In [14]:
```
# https://pythonhosted.org/Python%20Shapefile%20Library/
import shapefile
```

In [3]:
```
sf = shapefile.Reader("pu_connect.shp")
```

In [4]:
```
shapes = sf.shapes()
```

In [5]:
```
len(shapes)
```

Out[5]:
```
653
```

In [6]:
```
dir(shapes[0])
```

Out[6]:
```
['_Shape__oid',
 '__class__',
 '__delattr__',
 '__dict__',
 '__dir__',
 '__doc__',
 '__eq__',
 '__format__',
 '__ge__',
 '__geo_interface__',
 '__getattribute__',
 '__gt__',
 '__hash__',
 '__init__',
 '__init_subclass__',
 '__le__',
 '__lt__',
 '__module__',
 '__ne__',
```

In [7]:
```
dir(shapes[1])
```

Out[7]:
```
['_Shape__oid',
 '__class__',
 '__delattr__',
 '__dict__',
 '__dir__',
 '__doc__',
 '__eq__',
 '__format__',
 '__ge__',
 '__geo_interface__',
 '__getattribute__',
 '__gt__',
 '__hash__',
 '__init__',
 '__init_subclass__',
 '__le__',
 '__lt__',
 '__module__',
 '__ne__',
```

In [8]:
```
shapes[3].shapeType
```

Out[8]:
```
5
```

In [9]:
```
shapes[3].bbox
```

Out[9]:
```
[148.00130666856472, -19.89423338879901, 148.14307771997147, -19.74115940118636]
```

In [10]:
```
shapes[3].points
```

Out[10]:
```
[(148.0021324713886, -19.778770930634515),
 (148.0729988455415, -19.74115940118636),
 (148.14307771997147, -19.780055185468264),
 (148.14232603767255, -19.85659250394776),
 (148.07142135911042, -19.89423338879901),
 (148.00130666856472, -19.855307584687562),
 (148.0021324713886, -19.778770930634515)]
```

In [11]:
```
shapes[3].parts
```

Out[11]:
```
[0]
```

In [12]:
```
shapes[3].shapeTypeName
```

Out[12]:
```
'POLYGON'
```

In [13]:
```
shapes[3].oid
```

Out[13]:
```
3
```

In [15]:
```
sf.fields
```

Out[15]:
```
[('DeletionFlag', 'C', 1, 0),
 ['FID', 'N', 24, 15],
 ['BIORE_102', 'N', 24, 15],
 ['BIORE_103', 'N', 24, 15],
 ['BIORE_114', 'N', 24, 15],
 ['BIORE_116', 'N', 24, 15],
 ['BIORE_117', 'N', 24, 15],
 ['BIORE_118', 'N', 24, 15],
 ['BIORE_119', 'N', 24, 15],
 ['BIORE_121', 'N', 24, 15],
 ['BIORE_13', 'N', 24, 15],
 ['BIORE_132', 'N', 24, 15],
 ['BIORE_142', 'N', 24, 15],
 ['BIORE_147', 'N', 24, 15],
 ['BIORE_15', 'N', 24, 15],
 ['BIORE_16', 'N', 24, 15],
 ['BIORE_23', 'N', 24, 15],
 ['BIORE_26', 'N', 24, 15],
 ['BIORE_27', 'N', 24, 15],
```

In [16]:
```
records = sf.records()
```

In [17]:
```
len(records)
```

Out[17]:
```
653
```

In [18]:
```
records[0]
```

Out[18]:
```
Record #0: [0.0, None, None, None, None, None, None, None, None, None, None, None, 76146210.7964392, None,
None, None, None, None, None, None, 0.000917735312108, 0, 0, 16, 0]
```

In [19]:
```
len(records[0]), len(sf.fields)
```

Out[19]:
```
(26, 27)
```

In [20]:
```
shapeRecs = sf.shapeRecords()
```

In [21]:
```
shapeRecs[3]
```

Out[21]:
```
<shapefile.ShapeRecord at 0x7f05933443a0>
```

In [22]:
```
shapeRecs[3].shape
```

Out[22]:
```
Shape #3: POLYGON
```

In [23]:
```
shapeRecs[3].record
```

Out[23]:
```
Record #3: [3.0, None, None, None, None, None, None, None, None, None, None, None, 106351934.752169, None,
None, None, None, None, None, None, 0.001106275494312, 0, 1, 23, 0]
```

In [24]:
```
dir(sf)
```

Out[24]:
```
['_Reader__dbfHdrLength',
 '_Reader__dbfHeader',
 '_Reader__fieldLookup',
 '_Reader__fullRecLookup',
 '_Reader__fullRecStruct',
 '_Reader__getFileObj',
 '_Reader__record',
 '_Reader__recordFields',
 '_Reader__recordFmt',
 '_Reader__recordLength',
 '_Reader__restrictIndex',
 '_Reader__shape',
 '_Reader__shapeIndex',
 '_Reader__shpHeader',
 '_Reader__shxHeader',
 '_Reader__shxOffsets',
 '__class__',
 '__del__',
 '__delattr__',
```

In [25]:
```
dir(shapeRecs)
```

Out[25]:
```
['__add__',
 '__class__',
 '__class_getitem__',
 '__contains__',
 '__delattr__',
 '__delitem__',
 '__dict__',
 '__dir__',
 '__doc__',
 '__eq__',
 '__format__',
 '__ge__',
 '__geo_interface__',
 '__getattribute__',
 '__getitem__',
 '__gt__',
 '__hash__',
 '__iadd__',
 '__imul__',
```

In [28]:
```
dir(shapeRecs[3])
```

Out[28]:
```
['__class__',
 '__delattr__',
 '__dict__',
 '__dir__',
 '__doc__',
 '__eq__',
 '__format__',
 '__ge__',
 '__geo_interface__',
 '__getattribute__',
 '__gt__',
 '__hash__',
 '__init__',
 '__init_subclass__',
 '__le__',
 '__lt__',
 '__module__',
 '__ne__',
 '__new__',
```

In [29]:
```
dir(shapeRecs[3].shape)
```

Out[29]:
```
['_Shape__oid',
 '__class__',
 '__delattr__',
 '__dict__',
 '__dir__',
 '__doc__',
 '__eq__',
 '__format__',
 '__ge__',
 '__geo_interface__',
 '__getattribute__',
 '__gt__',
 '__hash__',
 '__init__',
 '__init_subclass__',
 '__le__',
 '__lt__',
 '__module__',
 '__ne__',
```

In [30]:
```
dir(shapeRecs[3].record)
```

Out[30]:
```
['BIORE_102',
 'BIORE_103',
 'BIORE_114',
 'BIORE_116',
 'BIORE_117',
 'BIORE_118',
 'BIORE_119',
 'BIORE_121',
 'BIORE_13',
 'BIORE_132',
 'BIORE_142',
 'BIORE_147',
 'BIORE_15',
 'BIORE_16',
 'BIORE_23',
 'BIORE_26',
 'BIORE_27',
 'BIORE_29',
 'BIORE_3',
```

In [32]:
```
shapeRecs[3].record.BIORE_103
```

In [33]:
```
# https://pypi.org/project/pyshp/#reading-shapefiles
```

In [34]:
```
print(sf)
```

```
shapefile Reader
    653 shapes (type 'POLYGON')
    653 records (27 fields)
```

In [35]:
```
sf.mbox
```

Out[35]:
```
[0.0, 0.0]
```

In [36]:
```
sf.zbox
```

Out[36]:
```
[0.0, 0.0]
```

In [37]:
```
# https://geopandas.org/en/stable/docs/user_guide/io.html
```

In [39]:
```
import geopandas
```

In [46]:
```
pu_connect = geopandas.read_file("pu_connect.shp")
pu_connect
```

Out[46]:

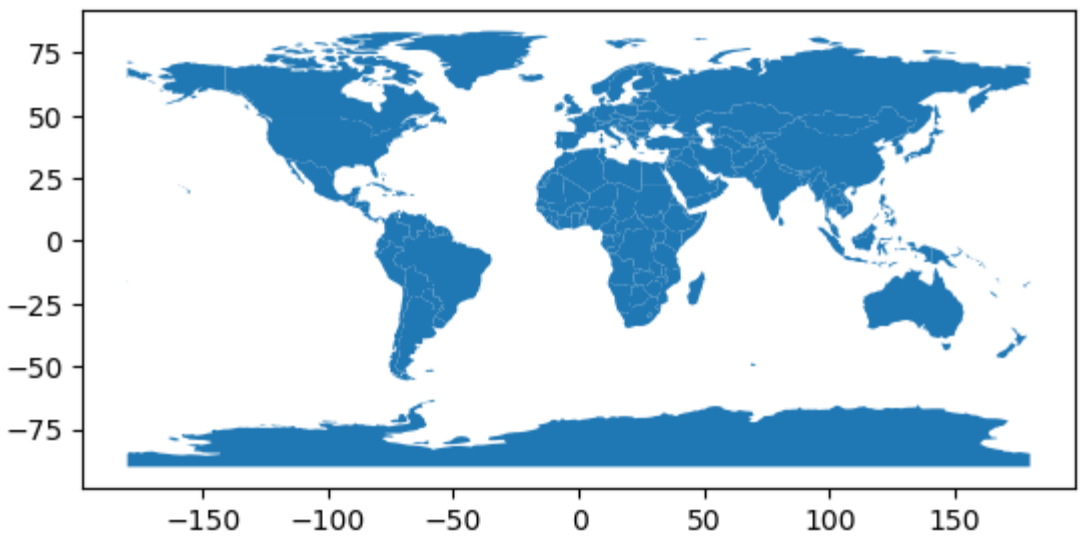
	FID	BIORE_102	BIORE_103	BIORE_114	BIORE_116	BIORE_117	BIORE_118	BIORE_119	BIORE_121	BIORE_13	...	BIORE_27	BIORE_
0	0.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	N
1	1.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	N
2	2.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	N

In [41]:
```
# https://geopandas.org/en/stable/docs/user_guide/mapping.html
world = geopandas.read_file(geopandas.datasets.get_path('naturalearth_lowres'))
```

In [42]:
```
cities = geopandas.read_file(geopandas.datasets.get_path('naturalearth_cities'))
```

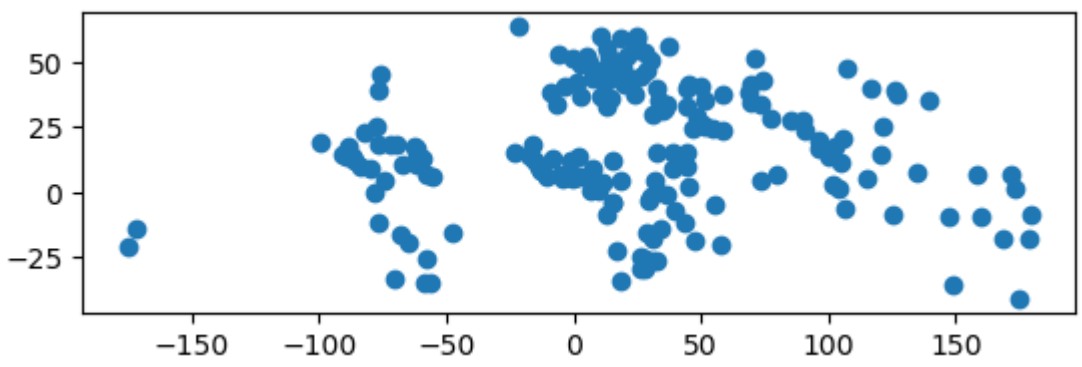
In [43]:
```
world.plot()
```

Out[43]: <AxesSubplot:>

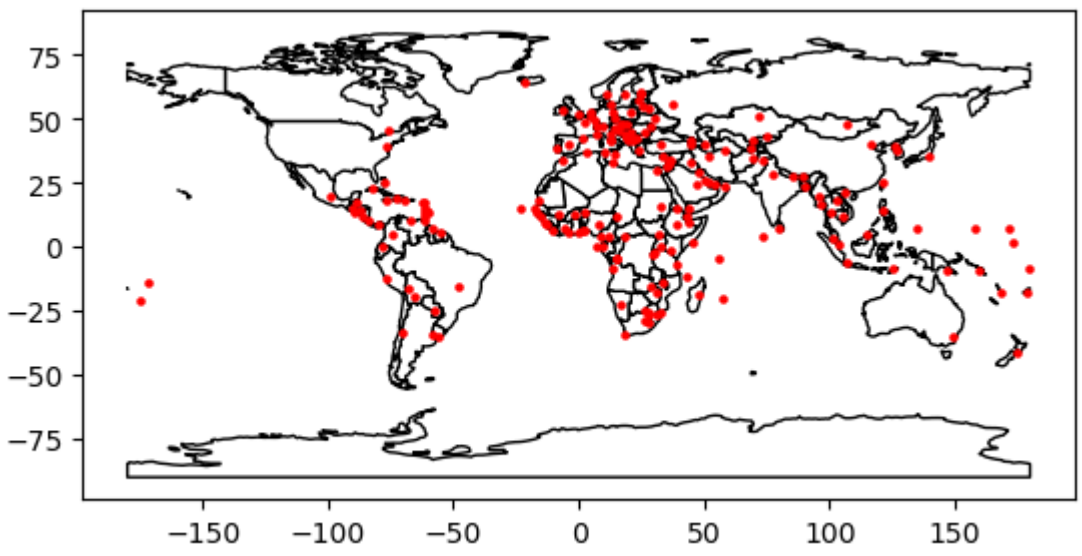


In [44]:
```
cities.plot()
```

Out[44]: <AxesSubplot:>

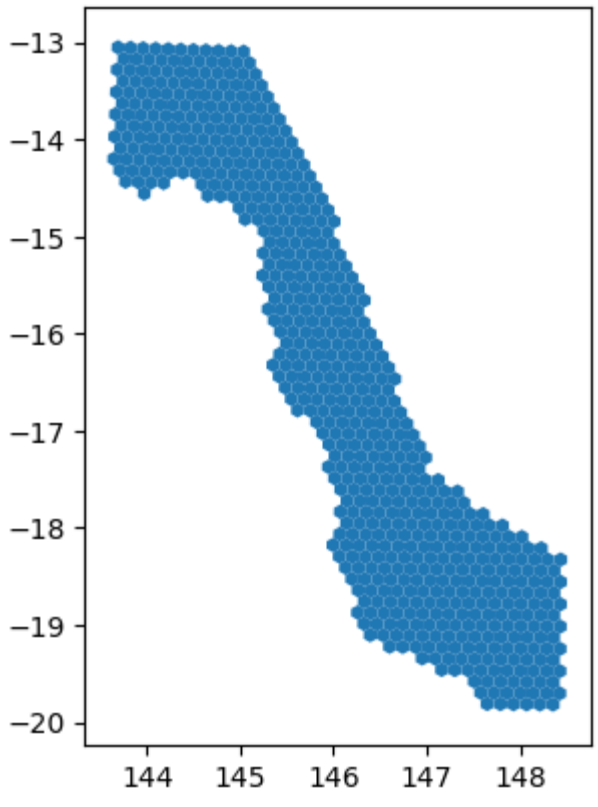


In [45]:
```
base = world.plot(color='white', edgecolor='black')
cities.plot(ax=base, marker='o', color='red', markersize=5);
```



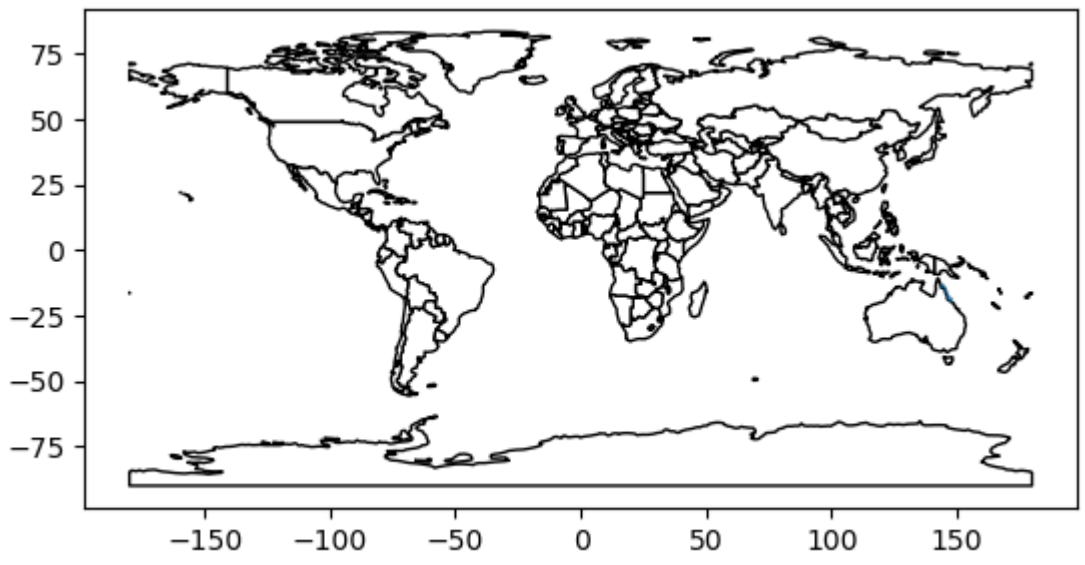
In [47]:
```
pu_connect.plot()
```

Out[47]: <AxesSubplot:>



In [49]:
```
base = world.plot(color='white', edgecolor='black')
pu_connect.plot(ax=base)
```

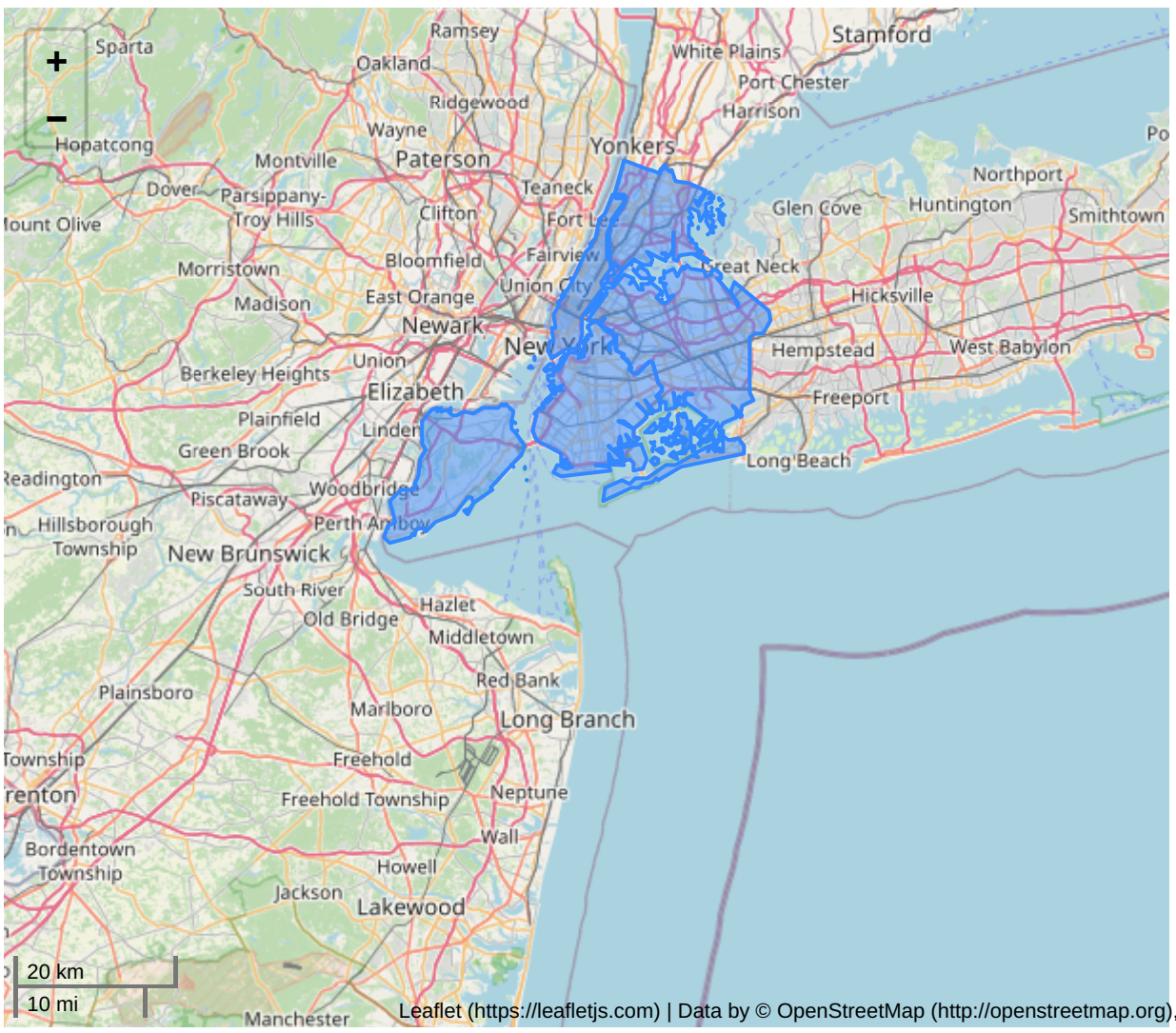
Out[49]: <AxesSubplot:>



In [51]:
```
# https://geopandas.org/en/stable/docs/user_guide/interactive_mapping.html
nybb = geopandas.read_file(geopandas.datasets.get_path('nybb'))
world = geopandas.read_file(geopandas.datasets.get_path('naturalearth_lowres'))
cities = geopandas.read_file(geopandas.datasets.get_path('naturalearth_cities'))
```

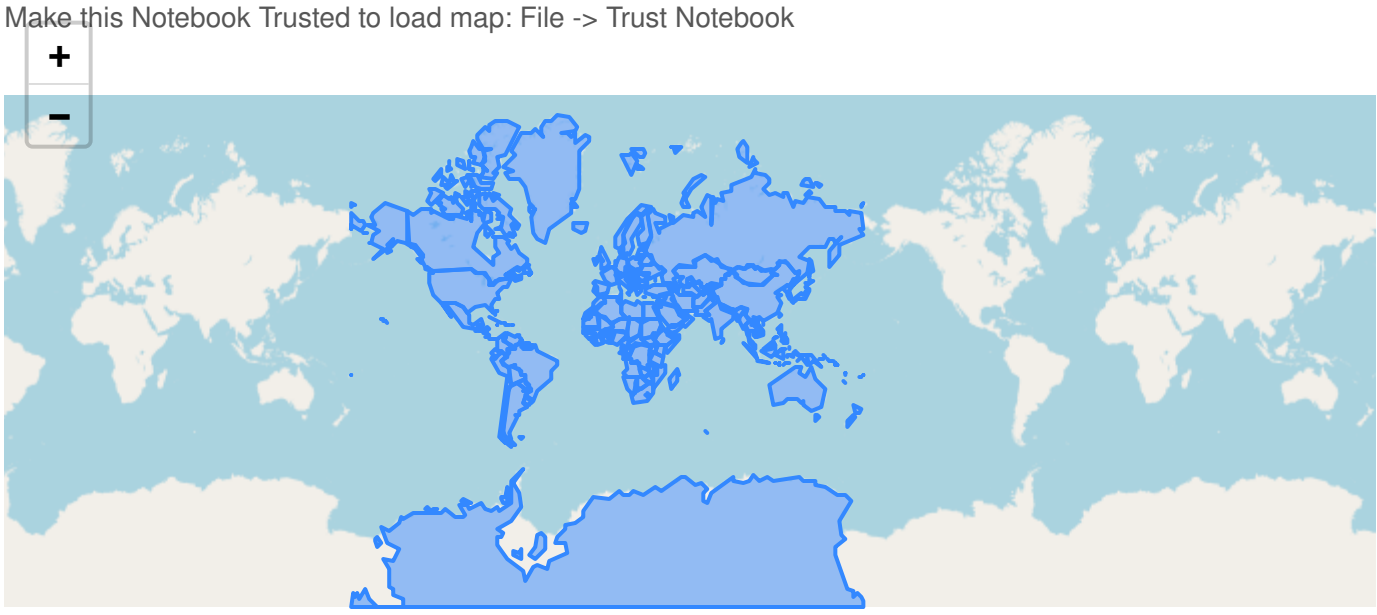
In [59]:
```
nybb.explore()
```

Out[59]:



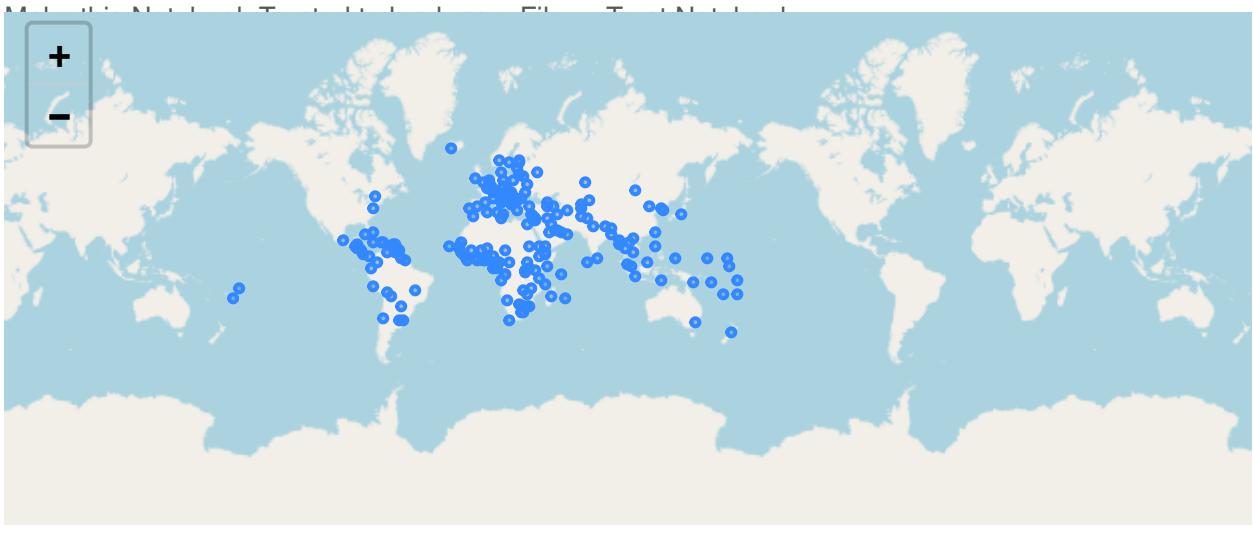
In [60]:
```
world.explore()
```

Out[60]: Make this Notebook Trusted to load map: File -> Trust Notebook



In [61]:
```
cities.explore()
```

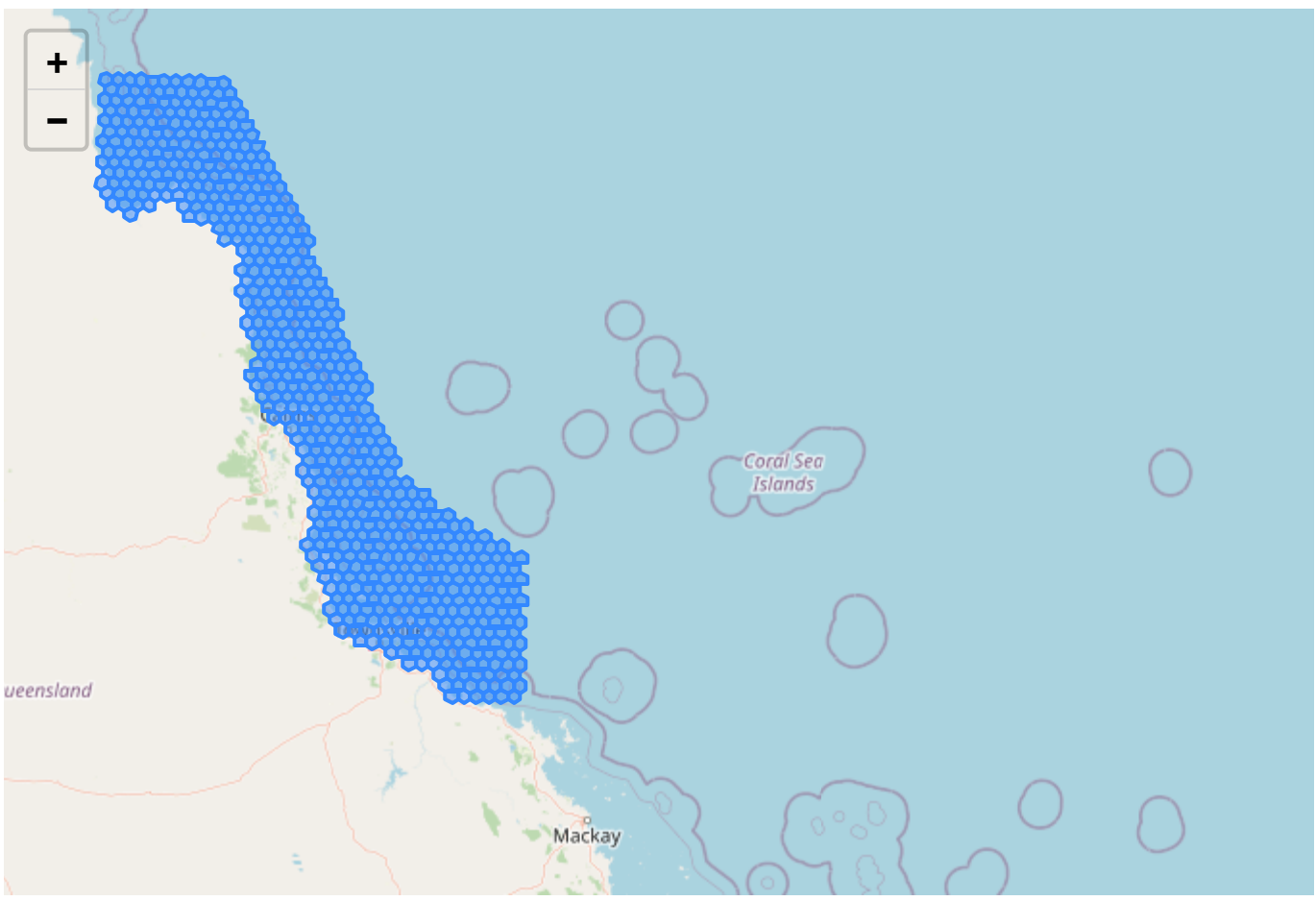
Out[61]:



5000 km
3000 mi

In [62]:
```
pu_connect.explore()
```

Out[62]:

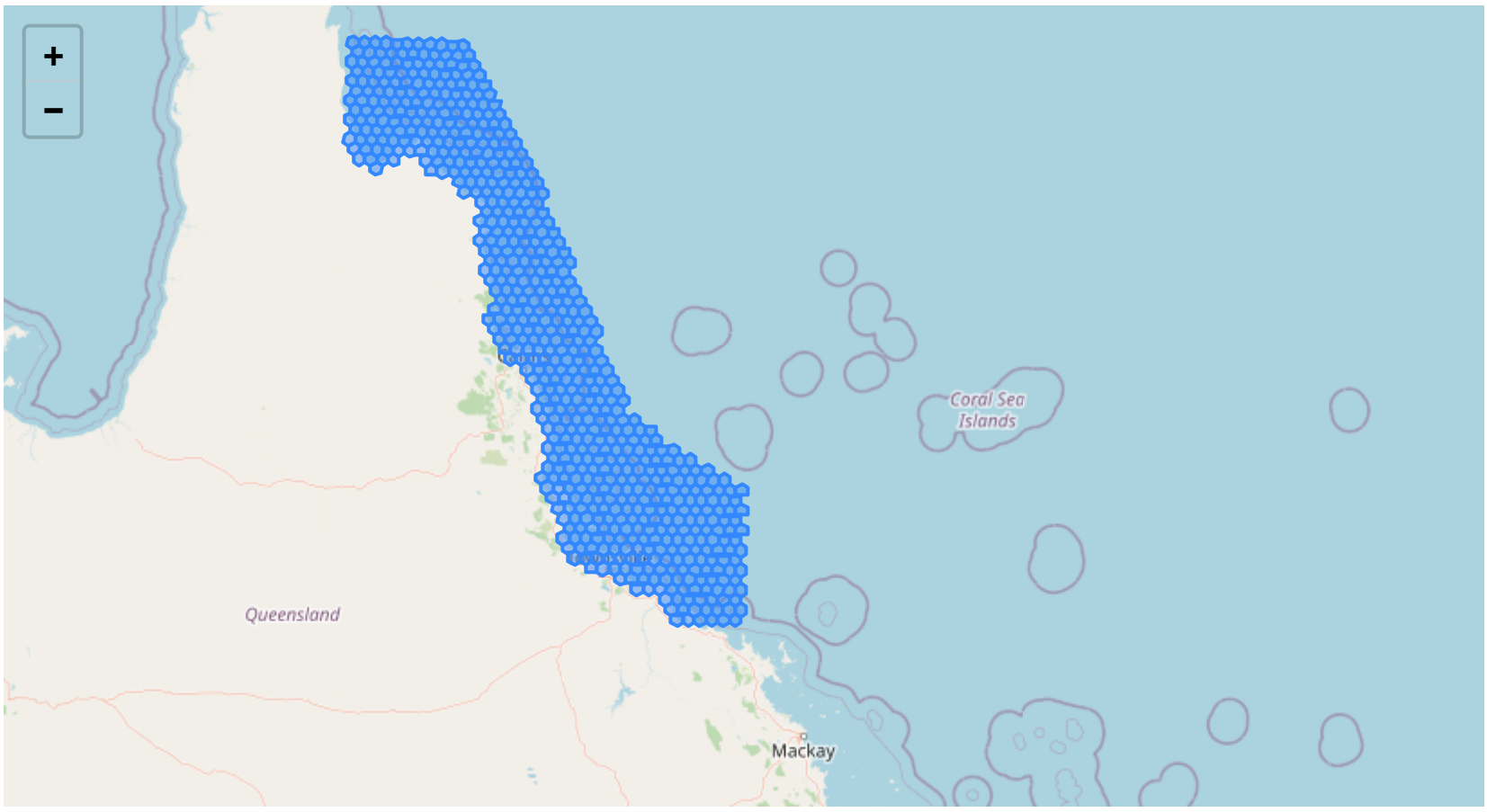


200 km
100 mi

In [64]:
```
pu_no_connect = geopandas.read_file("pu_no_connect.shp")
```

In [65]:
```
pu_no_connect.explore()
```

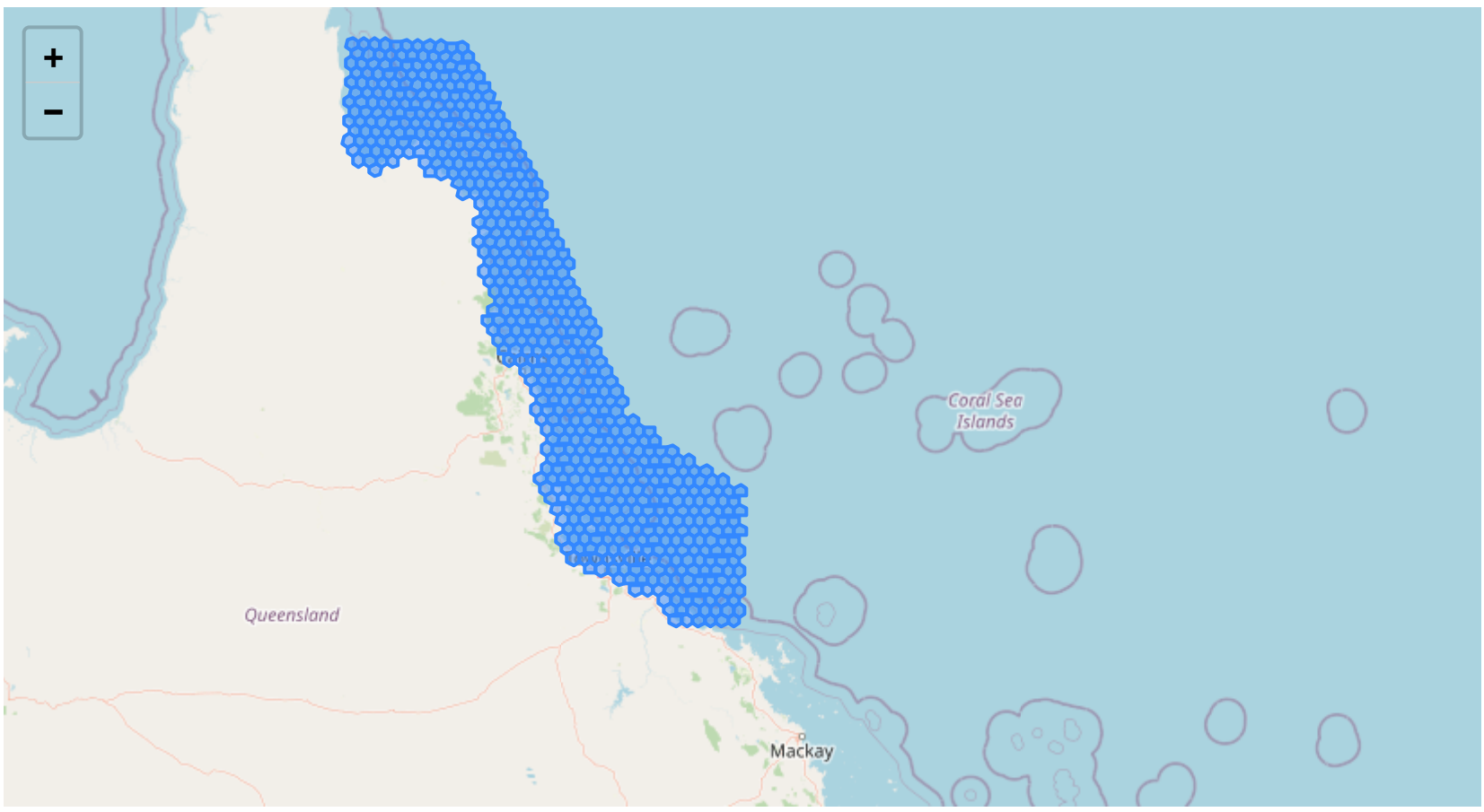
Out[65]:



In [66]:
```
hex_planning_units = geopandas.read_file("../hex_planning_units.shp")
```

In [67]:
```
hex_planning_units.explore()
```

Out[67]:



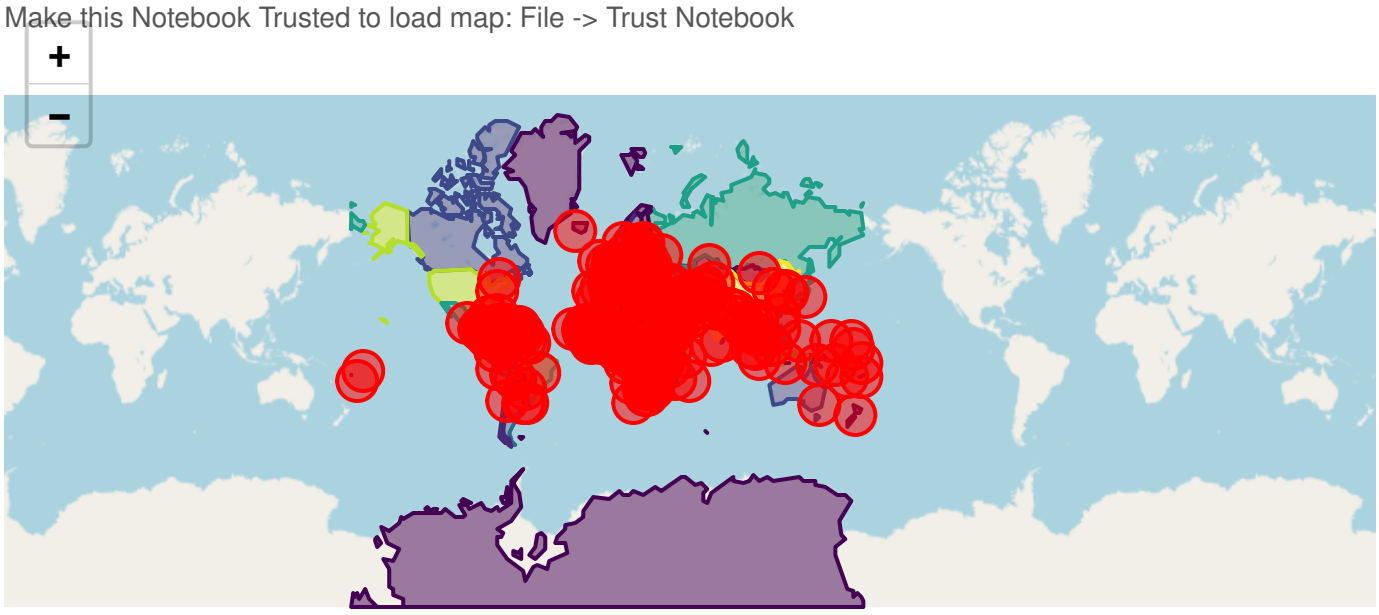
In [69]:
```
nybb.explore(
     column="BoroName", # make choropleth based on "BoroName" column
     tooltip="BoroName", # show "BoroName" value in tooltip (on hover)
     popup=True, # show all values in popup (on click)
     tiles="CartoDB positron", # use "CartoDB positron" tiles
     cmap="Set1", # use "Set1" matplotlib colormap
     style_kwds=dict(color="black") # use black outline
    )
```

Out[69]:

In [71]:
```
import folium

m = world.explore(
     column="pop_est",  # make choropleth based on "BoroName" column
     scheme="naturalbreaks",  # use mapclassify's natural breaks scheme
     legend=True, # show legend
     k=10, # use 10 bins
     legend_kwds=dict(colorbar=False), # do not use colorbar
     name="countries" # name of the layer in the map
)

cities.explore(
     m=m, # pass the map object
     color="red", # use red color on all points
     marker_kwds=dict(radius=10, fill=True), # make marker radius 10px with fill
     tooltip="name", # show "name" column in the tooltip
     tooltip_kwds=dict(labels=False), # do not show column label in the tooltip
     name="cities" # name of the layer in the map
)

folium.TileLayer('Stamen Toner', control=True).add_to(m)  # use folium to add alternative tiles
folium.LayerControl().add_to(m)  # use folium to add layer control

m  # show map
```

Out[71]:

Make this Notebook Trusted to load map: File -> Trust Notebook

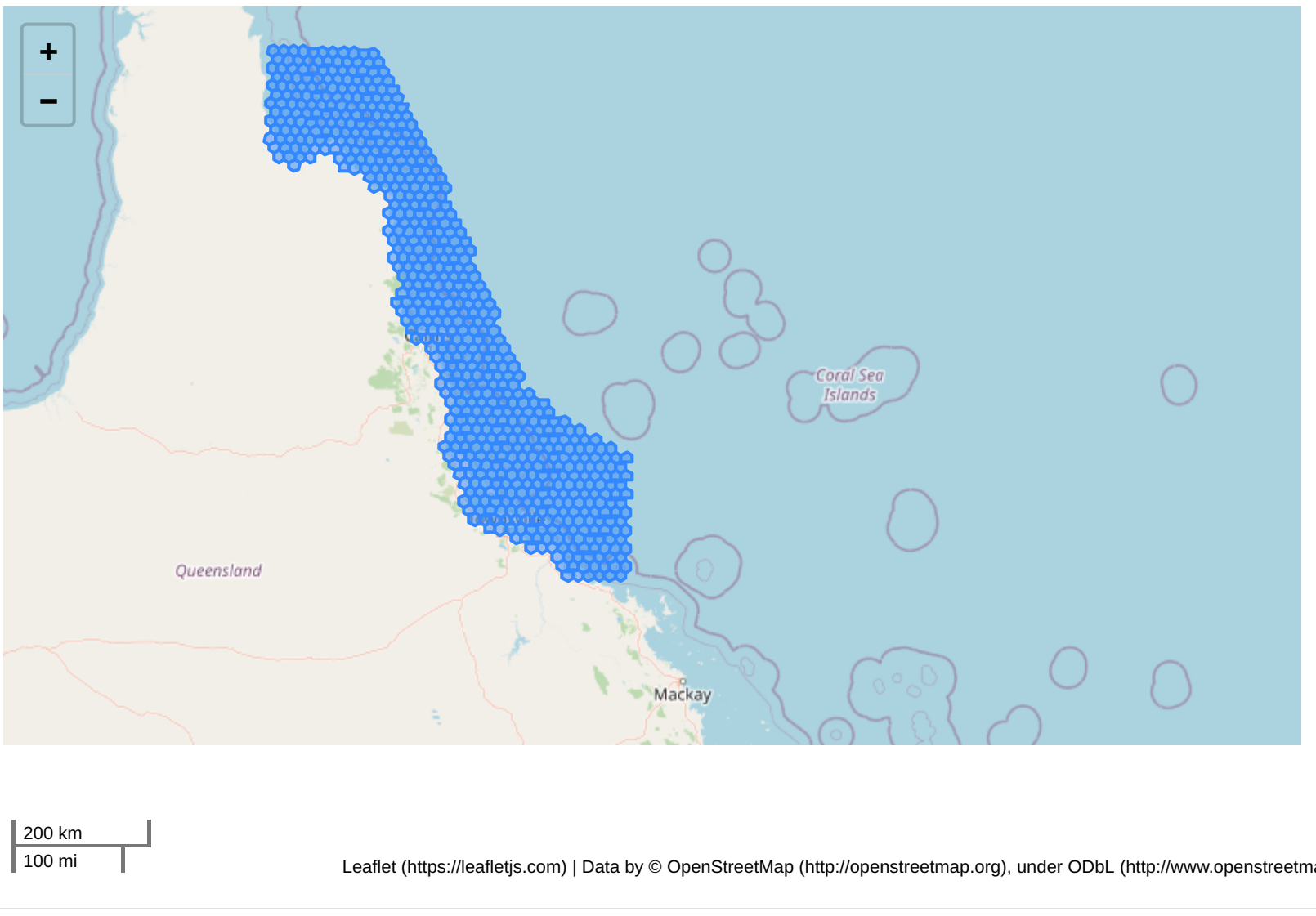


pop_est

- 140.00, 8082366.00
- 8082366.00, 21803000.00
- 21803000.00, 39309783.00
- 39309783.00, 69625582.00
- 69625582.00, 112078730.00
- 112078730.00, 163046161.00
- 163046161.00, 216565318.00
- 216565318.00, 270625568.00
- 270625568.00, 328239523.00
- 328239523.00, 1397715000.00

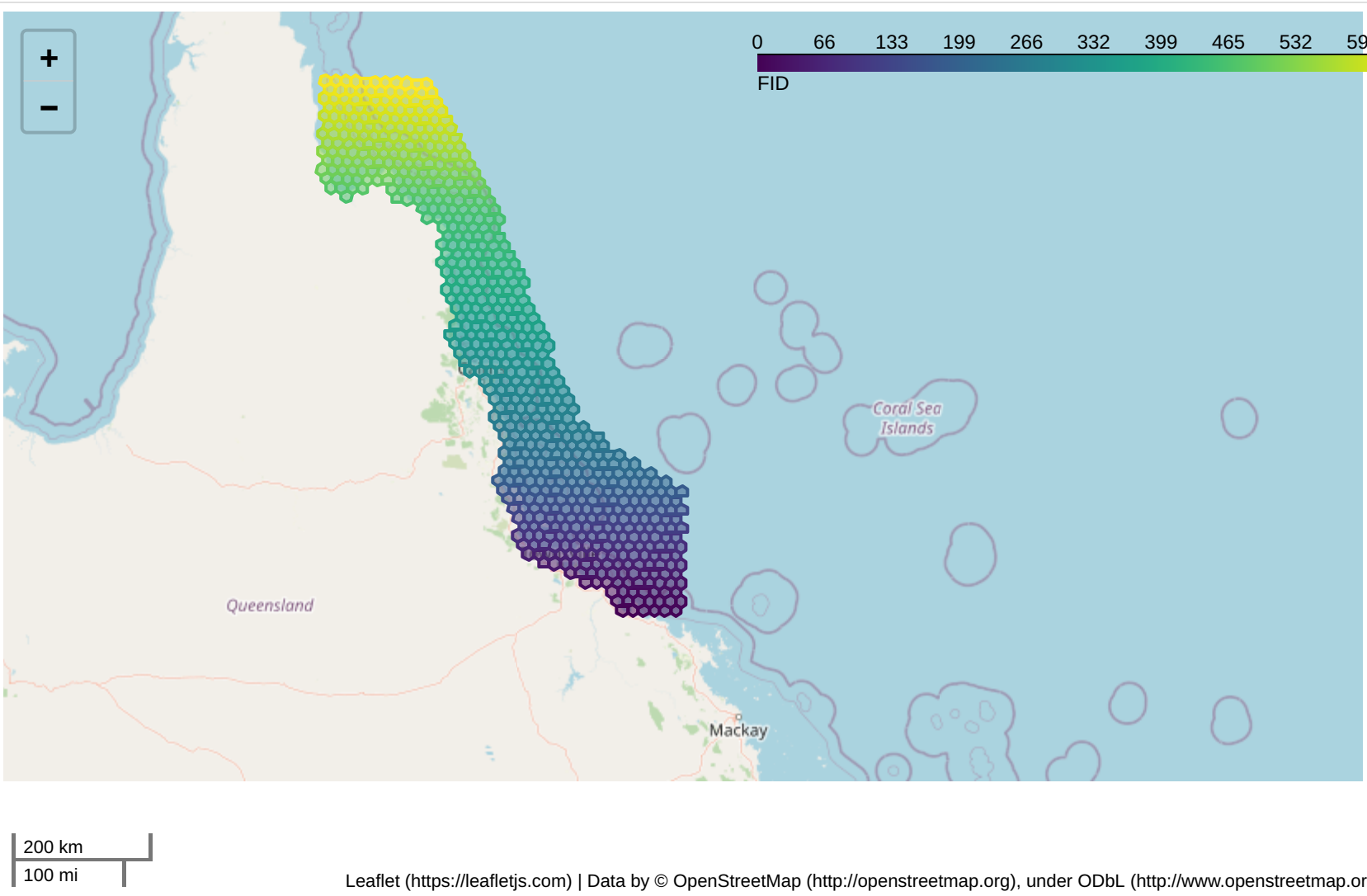
In [72]:
```
hex_planning_units.explore()
```

Out[72]:



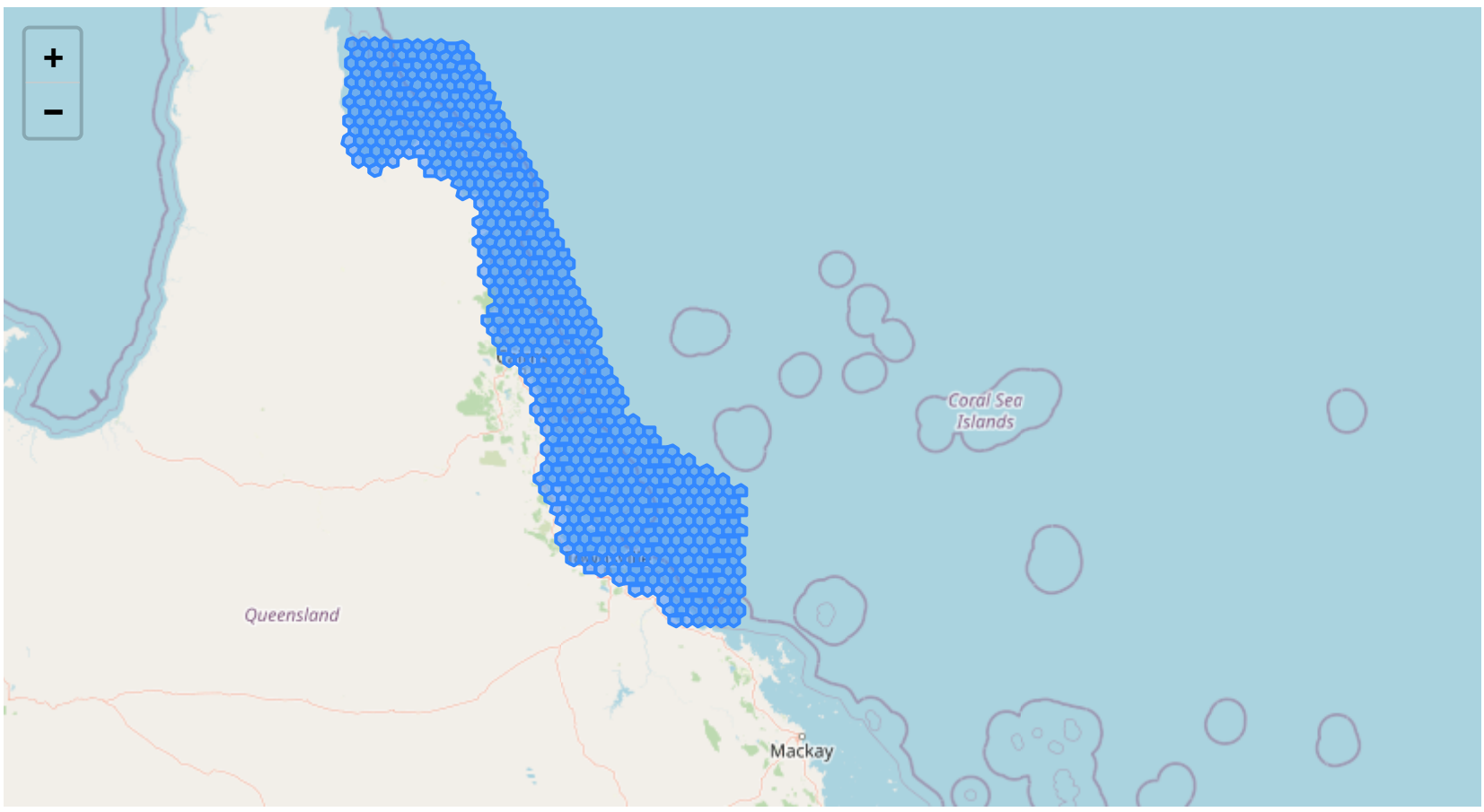
In [73]:
```
hex_planning_units.explore(column="FID")
```

Out[73]:



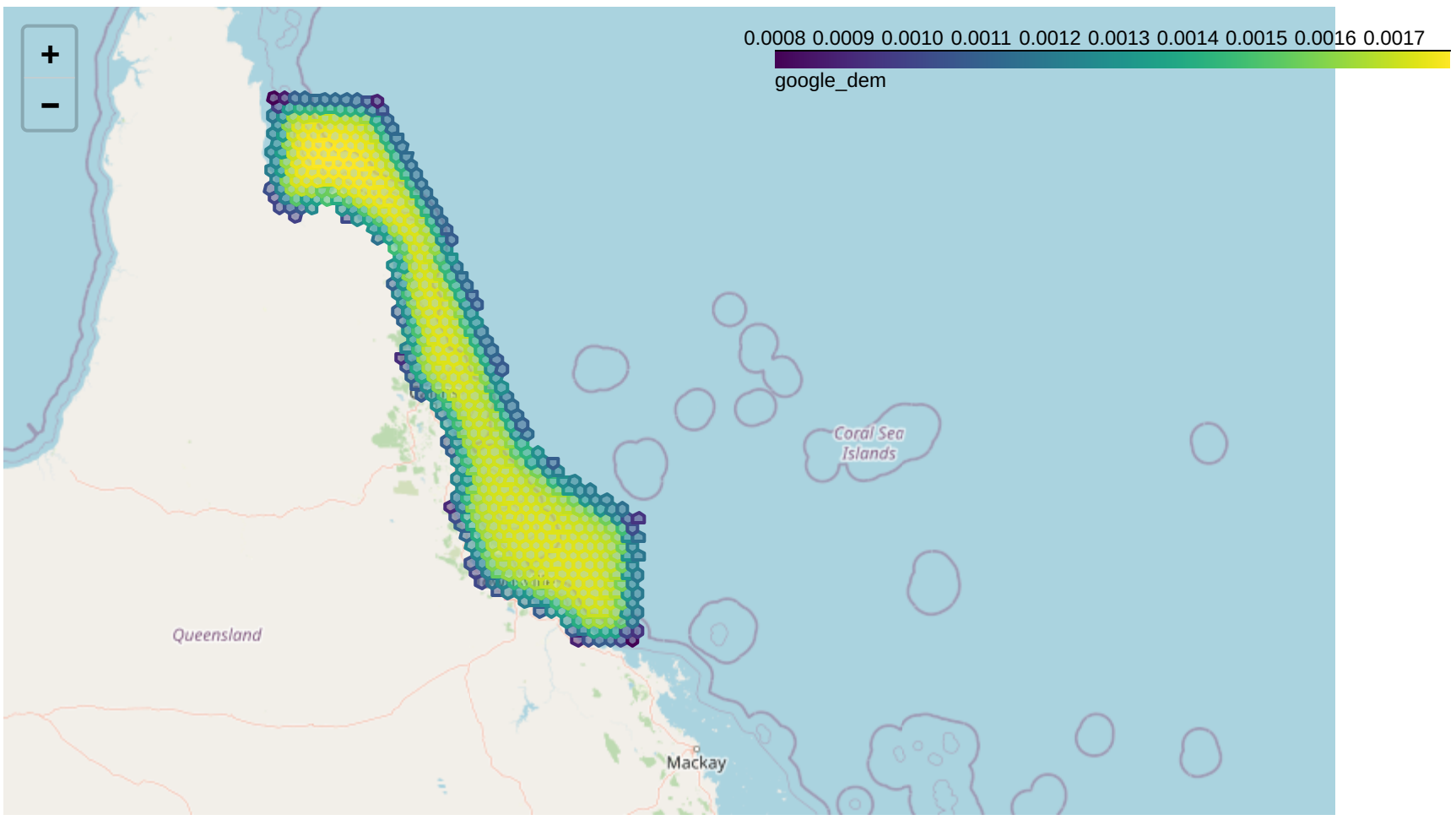
In [74]:
```
pu_connect.explore()
```

Out[74]:



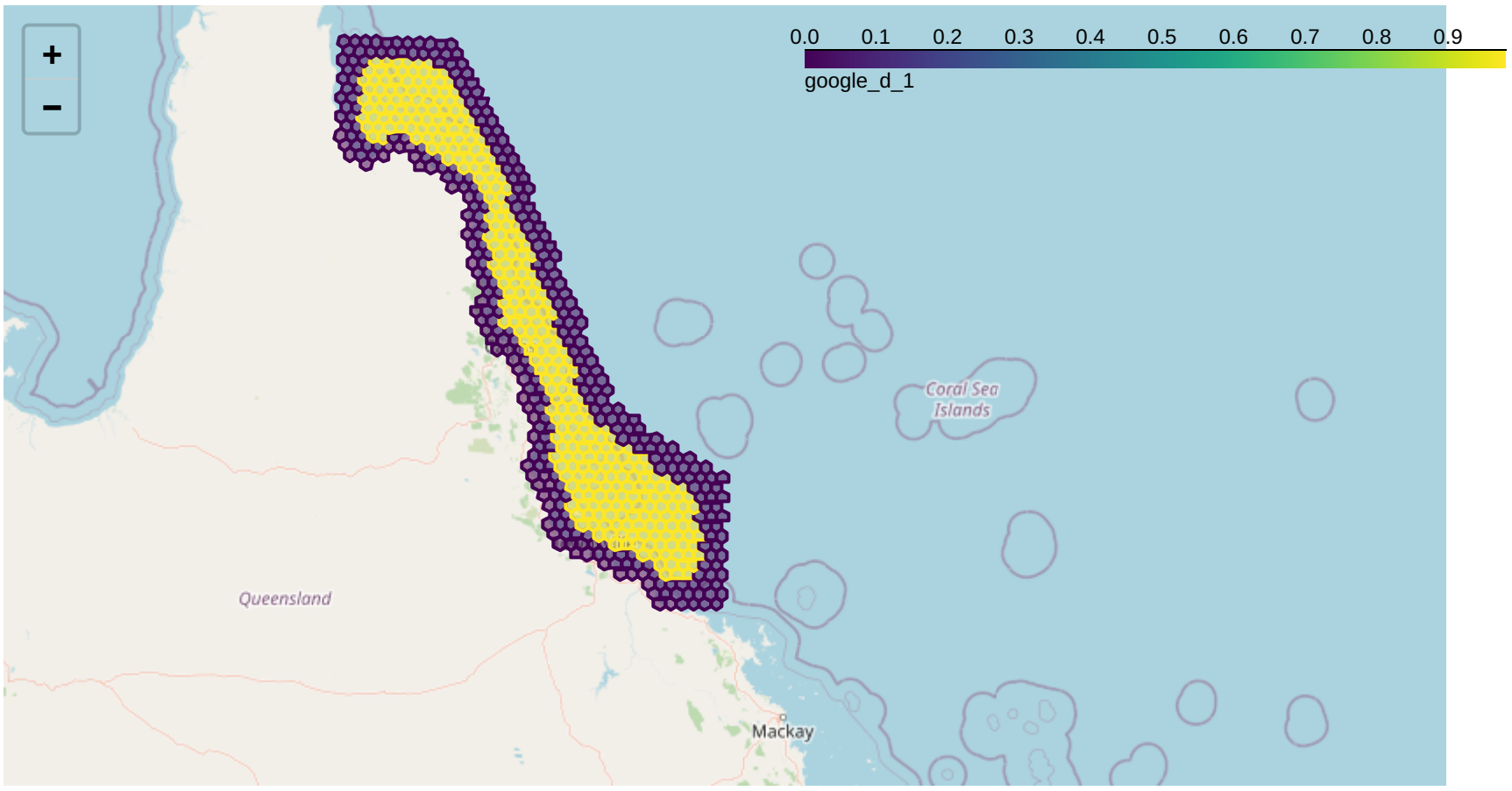
In [76]:
```
pu_connect.explore(column="google_dem")
```

Out[76]:



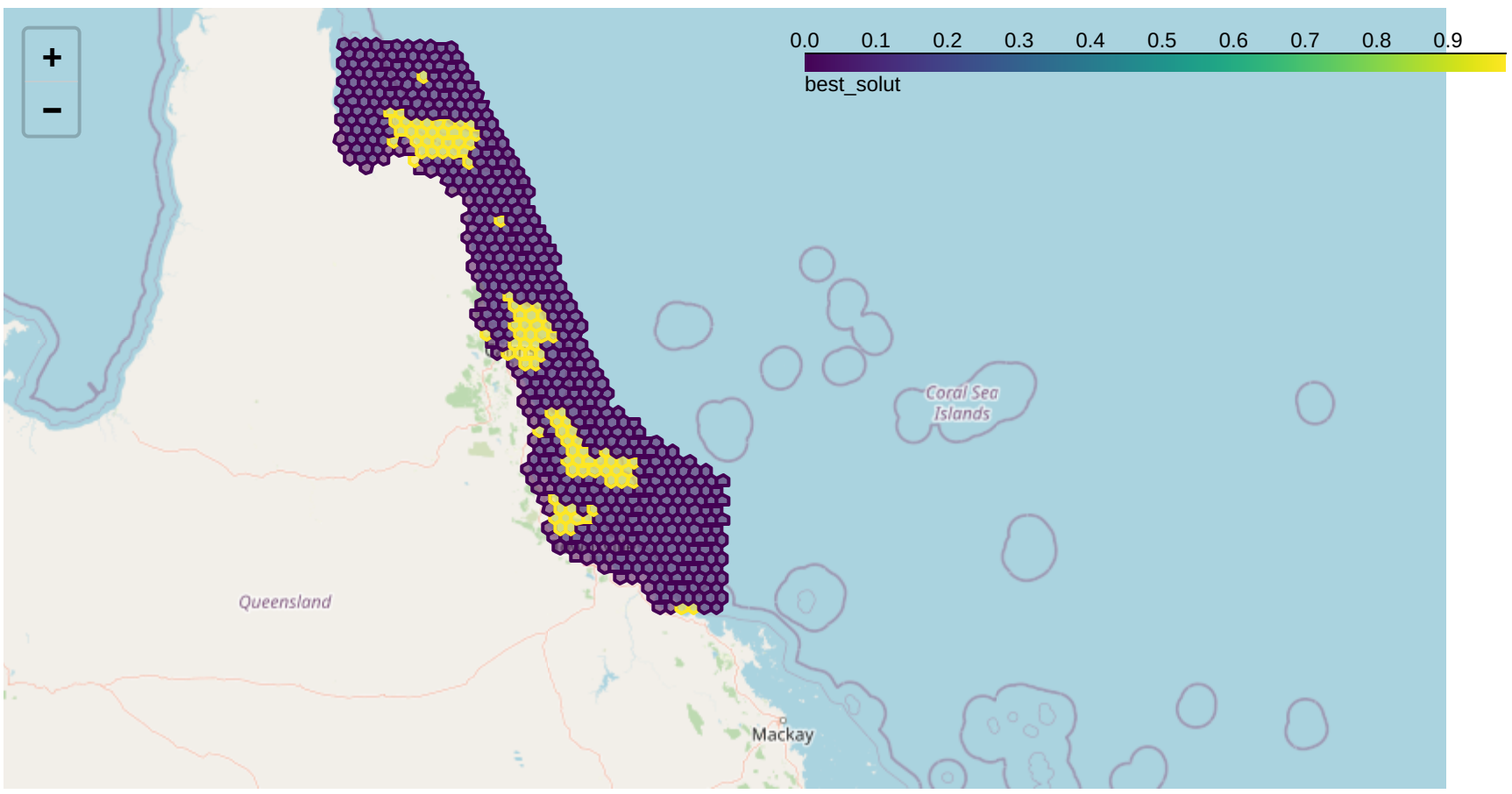
In [78]:
```
pu_connect.explore(column="google_d_1")
```

Out[78]:



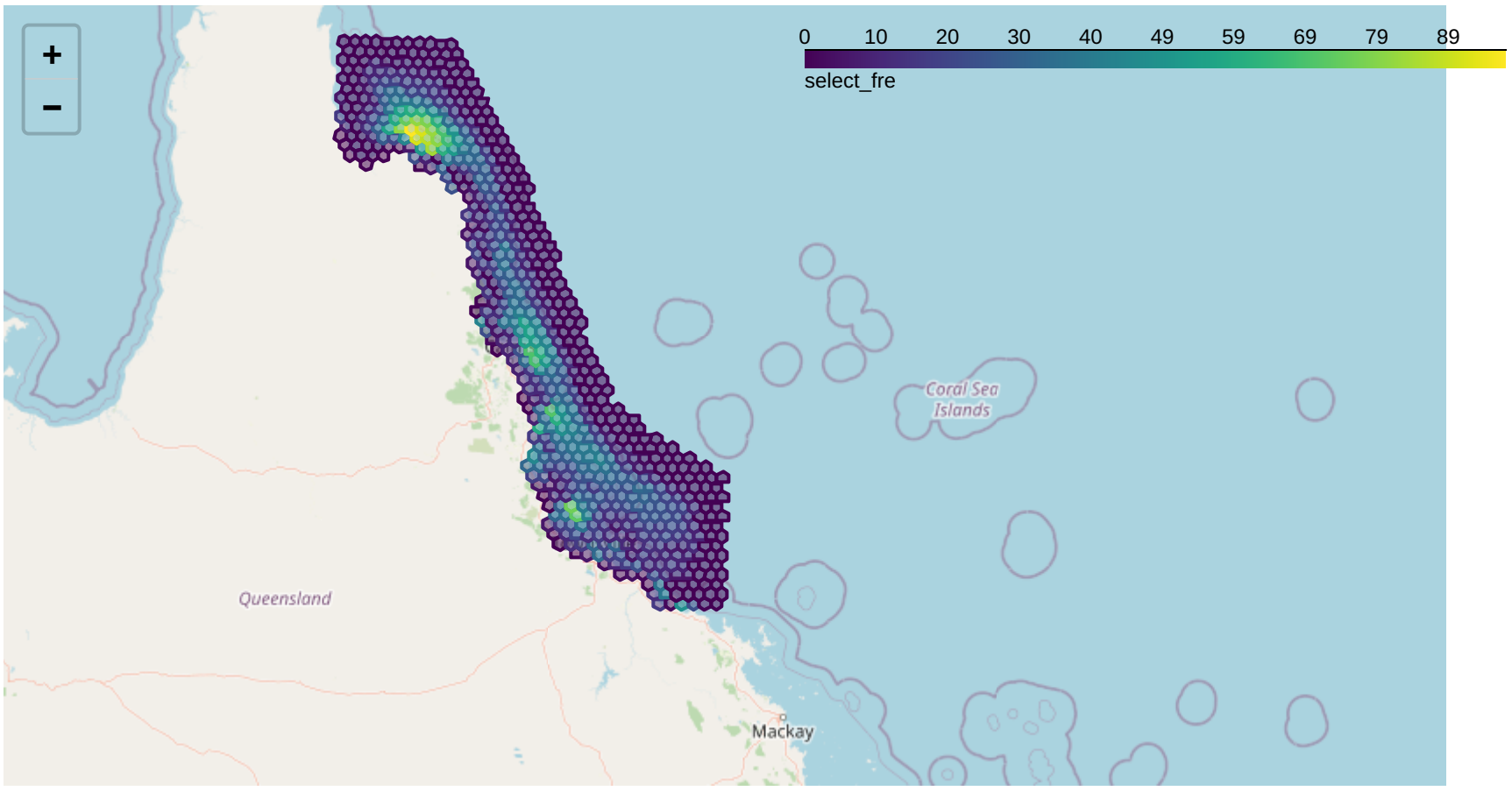
In [79]:
```
pu_connect.explore(column="best_solut")
```

Out[79]:



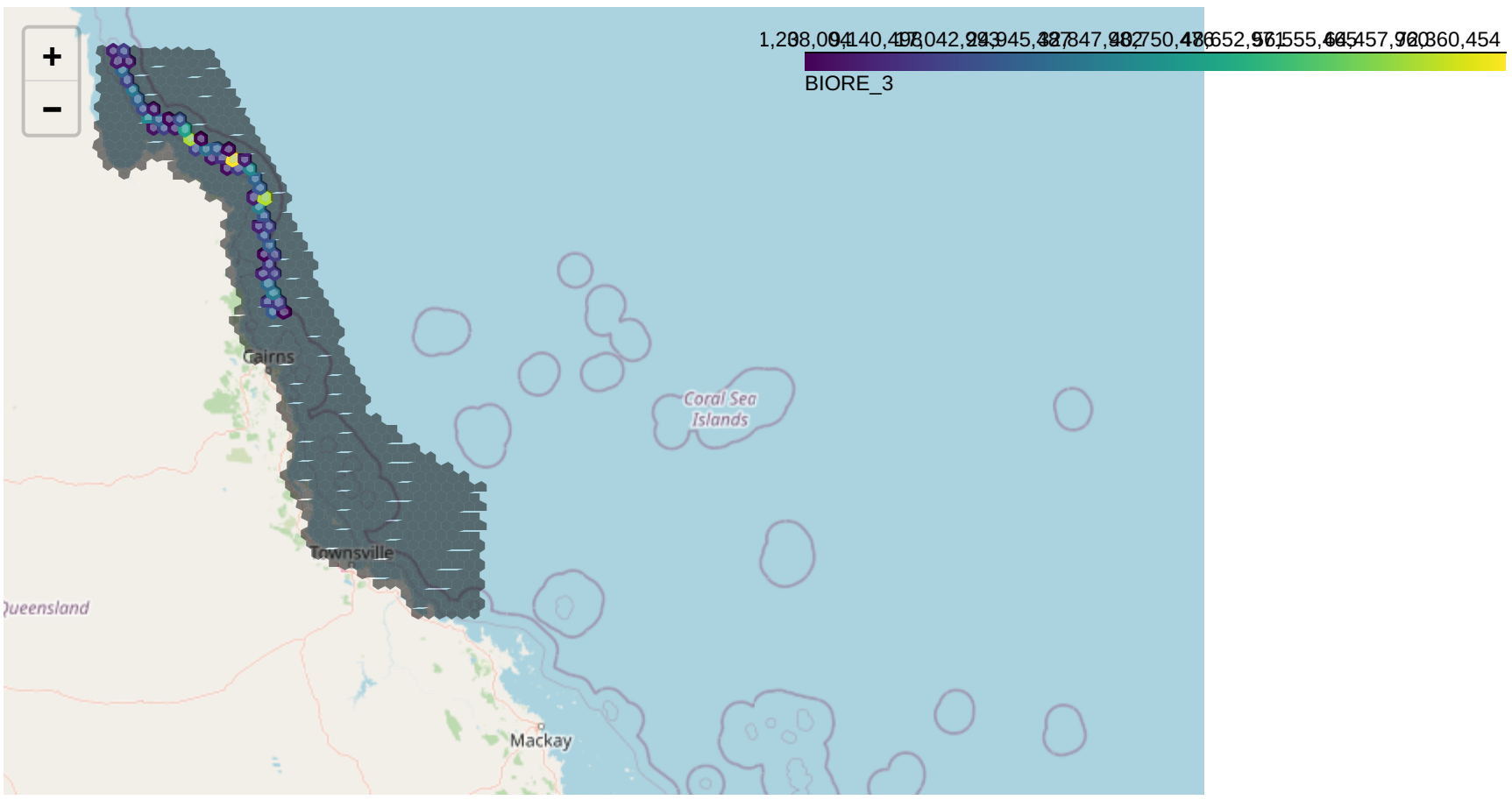
In [80]:
```
pu_connect.explore(column="select_fre")
```

Out[80]:



In [81]:
```
pu_connect.explore(column="BIORE_3")
```

Out[81]:



In [ ]: