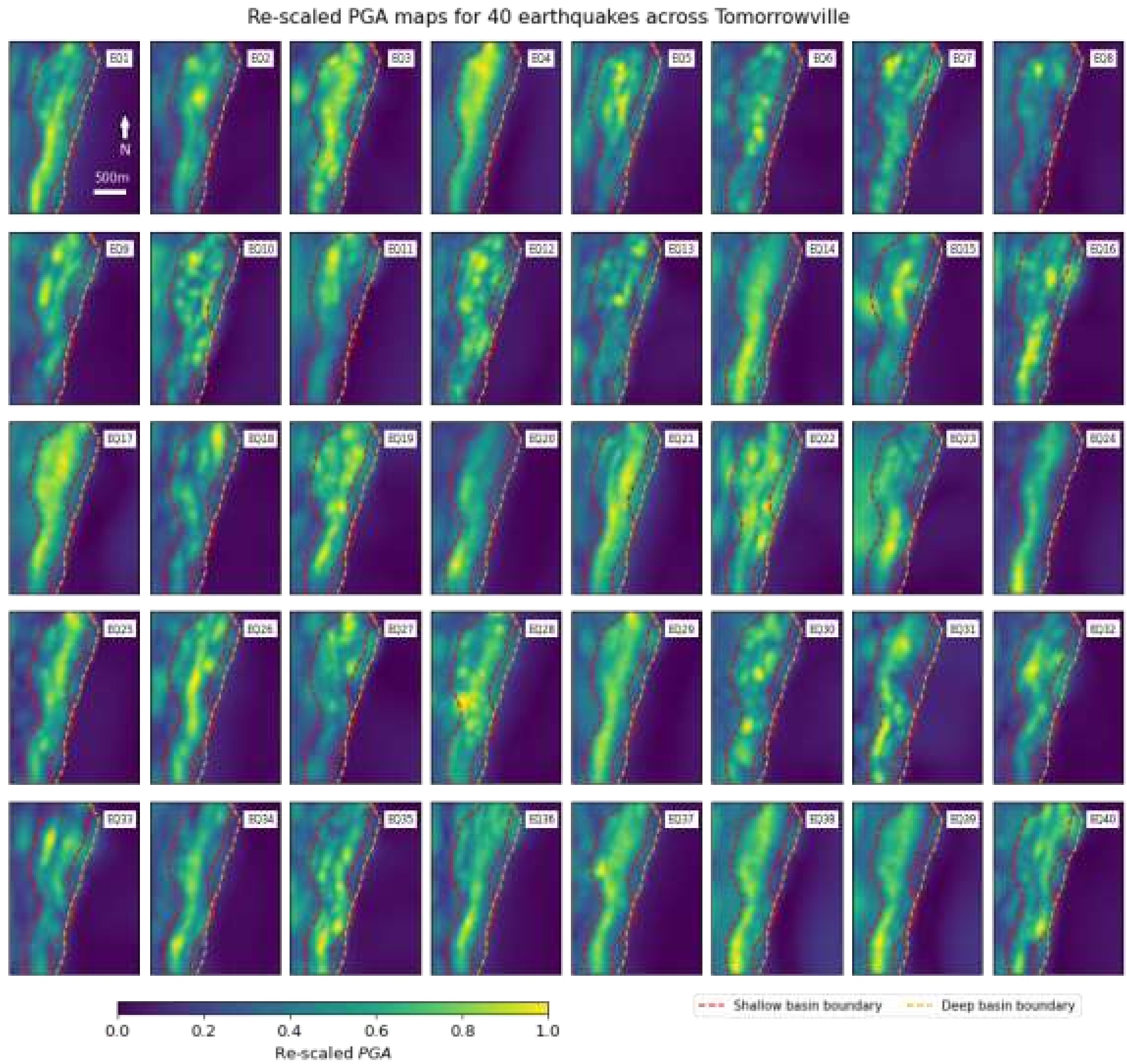


Figure S4. PGA maps for 40 events plotted on TV city domain using vertical component (Z) of accelaration. EQ1 to EQ20 represent data from Mw6 earthquakes while EQ21 to EQ40 are for Mw5. Note that we have scaled the values in each map between 0 and 1, where 0 is minimum and 1 is maximum PGA for each earthquake.

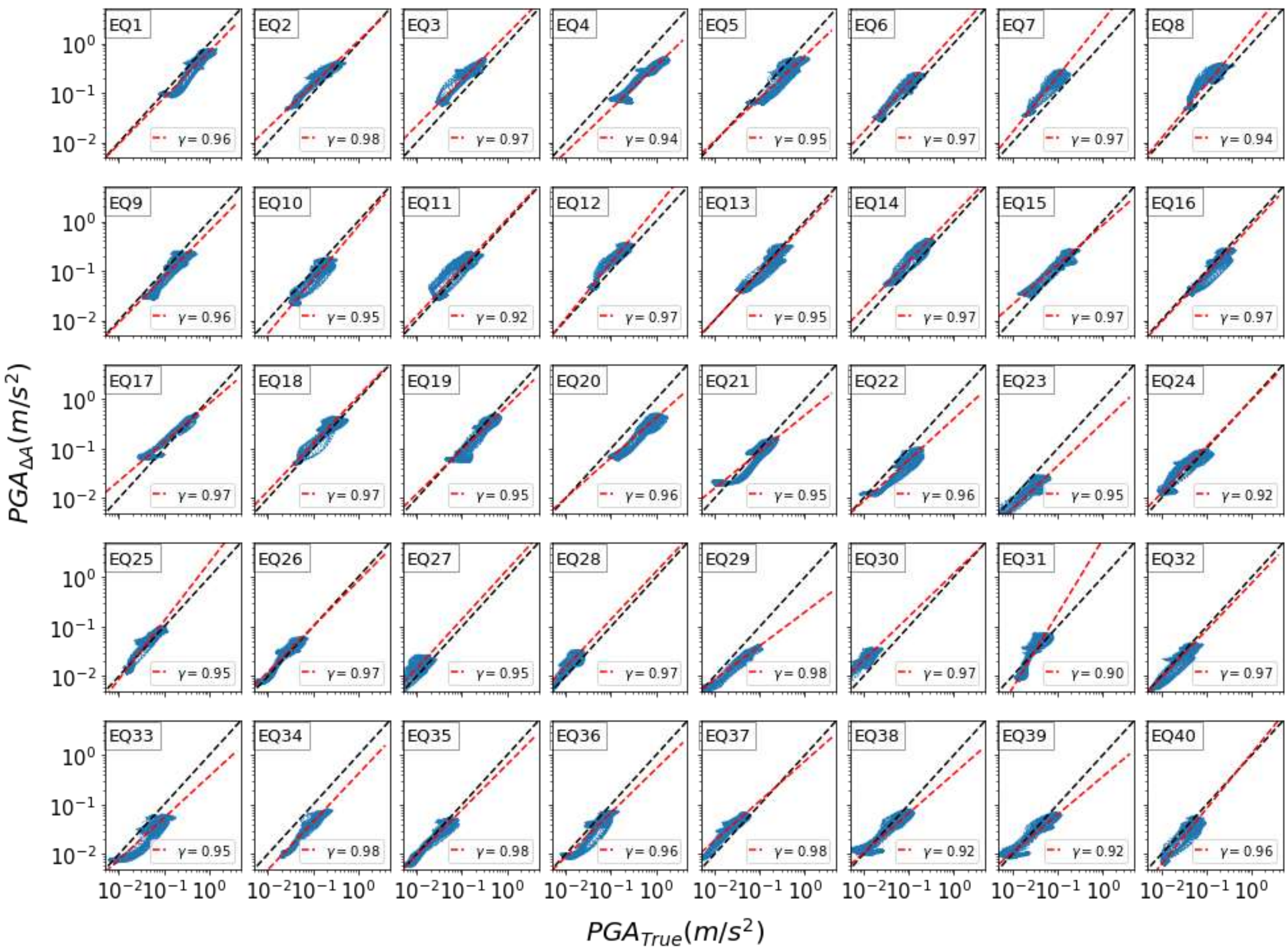


Figure S5. Shows the correlation between $\mathrm{PGA}_{\Delta\mathrm{A}}$ and $\mathrm{PGA}_{\mathrm{true}}$ for all earthquakes. PGA values are obtained using vertical component of acceleration (Z).

Movie S1. A sequential compilation of PGA distributions for earthquakes EQ1 to EQ40 spanning the entire surface of the crustal domain. The location of the rupture surface is indicated by a blue dashed rectangle, while the Tomorrowville location is denoted by a black rectangle, and the hypocenter for each earthquake is represented by a red star. The solid blue line designates the upper edge of the fault geometry.

Movie S2. Simulation movie showing the displacement wave front along east-west (X) direction for EQ1. Blue dashed rectangle shows the position of rupture surface and red star shows the hypocenter. A black rectangle in the middle shows the location of Tomorrowville. Similar representation is used in movies S3 and S4 as well.

Movie S3. Simulation movie showing the displacement wave front along north-south (Y) direction for EQ1.

Movie S4. Simulation movie showing the displacement along vertical (Z) direction for EQ1.

Dataset S1. A repository containing 40 NetCDF files of PGA values resulting out of the simulations. The earthquake scenarios are numbered from 0 to 39.