Earthquakes

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Topic & Data Source

Topic

- Earthquakes
  - Magnitude
  - Latitude/Longitude

Data Source

- Kaggle
  - http://kaggle.com/usgs/earthquake-database/

Business Questions

- How frequent can such earthquake occur?
- In what year was the highest recorded magnitude from 5.0-5.99 and how could companies use this to benefit them?
- What future prediction can be made with the data of Earthquakes and what does this mean for businesses?

Earthquake Dataset

Date	Time	Latitude	Longitude	Type	Depth	Depth Error	Depth Seismic Stations	Magnitude	Magnitude Type
2-Jan-1965	13:44:18	19.2460	145.6160	Earthquake	131.6			6	MW
4-Jan-1965	11:29:49	1.8630	127.3520	Earthquake	80			5.8	MW
5-Jan-1965	18:05:58	-20.5790	-173.9720	Earthquake	20			6.2	MW
8-Jan-1965	18:49:43	-59.0760	-23.5570	Earthquake	15			5.8	MW
9-Jan-1965	13:32:50	11.9380	126.4270	Earthquake	15			5.8	MW
10-Jan-1965	13:36:32	-13.4050	166.6290	Earthquake	35			6.7	MW
12-Jan-1965	13:32:25	27.3570	87.8670	Earthquake	20			5.9	MW
15-Jan-1965	23:17:42	-13.3090	166.2120	Earthquake	35			6	MW
16-Jan-1965	11:32:37	-56.4520	-27.0430	Earthquake	95			6	MW
17-Jan-1965	10:43:17	-24.5630	178.4870	Earthquake	565			5.8	MW
17-Jan-1965	20:57:41	-6.8070	108.9880	Earthquake	227.9			5.9	MW
24-Jan-1965	0:11:17	-2.6080	125.9520	Earthquake	20			8.2	MW
29-Jan-1965	9:35:30	54.6360	161.7030	Earthquake	55			5.5	MW
1-Feb-1965	5:27:06	-18.6970	-177.8640	Earthquake	482.9			5.6	MW
2-Feb-1965	15:56:51	37.5230	73.2510	Earthquake	15			6	MW
4-Feb-1965	3:25:00	-51.8400	139.7410	Earthquake	10			6.1	MW
4-Feb-1965	5:01:22	51.2510	178.7150	Earthquake	30.3			8.7	MW
4-Feb-1965	6:04:59	51.6390	175.0550	Earthquake	30			6	MW
4-Feb-1965	6:37:06	52.5280	172.0070	Earthquake	25			5.7	MW
4-Feb-1965	6:39:32	51.6260	175.7460	Earthquake	25			5.8	MW
4-Feb-1965	7:11:23	51.0370	177.8480	Earthquake	25			5.9	MW
4-Feb-1965	7:14:59	51.7300	173.9750	Earthquake	20			5.9	MW

What does it mean?

We are using past data to predict future data.

By using excel function (vlookup, countif, averageif, sumif), we are hoping to find what is the average frequency of earthquake in a year.

By seeing the average frequency every year, we are trying to predict an increase or decrease of magnitude each year.

Richter Scale

The Richter Scale is a numerical scale for expressing the magnitude of an earthquake on the basis of seismograph oscillations.

The more destructive earthquakes typically have magnitudes between about 5.5 and 10.

The scale is logarithmic and a difference of one represents approximately thirtyfold difference in magnitude.

Understanding the Richter Scale:

Richter Magnitude	Feels like KG of TNT	Extra Information
0-1	0.6-20 kilograms of dynamite	We can not feel these
2	600 kilograms of dynamite	Smallest Quake people can normally feel
3	20,000 kilograms of dynamite	People near the epicenter feel this quake
4	60,000 kilograms of dynamite	This will cause damage around the epicenter. It is the same as a small fission bomb
5	20,000,000 kilograms of dynamite	Damage done to weak buildings in the area of the epicenter
6	60,000,000 kilograms of dynamite	Can cause great damage around the epicenter
7	20 bilion kilograms of dynamite	Creates enough energy to heat New York city for one year. Can be detected all over the world. Causes serious damage
8	60 bilion kilograms of dynamite	Causes death and major destruction. Destroyed San Francisco in 1906
9	20 trillion kilograms of dynamite	Rare, but would causes unbelievable damage!

Our next step

- We are planning to add a input form and search.
- We are going to use a line graph to show the interval each year.
- May experiment and add more year before such as 1965-2016
- Finding the average mean for each year through a formula involving sumproduct.
- Implementation of userforms as an alternative method of data entry

How frequently can a 6.0+ magnitude occur? (Year 1965-2016)

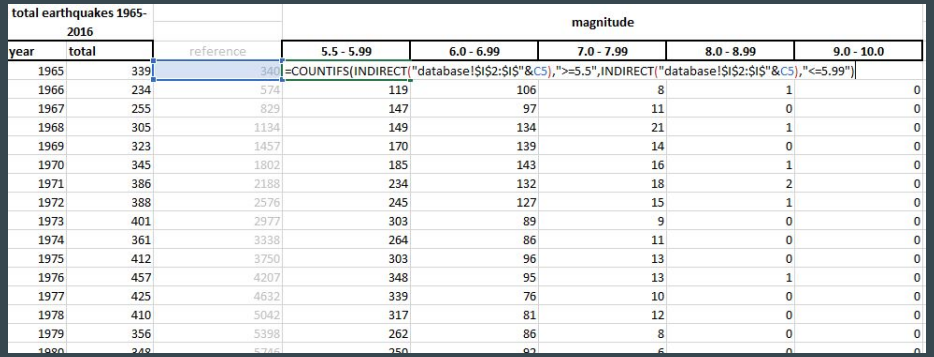
Using an average function, we found that the magnitude of earthquake seems to be around 5.88, with the highest being 9.1 and the lowest being at 5.5.

With the countif function, the amount of time a 6 or higher occuring is 7356 times.

Average Magnitude	5.882530753
Highest Magnitude	9.1
Lowest Magnitude	5.5
Most Common Magnitude	5.5

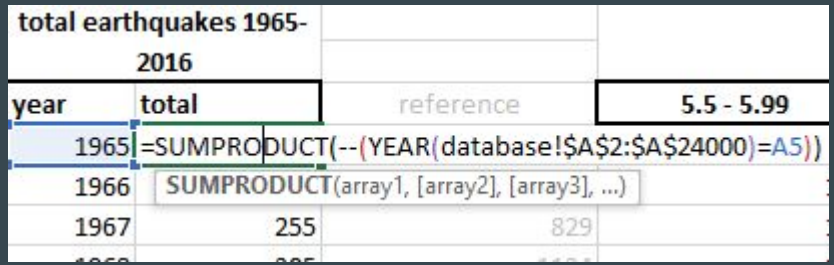
CountIf & SumProduct

- We used the CountIf function to count all the earthquakes that happened in a certain year based on the certain points of magnitude.
  - Utilized INDIRECT and conditional statements (>, <, <=, >=, etc.)



total earthquakes 1965-2016			magnitude				
year	total	reference	5.5 - 5.99	6.0 - 6.99	7.0 - 7.99	8.0 - 8.99	9.0 - 10.0
1965	339	340	=COUNTIFS(INDIRECT("database!$I$2:I"&C5),">=5.5",INDIRECT("database!$I$2:I"&C5),"<=5.99")				
1966	234	574	119	106	8	1	0
1967	255	829	147	97	11	0	0
1968	305	1134	149	134	21	1	0
1969	323	1457	170	139	14	0	0
1970	345	1802	185	143	16	1	0
1971	386	2188	234	132	18	2	0
1972	388	2576	245	127	15	1	0
1973	401	2977	303	89	9	0	0
1974	361	3338	264	86	11	0	0
1975	412	3750	303	96	13	0	0
1976	457	4207	348	95	13	1	0
1977	425	4632	339	76	10	0	0
1978	410	5042	317	81	12	0	0
1979	356	5398	262	86	8	0	0

- We also used the SumProduct function to find out how many earthquakes that happened in a certain year.
  - Utilized YEAR function



total earthquakes 1965-2016			
year	total	reference	5.5 - 5.99
1965	=SUMPRODUCT(--(YEAR(database!$A$2:$A$24000)=A5))		
1966	SUMPRODUCT(array1, [array2], [array3], ...)		
1967	255	829	

CountIf & SumProduct (cont.)

- Using the countIF function we found that the year with the highest magnitude from 5.0=5.99 was in 2011. Companies can use this knowledge to build their buildings to such earthquakes.

AverageIF, Min, Max

- Used the AverageIf function to calculate the average of the original data with the years it is associated with.

depth		
average	min	max
=AVERAGEIFS(database!F:F,database!A:A,">="&DATE($A5,1,1),database!A:A,"<"&DATE($A6,1,1))		
58.7982906	1.2	625
73.00941176	10	642.9
66.63311475	1.2	635.4

- Used the Min function to see what was the smallest depth.
  - Utilized IF and YEAR function

depth		
average	min	max
71.18879056	=MIN(IF(YEAR(database!$A$2:$A$23413)=calculations!A5,database!$F$2:$F$23413))	
58.7982906	1.2	625
73.00941176	10	642.9

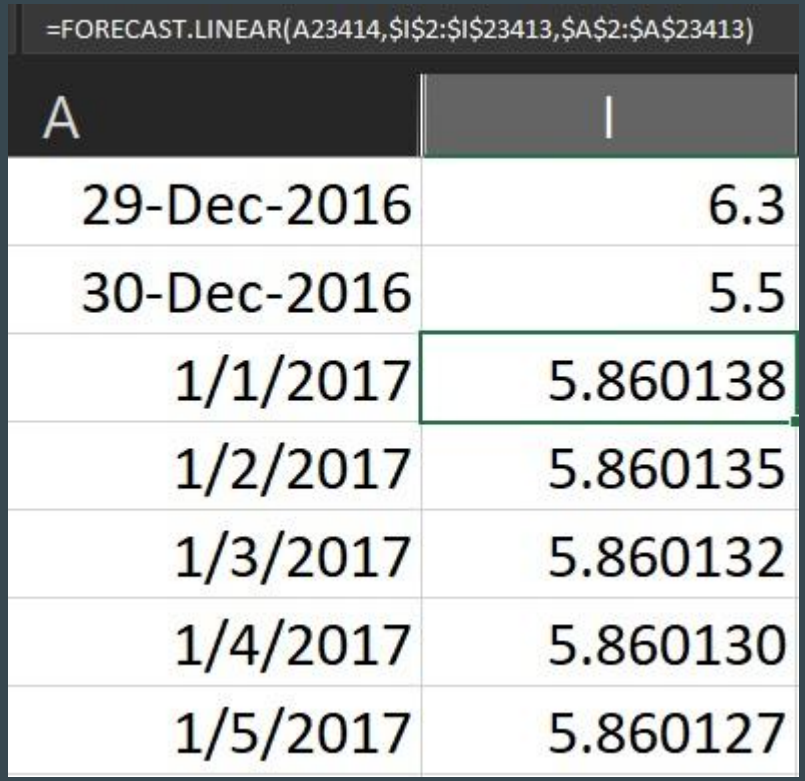
- Used the Max function to see what was the largest depth in a certain Year.
  - Utilized IF and YEAR function with it.

depth		
average	min	max
71.18879056	-1.1	=MAX(IF(YEAR(database!$A$2:$A$23413)=calculations!A5,database!$F$2:$F$23413))
58.7982906	1.2	625
73.00941176	10	642.9

Forecast Formula (2017-2021)

Using the forecast.linear formula, we are able to predict future magnitude.

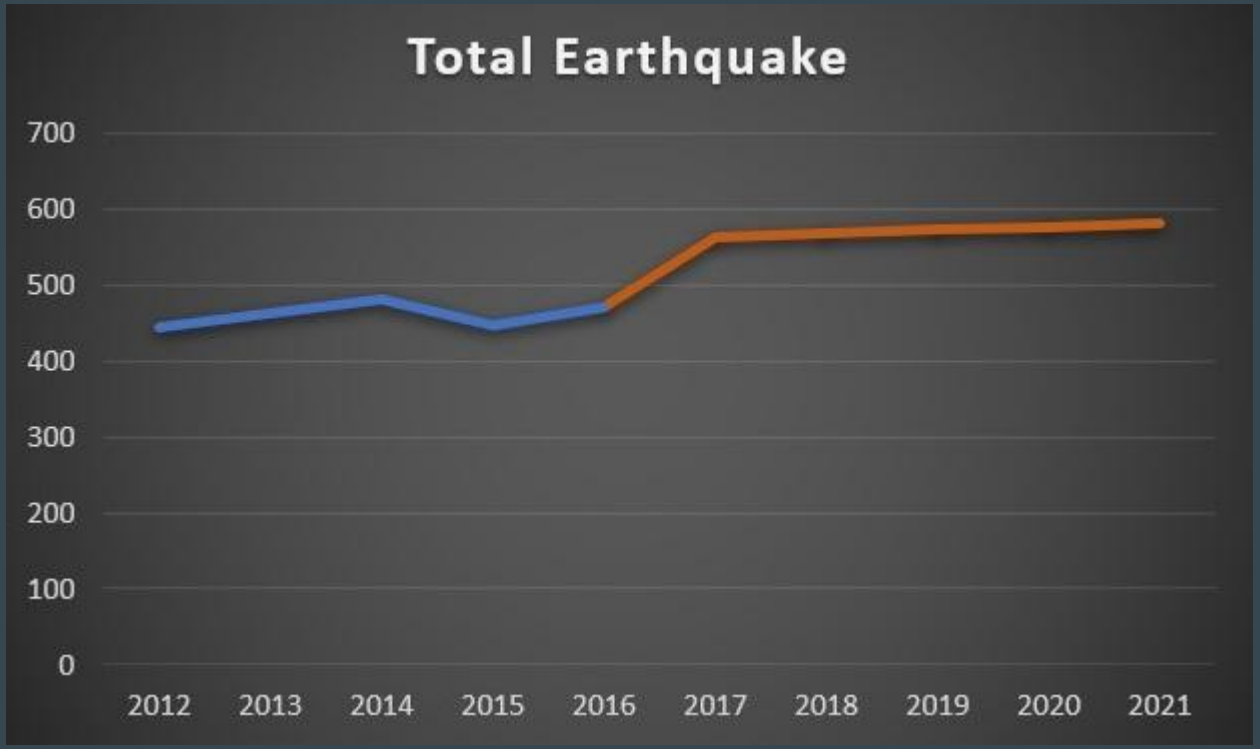
The average magnitude each the year 2017 is around 5.9.



A	I
29-Dec-2016	6.3
30-Dec-2016	5.5
1/1/2017	5.860138
1/2/2017	5.860135
1/3/2017	5.860132
1/4/2017	5.860130
1/5/2017	5.860127

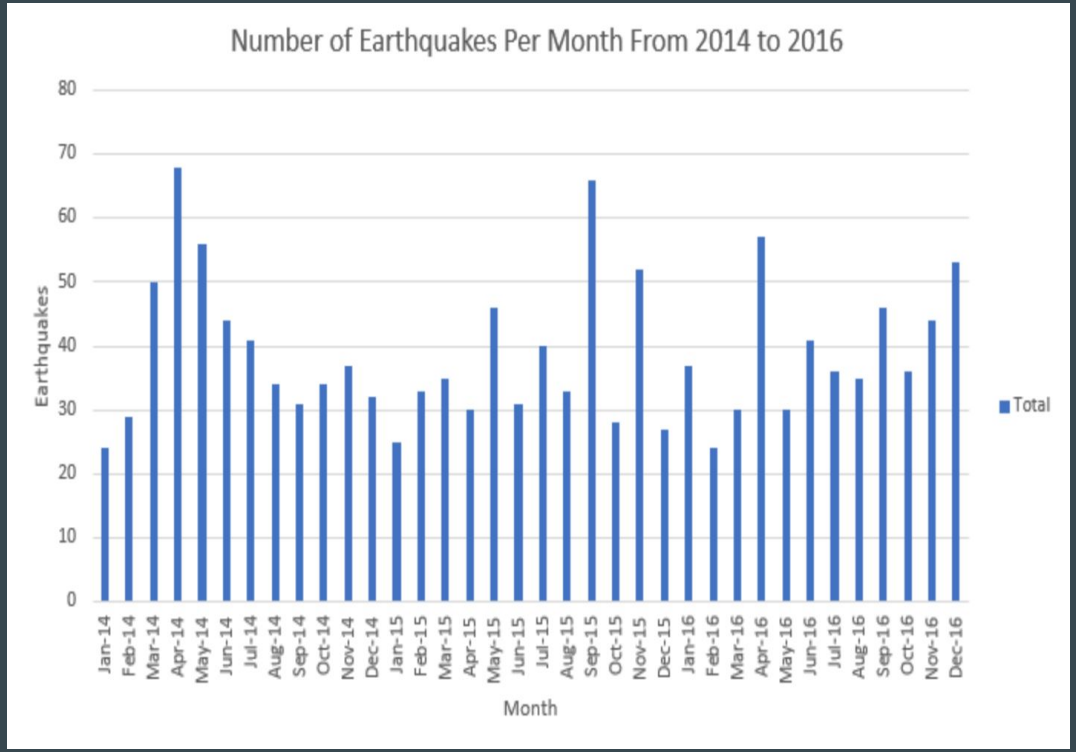
Trends Function (2017-2021)

Using the trends analysis, we found that the number of earthquake seems to be increasing per year.



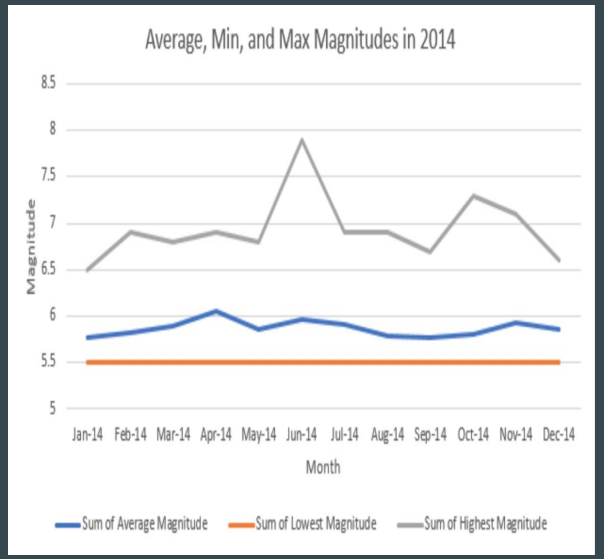
Pivot Table

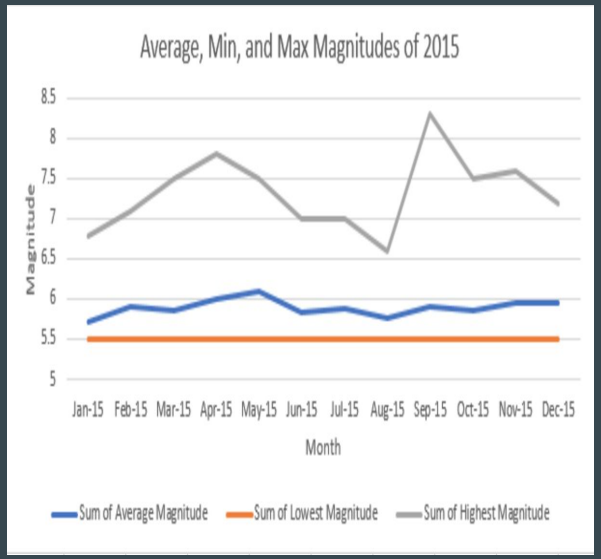
- Pivot Table helped filter out the dates that are not in between 2014-2016.
- Used the Countifs function to find the sum of earthquakes each month of 2014-2016.

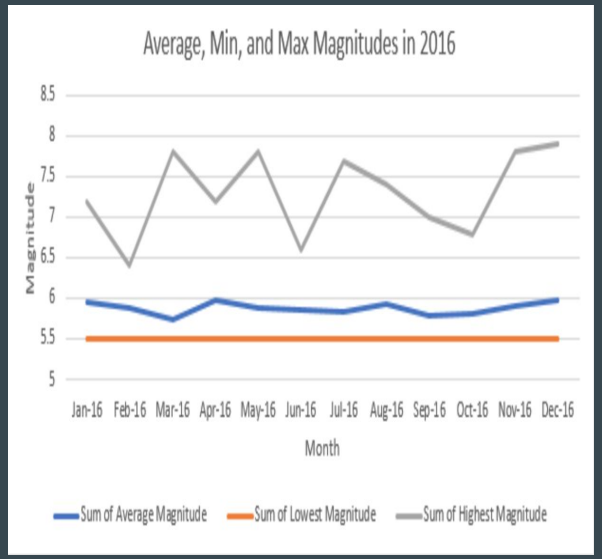


Pivot Table Cont.

- Used the AverageIfs function to find the averages of each month from 2014-2016.







What does this mean for businesses?

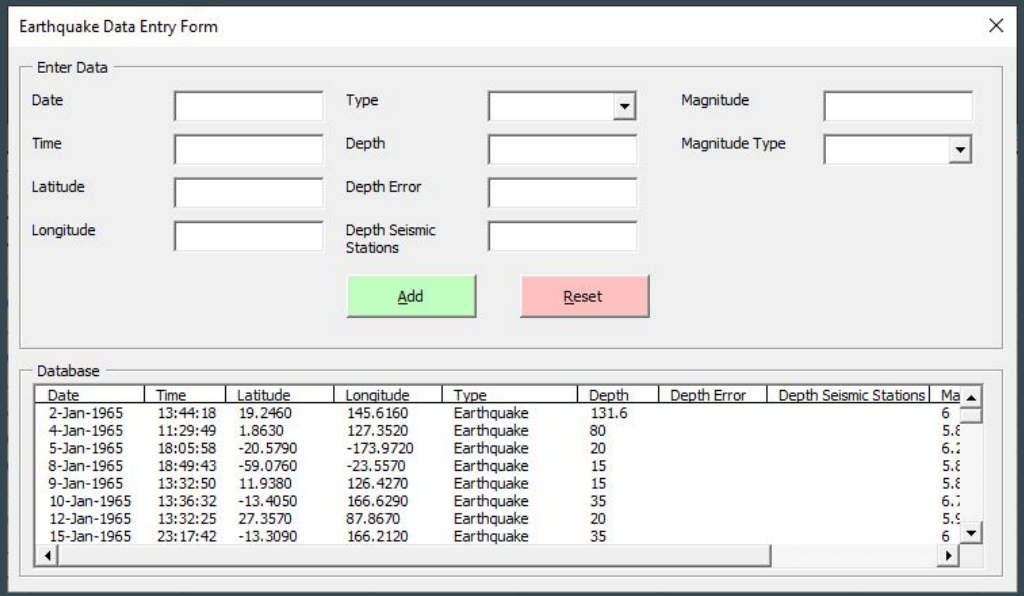
With earthquakes being predicted to increase every year businesses can use this information to be more prepared when an earthquake happens.

Userforms

Data entry form can be accessed through main worksheet via button.

The graphical user interface (GUI) for the data entry form.
It includes:

- Data entry
  - Dates
  - Time
  - Latitude / Longitude
  - Type of trigger (EQ, Nuclear)
  - Depth / Depth Error / # of Stations
  - Magnitude / Magnitude Type
- Real-time database list

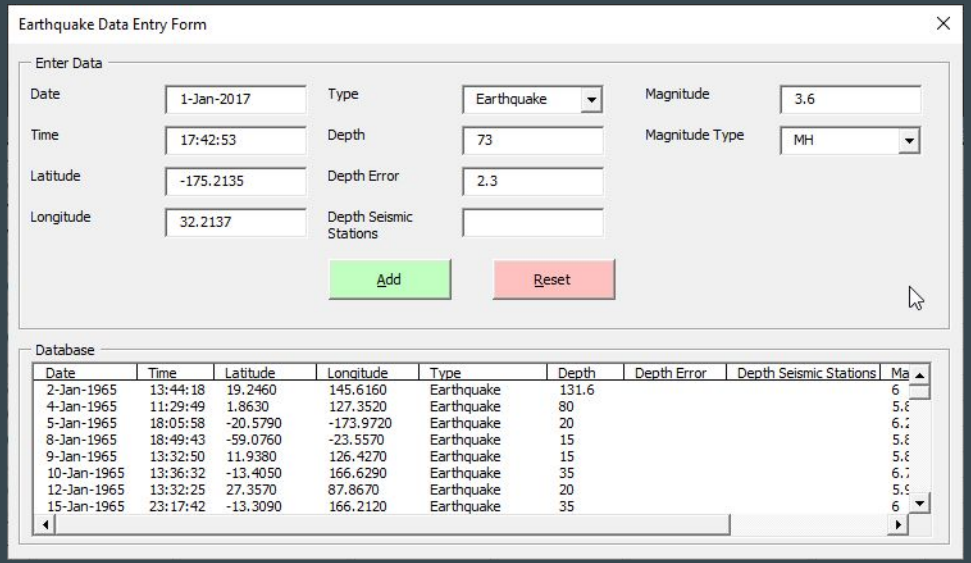


Userforms (cont.)

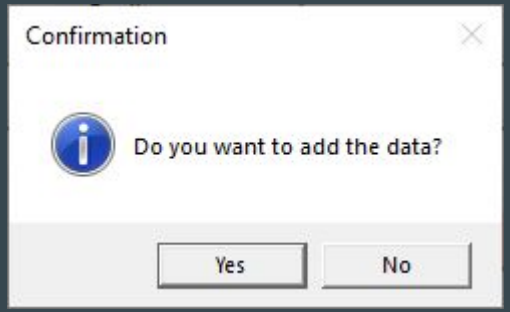
Input of data.

You can leave entries blank if data is unknown.

Blank entries will not affect data.

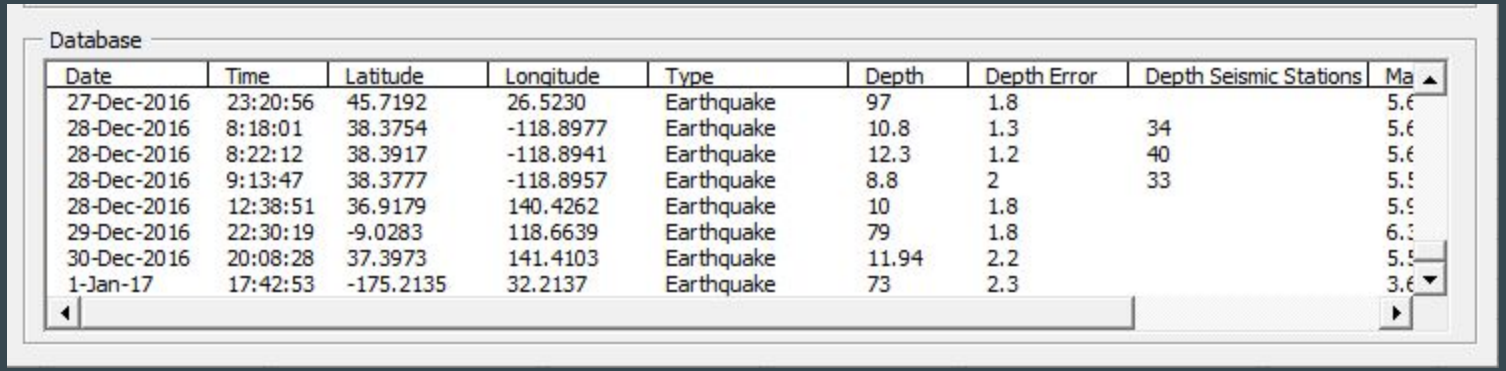


Confirmation prompt after clicking ‘Add’.



Userforms (cont.)

Data reflects on the userform database as well as the worksheet.



Database

Date	Time	Latitude	Longitude	Type	Depth	Depth Error	Depth Seismic Stations	Ma
27-Dec-2016	23:20:56	45.7192	26.5230	Earthquake	97	1.8		5.6
28-Dec-2016	8:18:01	38.3754	-118.8977	Earthquake	10.8	1.3	34	5.6
28-Dec-2016	8:22:12	38.3917	-118.8941	Earthquake	12.3	1.2	40	5.6
28-Dec-2016	9:13:47	38.3777	-118.8957	Earthquake	8.8	2	33	5.5
28-Dec-2016	12:38:51	36.9179	140.4262	Earthquake	10	1.8		5.9
29-Dec-2016	22:30:19	-9.0283	118.6639	Earthquake	79	1.8		6.3
30-Dec-2016	20:08:28	37.3973	141.4103	Earthquake	11.94	2.2		5.5
1-Jan-17	17:42:53	-175.2135	32.2137	Earthquake	73	2.3		3.6

23408	28-Dec-2016	8:18:01	38.3754	-118.8977	Earthquake	10.8	1.3	34	5.6	ML
23409	28-Dec-2016	8:22:12	38.3917	-118.8941	Earthquake	12.3	1.2	40	5.6	ML
23410	28-Dec-2016	9:13:47	38.3777	-118.8957	Earthquake	8.8	2	33	5.5	ML
23411	28-Dec-2016	12:38:51	36.9179	140.4262	Earthquake	10	1.8		5.9	MWW
23412	29-Dec-2016	22:30:19	-9.0283	118.6639	Earthquake	79	1.8		6.3	MWW
23413	30-Dec-2016	20:08:28	37.3973	141.4103	Earthquake	11.94	2.2		5.5	MB
23414	1-Jan-17	17:42:53	-175.2135	32.2137	Earthquake	73	2.3		3.6	MH
23415										
23416										
23417										

Challenges

- Complexity of algorithms to determine some values in calculations
- The variables in the data made it difficult to create a Power Pivot.
  - Some of the dates of the earthquakes was missing.
  - Creating a pivot table within the power pivot.
    - The column, “dates”, only showed months rather than the days in the month.
  - Difficult to find the top and bottom 10 magnitudes.
    - Dates that had multiple earthquakes in one day were shown.

Conclusion

- It is difficult for anyone to accurately predict future earthquakes and their magnitude.
- Many external factors to consider.
  - Shifts in tectonic plates
  - Other earthquakes causing subsequent shifts, etc.
- Because of these factors, prediction is often not what scientists pursue.
  - Mitigation techniques
  - Structural reinforcement
  - Load testing (Seismic stress tests)
  - Economic consequences as a result of destructive earthquakes
  - Financial planning