In [1]:

```python
# importing standard python libraries + geopandas for dealing with geospatial data
import geopandas as gpd
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline
```

In [2]:

```python
# reading shapefile of France divided into communes
gdf = gpd.read_file(r"CONTOURS-IRIS\1_DONNEES_LIVRAISON_2014\CONTOURS-IRIS_2-0_SHP_LAMB
93_FE-2014\CONTOURS-IRIS_FE.shp")
```

In [3]:

```python
# viewing geodataframe
gdf.head()
```

Out[3]:

	DEPCOM	NOM_COM	IRIS	DCOMIRIS	NOM_IRIS	TYP_IRIS	geometry
0	95580	Saint-Witz	0000	955800000	Saint-Witz	Z	POLYGON ((667826.500 6888732.700, 667871.500 6...
1	95258	Frouville	0000	952580000	Frouville	Z	POLYGON ((639020.100 6896582.300, 638964.900 6...
2	95116	Bruyères-sur-Oise	0000	951160000	Bruyères-sur-Oise	Z	POLYGON ((650549.700 6898511.300, 650534.500 6...
3	95308	Hérouville	0000	953080000	Hérouville	Z	POLYGON ((635467.800 6888554.700, 635389.470 6...
4	95055	Bellefontaine	0000	950550000	Bellefontaine	Z	POLYGON ((660098.000 6887893.200, 660133.100 6...

In [4]:

```
gdf.iloc[22]['geometry']
```

Out[4]:


In [4]:

```
gdf.iloc[22]['geometry']
```

Out[4]:

In [5]:
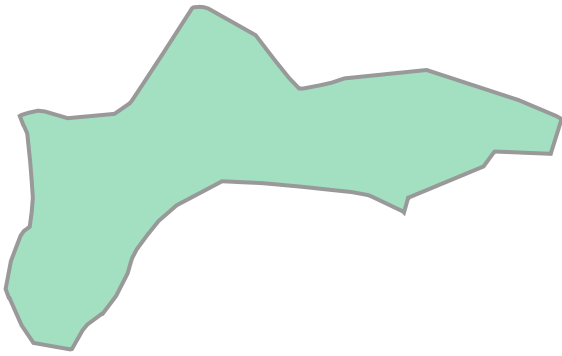
```python
# reading Excel sheet with number of avalanche accidents in communes
avalanche = pd.read_excel("tableau-accidents.xlsx")
avalanche.head()
```

Out[5]:

	code accident	date	heure	département	commune	massif	site	coordonnées\nzone départ
0	1011-05-01	2011-01-08	11:06	5	monetier les bains	pelvoux	cibouit	NaN
1	1011-05-02	2011-01-30	10:00	5	molines	queyras	col agnel	32t0339842 4950312
2	1011-05-03	2011-02-19	13:10	5	orcières	champsaur	col de la montagne haute / mourre froid	NaN
3	1011-05-04	2011-02-26	16:10	5	orcières	champsaur	col combeau / grande autane	32t 0292853 4947510
4	1011-05-05	2011-03-02	16:40	5	val des prés	queyras	vallon de Vachette / secteur ombilic	NaN

5 rows × 28 columns

In [6]:
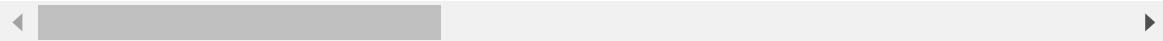
```python
# names of communes in geodataframe gdf and dataframe avalanche need to be in same form
at
# avoiding mixing upper and lowercase
avalanche['commune'] = avalanche.commune.str.lower()
gdf['NOM_COM'] = gdf.NOM_COM.str.lower()
```

In [7]:

```python
# eyeballing through manually inserted names of communes I found some double records
# for ex:'bagnères de luchon', 'bareges', 'barèges'
# or "val d'isere", "val d'isère",'val isere', 'val isère'
np.sort(avalanche.commune.unique())
```

Out[7]:

```
array(['abondance', 'abriès', 'aillons le vieux', 'aime', 'allemond',
       'allos', "alpe d'huez", 'araches la frasse', 'aragnouet',
       'arvieux', 'arêche beaufor', 'arêche beaufort', 'aston', 'aulon',
       'auris', 'auris en oisans', 'aussois', 'auzat', 'avoriaz',
       'avrieux', 'ax les thermes', 'bagnère de bigorre',
       'bagnères de bigorre', 'bagnères de luchon', 'bareges', 'barèges',
       'beaufort', 'bellentre', 'bellevaux', 'bernex', 'bessans',
       'bezaudun sur bine', 'bonneval', 'bonneval s/ arc',
       'bonneval sur arc', 'bourg saint maurice', 'bourg st maurice',
       'boutx', 'cauteret', 'cauterets', 'ceillac', 'cervières',
       'chamonix', 'champagny', 'champagny en vanoise', 'champcella',
       'chamrousse', 'chantelouve', 'chateauroux les alpes', 'chatel',
       'chevaline', 'contamines', 'contamines montjoie', 'cordon',
       'corrençon en vercors', "cote d'aime", 'courchevel', 'crots',
       'crévoux', 'doucy en bauges', 'dévoluy', 'eaux bonnes',
       'enchastrayes', 'entraunes', 'err', 'faverges-seythenex',
       'ferrère', 'fontcouverte la toussuire', 'formigueres',
       'freissiniere', "freney d'oisans", 'gavarnie', 'gedre', 'glandage',
       'gouaux de larboust', 'granier', 'guillestre', 'hauteluce',
       'isola', 'jarsy', 'jausiers', "l'hospitalet pres l'andorre",
       'la bathie', 'la chapelle en valgaudemar', 'la clusaz',
       'la combe de lancey', "la cote d'aime", 'la ferrière',
       "la ferrière d'allevard", 'la giettaz', 'la grave', 'la léchère',
       'la morte', 'la perrière', 'la plagne tarentaise',
       'la salle les alpes', 'la vigerie', 'landry', 'lanslebourg',
       'lanslevillard', 'laruns', 'laval', 'lavaldens', 'laveissière',
       'le bouchet montcharvin', 'le chatel', "le freney d'oisans",
       "le freneyr d'oisans", 'le grand bornand', 'le monetier les bains',
       'le mont dore', 'le monêtier les bains',
       'le petit bornand des glières', 'le reposoir', 'le vernet',
       'les adrets', 'les allues', 'les avanchers',
       'les avanchers-valmorel', 'les belleville', 'les clefs',
       'les contamines', 'les contamines montjoie', 'les deux alpes',
       'les houches', 'les orres', 'lozzi', 'macot', 'macot la plagne',
       'magland', 'manigod', 'metzeral', 'mieussy', 'mittlach', 'modane',
       'molines', 'molines en queyras', 'monetier', 'monetier les bains',
       'mont de lans', 'mont dore', 'montchavin', 'montclar',
       'montgellafrey', 'montgenevre', 'montgenèvre', 'montricher albane',
       'montricher albanne', 'montricher-albanne', 'montsapey',
       'montvalezan', 'monêtier les bains', 'morzine', 'méribel',
       'névache', 'ombleze', 'orcieres', 'orcières', 'orelle', 'ornon',
       'oz en oisans', 'oô', 'peisey', 'peisey nancroix',
       'peisey-nancroix', 'pelvoux', 'pinsot', 'pontamafrey montpascal',
       'porta', 'porté puymorens', 'pralognan', 'pralognan la vanoise',
       'praz sur arly', 'presle', 'puy saint vincent', 'puy st vincent',
       'rabat les trois seigneurs', 'revel', 'risoul', 'ristolas',
       'réallon', 'saint agnès', "saint andré d'embrun",
       'saint bon courchevel', 'saint bon tarentaise', 'saint chaffrey',
       'saint christophe en oisans', 'saint christophe sur guiers',
       'saint colomban les villards', 'saint crepin',
       'saint dalmas de selvage', 'saint etienne de tinee',
       'saint gervais', 'saint gervais les bains', 'saint honoré',
       'saint jean de belleville', 'saint martin belleville',
       'saint martin de belleville',
       'saint martin de belleville (val thorens)',
       'saint maurice sur moselle', 'saint pancrasse',
       'saint paul s/ ubaye', 'saint paul sur ubaye',
       'saint pierre de chartreuse', 'saint veran', 'saint véran',
       'sainte agnes', 'sainte foy tarentaise', 'sainte marie de cuines',
```

```
        'samoens', 'sarcenas', 'serraval', 'sers', 'seythenex', 'sixt',
        'sixt fer à cheval', 'st bernard du touvet', 'st bon tarentaise',
        'st christophe en oisans', 'st christophe sur guiers',
        'st dalmas le selvage', 'st etienne dévoluy', 'st etienne tinee',
        'st françois longchamp', 'st gervais les bains', 'st honoré',
        'st lary soulan', 'st martin de belleville', 'st martin vésubie',
        'st pierre de chartreuse', 'st véran', 'ste foy tarentaise',
        'stockersohn', 'stosswhir', 'stosswihr', 'termignon',
        'thollon les mémises', 'tignes', 'ustou', 'uvernet fours',
        'vacheresse', "val d'isere", "val d'isère", 'val des prés',
        'val isere', 'val isère', 'valloire', 'vallorcine', 'valmeinier',
        'vars', 'vaujany', 'vieille aure', 'villar arene',
        "villard d'arene", 'villard de lans', 'villards de lans',
        'villarodin bourget', 'villaroger', 'wasserbourg', 'épierre'],
      dtype=object)
```

In [8]:

```python
# because of inconsistent using of french special characters and some other characters
 I change them to unified writing
avalanche['commune'].replace(['è', 'é', 'ê', 'ë'], 'e', inplace=True, regex=True)
avalanche['commune'].replace('-', ' ', inplace=True, regex=True)
avalanche['commune'].replace('à', 'a',inplace=True, regex=True)
avalanche['commune'].replace('î', 'i',inplace=True, regex=True)
avalanche['commune'].replace('ô', 'o',inplace=True, regex=True)
avalanche['commune'].replace("d'", "d ", inplace=True, regex=True)
avalanche['commune'].replace(['st ', 'St '], 'saint ', inplace=True, regex=True)
avalanche['commune'].replace('s/', 'sur', inplace=True, regex=True)
gdf['NOM_COM'].replace(['è', 'é', 'ê', 'ë'], 'e', inplace=True, regex=True)
gdf['NOM_COM'].replace('-', ' ', inplace=True, regex=True)
gdf['NOM_COM'].replace(['à', 'â'], 'a',inplace=True, regex=True)
gdf['NOM_COM'].replace('î', 'i',inplace=True, regex=True)
gdf['NOM_COM'].replace('ô', 'o',inplace=True, regex=True)
gdf['NOM_COM'].replace("d'", "d ", inplace=True, regex=True)
gdf['NOM_COM'].replace(['st ', 'St '], 'saint ', inplace=True, regex=True)
gdf['NOM_COM'].replace('s/', 'sur', inplace=True, regex=True)
```

In [9]:

```python
# all commune names in avalanche communes should be also in gdf geodataframe
# to find avalanche communes missing from gdf because of use of inconsistent names
# I will merge both dataframes and check differences
aval_gdf = pd.merge(gdf, avalanche, left_on ='NOM_COM', right_on = 'commune', how='inner')
# creating two arrays of commune names in merged datafrane and avalanche dataframe
aval_gdf_com = np.sort(aval_gdf['NOM_COM'].unique())
avalanche_com = np.sort(avalanche['commune'].unique())
# looking for communes in avalanche dataframe not found in merged aval_gdf
np.setdiff1d(avalanche_com, aval_gdf_com)
```

Out[9]:

```
array(['aillons le vieux', 'alpe d huez', 'areche beafor',
       'areche beaufort', 'auris en oisans', 'avoriaz',
       'bagnere de bigorre', 'cauteret', 'chamonix', 'contamines',
       'contamines montjoie', 'cote d aime', 'courchevel',
       'faverges seythenex', 'freissiniere', 'freney d oisans',
       'la ferriere d allevard', 'la plagne tarentaise', 'la vigerie',
       'lanslebourg', 'le bouchet montcharvin', 'le freneyr d oisans',
       'le mont dore', 'le petit bornand des glieres', 'les avanchers',
       'les belleville', 'les contamines', 'les deux alpes', 'macot',
       'meribel', 'molines', 'monetier', 'monetier les bains',
       'montchavin', 'montricher albane', 'oz en oisans', 'peisey',
       'pralognan', 'saint agnes', 'saint bernard du touvet',
       'saint bon courchevel', 'saint colomban les villards',
       'saint dalmas de selvage', 'saint etienne devoluy',
       'saint etienne tinee', 'saint martin belleville',
       'saint martin de belleville (val thorens)', 'sixt',
       'ste foy tarentaise', 'stockersohn', 'stosswhir', 'val isere',
       'vieille aure', 'villar arene', 'villard d arene',
       'villards de lans'], dtype=object)
```

In [10]:

```
# I take 'alpe d huez' as example. Why it was not found in aval_gdf_com?
# correct name for commune is not 'alpe d huez', but just 'huez'
gdf[gdf.NOM_COM.str.contains(pat='crepin')]
```

Out[10]:

	DEPCOM	NOM_COM	IRIS	DCOMIRIS	NOM_IRIS	TYP_IRIS	geometry
18745	61339	putanges pont ecrepin	0000	613390000	Putanges-Pont-Écrepin	Z	POLYGON ((459538.600 6857933.400, 459568.600 6...
19604	60570	saint crepin ibouvillers	0000	605700000	Saint-Crépin-Ibouvillers	Z	POLYGON ((632796.600 6909698.000, 632890.520 6...
19857	60569	saint crepin aux bois	0000	605690000	Saint-Crépin-aux-Bois	Z	POLYGON ((701678.400 6927283.400, 701640.970 6...
39330	24391	saint crepin de richemont	0000	243910000	Saint-Crépin-de-Richemont	Z	POLYGON ((513735.100 6486445.400, 513777.130 6...
39378	24392	saint crepin et carlucet	0000	243920000	Saint-Crépin-et-Carlucet	Z	POLYGON ((565960.500 6427850.000, 565881.880 6...
39742	24390	saint crepin d auberoche	0000	243900000	Saint-Crépin-d'Auberoche	Z	POLYGON ((533502.200 6450714.900, 533502.500 6...
42421	17321	saint crepin	0000	173210000	Saint-Crépin	Z	POLYGON ((407928.800 6550148.800, 407962.220 6...
48084	05136	saint crepin	0000	051360000	Saint-Crépin	Z	POLYGON ((982424.700 6406169.100, 982434.000 6...

In [11]:

```python
# I will create dictionary with wrong commune names as keys and its correct variants as
values
# based on similar search as in previous example and wikipedia info about changes of co
mmune names
correct = {'aillons le vieux':'aillon le vieux', 'alpe d huez':'huez', 'areche beaufor'
:'beaufort savoie',
        'areche beaufort':'beaufort savoie','auris en oisans':'auris', 'avoriaz':'morzin
e',
        'bagnere de bigorre':'bagneres de bigorre', 'cauteret':'cauterets', 'chamonix':
'chamonix mont blanc',
        'contamines':'les contamines montjoie', 'contamines montjoie':'les contamines m
ontjoie',
        'cote d aime':'la plagne tarentaise', 'freissiniere':'freissinieres', 'freney d
oisans':'le freney d oisans',
        'la ferriere d allevard':'haut breda', 'la ferriere':'haut breda', 'la vigerie':
'lavigerie', 'la perriere':'courchevel',
        'lanslebourg':'lanslebourg mont cenis', 'le bouchet montcharvin':'le bouchet',
        'le freneyr d oisans':'le freney d oisans', 'le mont dore':'mont dore',
        'le petit bornand des glieres':'le petit bornand les glieres',
        'les avanchers':'les avanchers valmorel','les contamines':'les contamines montj
oie',
        'macot':'la plagne tarentaise', 'meribel':'les allues', 'molines':'molines en
 queyras',
        'monetier':'le monetier les bains', 'monetier les bains':'le monetier les bain
s',
        'montchavin':'la plagne tarentaise', 'montricher albane':'montricher albanne',
'oz en oisans':'oz',
        'peisey':'peisey nancroix', 'pralognan':'pralognan la vanoise', 'saint agnes':
'sainte agnes isere',
        'saint bernard du touvet':'le touvet', 'saint bon courchevel':'courchevel',
        'saint colomban les villards':'saint colomban des villards', 'saint dalmas de s
elvage':'saint dalmas le selvage',
        'saint etienne devoluy':'devoluy', 'saint etienne tinee':'saint etienne de tine
e', 'saint gervais':'saint gervais les bains',
        'saint martin belleville':'les belleville', 'saint martin de belleville (val th
orens)':'les belleville',
        'saint martin de belleville':'les belleville', 'saint crepin':'saint crepin alp
es',
        'sixt':'sixt fer a cheval', 'ste foy tarentaise':'sainte foy tarentaise', 'ser
s':'sers haute bigorre',
        'stockersohn':'storckensohn', 'stosswhir':'stosswihr',
        'val isere':'val d isere', 'vieille aure':'', 'villar arene':'villar d arene',
'villard d arene':'villar d arene',
        'villards de lans':'villard de lans', 'beaufort':'beaufort savoie', 'bonneval':
'bonneval sur arc', 'vars':'vars hautes alpes'}
```

In [12]:

```python
# loop to change wrong commune names, replacing dictionary key by value
correct_commune = []
for commune in avalanche.commune:
    if commune in list(correct.keys()):
        correct_commune.append(correct[commune])
    else:
        correct_commune.append(commune)
```

In [13]:

```
# checking column with corrected names is same length as original
(len(avalanche['commune'])) == (len(correct_commune))
```

Out[13]:

True

In [14]:

```
# adding column with correct column names
avalanche['commune'] = correct_commune
```

In [15]:

```
# some of commune names in gdf are outdated or same name is used for more communes
# therefore I create dictionary to correct them based on DEPCOM value

gdf_correct = {'73034':'beaufort savoie', '38350':'sainte agnes isere',
               '38163':'haut breda', '05177':'vars hautes alpes', '65046': 'aulon',
               '65424': 'sers haute bigorre', '05027':'cervieres hautes alpes',
               '73227':'courchevel', '73150':'la plagne tarentaise', '38253':'les deux a
lpes',
               '73257':'les belleville', '76589':'saint honore normandie',
               '04237':'le vernet', '39747':'sainte agnes jura',
               '05136':'saint crepin alpes', '06113':'sainte agnes pres nice',
               '31451':'revel occitanie', '53130':'laval mayenne',
               '11242':'montclar occitanie', '12149':'montclar occitanie 2',
               '74123':'faverges seythenex', '23011':'aulon aquitaine',
               '31023':'aulon occitanie', '73198':'courchevel',
               '16393':'vars aquitaine', '70523':'vars franche comte',
               '31051':'beaufort occitanie', '34026':'beaufort occitanie beziers',
               '38032':'beaufort isere', '39043':'beaufort orbagna', '59058':'beaufort
 nord',
               '30256':'saint gervais occitanie', '33415':'saint gervais aquitanie',
               '38390':'saint gervais isere', '95554':'saint gervais ile de france',
               '22058':'plemet', '37106':'la ferriere loire', '85089':'la ferrierre nan
tes',
               '28051':'bonneval loire', '43035':'bonneval haute loire', '73046':'la le
chere',
               '03306':'le vernet pres vichy','09331':'le vernet occitanie', '43260':'l
e vernet haute loire',
               '73198':'la perriere old', '73046':'bonneval old', '05177':'vars hautes a
lpes'}

# for loop to correct commune names
correct_commune_gdf = []
i = -1
for depcom in gdf.DEPCOM:
    i += 1
    if depcom in list(gdf_correct.keys()):
        correct_commune_gdf.append(gdf_correct[depcom])
    else:
        correct_commune_gdf.append(gdf.NOM_COM[i])
```

In [16]:

```python
# checking column with corrected names is same length as original
(len(gdf['NOM_COM'])) == (len(correct_commune_gdf))
```

Out[16]:

True

In [17]:

```python
# adding column with correct commune names
gdf['NOM_COM'] =correct_commune_gdf
```

In [18]:

```python
aval_gdf = pd.merge(gdf, avalanche, left_on ='NOM_COM', right_on = 'commune', how='inner')
aval_gdf_com = np.sort(aval_gdf['NOM_COM'].unique())
avalanche_com = np.sort(avalanche['commune'].unique())
```

In [19]:

```python
# check if there are still some communes missing from merged aval_gdf
# actually there are all old names of communes which need to be corrected to new ones
np.setdiff1d(avalanche_com, aval_gdf_com)
```

Out[19]:

```
array(['', 'macot la plagne', 'mont de lans', 'saint bon tarentaise'],
      dtype=object)
```

In [20]:

```python
# replacing old names based on wikipedia search of current names
# https://fr.wikipedia.org/wiki/M%C3%A2cot-la-Plagne
# https://fr.wikipedia.org/wiki/Mont-de-Lans
# https://fr.wikipedia.org/wiki/Saint-Bon-Tarentaise
avalanche.loc[avalanche['commune']=='macot la plagne', 'commune']='la plagne tarentaise'
avalanche.loc[avalanche['commune']=='mont de lans', 'commune']='les deux alpes'
avalanche.loc[avalanche['commune']=='saint bon tarentaise', 'commune']='courchevel'
# checking blankspace in commune
avalanche[avalanche.commune=='']
```

Out[20]:

	code accident	date	heure	département	commune	massif	site	coordonnées\nzon départ
73	1112-65-02	2012-02-18	NaN	65		haute bigorre	corneblanque	Na
416	1718-65-09	2018-02-23	NaN	65		aure louron	versant sud pic d'aygues cluses	42°52'15.8 0°10'0.

2 rows × 28 columns

◀   ▶
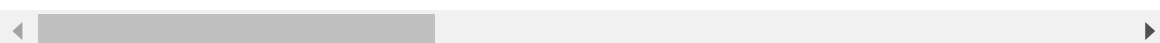
In [21]:

```python
# after search of sites inserting missing commune names
avalanche.loc[avalanche['code accident']=='1112-65-02', 'commune']='saint lary soulan'
avalanche.loc[avalanche['code accident']=='1718-65-09', 'commune']='vielle aure'
```

In [22]:

```python
# another check if all communes from avalanche dataframe are included
aval_gdf = pd.merge(gdf, avalanche, left_on ='NOM_COM', right_on = 'commune', how='inner')
aval_gdf_com = np.sort(aval_gdf['NOM_COM'].unique())
avalanche_com = np.sort(avalanche['commune'].unique())
# yes, finally all communes are in merged dataframe
np.setdiff1d(avalanche_com, aval_gdf_com)
```

Out[22]:

```
array([], dtype=object)
```

In [23]:

```python
# polygons in geodataframe are created for smaller unit then commune which is called ir
is
# in some cases there is more iris units for one commune, therefore I need to modify po
lygons
gdf[gdf.NOM_COM=='chamonix mont blanc']
```

Out[23]:

	DEPCOM	NOM_COM	IRIS	DCOMIRIS	NOM_IRIS	TYP_IRIS	geometry
11330	74056	chamonix mont blanc	0101	740560101	Les Bossons Les Moussoux	H	POLYGON ((996579.250 6540846.600, 996804.700 6...
11331	74056	chamonix mont blanc	0104	740560104	La Tour Argentiere Les Praz	H	POLYGON ((996579.250 6540846.600, 996536.450 6...
11332	74056	chamonix mont blanc	0102	740560102	Les Pelerins Le Betty	H	POLYGON ((999526.400 6542740.300, 999544.100 6...
11333	74056	chamonix mont blanc	0103	740560103	Chamonix Sud Bois du Bouchet	H	POLYGON ((999810.800 6544114.200, 999821.900 6...

In [24]:

```python
# creating polygons based on commune
# source 1 https://www.earthdatascience.org/workshops/gis-open-source-python/dissolve-p
olygons-in-python-geopandas-shapely/
# source 2 https://gis.stackexchange.com/questions/287064/dissolve-causes-no-shapely-ge
ometry-can-be-created-from-null-value-in-geopanda/287065
gdf['geometry'] = gdf.buffer(0.01)
commune_boundary = gdf[['DEPCOM', 'NOM_COM','geometry']]
gdf = commune_boundary.dissolve(by='DEPCOM')
```

In [25]:

```python
# counting number of avalance accindents for each commune
aval_final = (avalanche.groupby(['commune']).size()).sort_values(ascending=False)
# results put into new dataframe
aval_final = aval_final.to_frame().reset_index()
aval_final
```

Out[25]:

	commune	0
0	chamonix mont blanc	30
1	val d isere	23
2	tignes	23
3	les belleville	15
4	la clusaz	11
...	...	...
190	lozzi	1
191	magland	1
192	metzeral	1
193	mittlach	1
194	abondance	1

195 rows × 2 columns

In [26]:

```python
# renaming column to have clear description
aval_final.rename(columns={0:'count_of_avalanche_accidents'}, inplace=True)
aval_final.head()
```

Out[26]:

	commune	count_of_avalanche_accidents
0	chamonix mont blanc	30
1	val d isere	23
2	tignes	23
3	les belleville	15
4	la clusaz	11

In [27]:

```python
# creating final geodataframe to be transformed into graph via bokeh library
aval_gdf_final = pd.merge(gdf, aval_final, how='left', right_on='commune',left_on='NOM_
COM')
```

In [28]:

```
aval_gdf_final.sample(10)
```

Out[28]:

	geometry	NOM_COM	commune	count_of_avalanche_accidents
5957	POLYGON ((402447.401 6567668.990, 402347.911 6...	bouhet	NaN	NaN
4706	POLYGON ((429795.408 6890567.806, 429795.409 6...	coulvain	NaN	NaN
23762	POLYGON ((635709.613 6923384.681, 635709.613 6...	beauvais	NaN	NaN
2543	POLYGON ((784086.294 6940390.908, 784086.295 6...	conde les herpy	NaN	NaN
18246	POLYGON ((731528.909 6375730.404, 731528.910 6...	cultures	NaN	NaN
30764	POLYGON ((953603.294 6519320.008, 953603.295 6...	seythenex	seythenex	1.0
18332	POLYGON ((752247.703 6372175.309, 752315.213 6...	saint etienne du valdonnez	NaN	NaN
24200	POLYGON ((690893.596 6929103.491, 690893.595 6...	le plessis brion	NaN	NaN
32928	POLYGON ((624867.404 7016806.891, 624867.403 7...	estrees les crecy	NaN	NaN
8132	POLYGON ((629166.294 6554428.608, 629166.295 6...	lavaveix les mines	NaN	NaN

In [29]:

```
aval_gdf_final.fillna({'commune':'No avalanche', 'count_of_avalanche_accidents':'No ava
lanche'}, inplace = True)
# source https://towardsdatascience.com/a-complete-guide-to-an-interactive-geographical
-map-using-python-f4c5197e23e0
```

In [30]:

```python
aval_gdf_final.info()
```

```
<class 'geopandas.geodataframe.GeoDataFrame'>
Int64Index: 36595 entries, 0 to 36594
Data columns (total 4 columns):
geometry                    36595 non-null geometry
NOM_COM                     36595 non-null object
commune                     36595 non-null object
count_of_avalanche_accidents    36595 non-null object
dtypes: geometry(1), object(3)
memory usage: 1.4+ MB
```

In [31]:

```python
# importing bokeh elements
from bokeh.io import save
from bokeh.models import (ColorBar,
                          GeoJSONDataSource, HoverTool,
                          LinearColorMapper)
from bokeh.palettes import mpl
from bokeh.plotting import figure, output_file
# input GeoJSON source that contains features for plotting
import json
geosource = GeoJSONDataSource(geojson = aval_gdf_final.to_json())
```

In [32]:

```python
# define color palettes
palette = mpl['Viridis'][6]
palette = palette[::-1] # reverse order of colors so higher values have darker colors

# instantiate LinearColorMapper that linearly maps numbers in a range into a sequence of colors
# and nan values will be colored in grey
color_mapper = LinearColorMapper(palette = palette, low = 0, high = 30, nan_color = '#d9d9d9')

# define custom tick labels for color bar.
tick_labels = {'0': '1', '5': '5', '10':'10', '15':'15', '20':'20', '25':'25', '30':'30'}

# create color bar
color_bar = ColorBar(color_mapper = color_mapper,
                     label_standoff = 8,
                     width = 500, height = 20,
                     border_line_color = None,
                     location = (0,0),
                     orientation = 'horizontal',
                     major_label_overrides = tick_labels)

# create figure object

p = figure(title = 'Number of avalance accidents in commune',
          plot_height = 1400,
          plot_width = 1200,
          toolbar_location = 'below',
          tools = 'pan, wheel_zoom, box_zoom, reset')

p.xgrid.grid_line_color = None
p.ygrid.grid_line_color = None

# add patch renderer to figure.
communes = p.patches('xs','ys', source = geosource,
                    fill_color = {'field' :'count_of_avalanche_accidents',
                                  'transform' : color_mapper},
                    line_color = 'gray',
                    line_width = 0.20,
                    fill_alpha = 1)

# create hover tool
p.add_tools(HoverTool(renderers = [communes],
                    tooltips = [('Commune','@NOM_COM'),
                                ('Number of avalanche accidents','@count_of_avalanche_accidents')]))

p.add_layout(color_bar, 'below')


# final visualization can be seen as html page
output_file("mountains_danger.html")
save(p)
```

Out[32]:

'C:\\Users\\kamil\\OneDrive\\Plocha\\mountain_project\\mountain_avalanche\\mountains_danger.html'

In [ ]: