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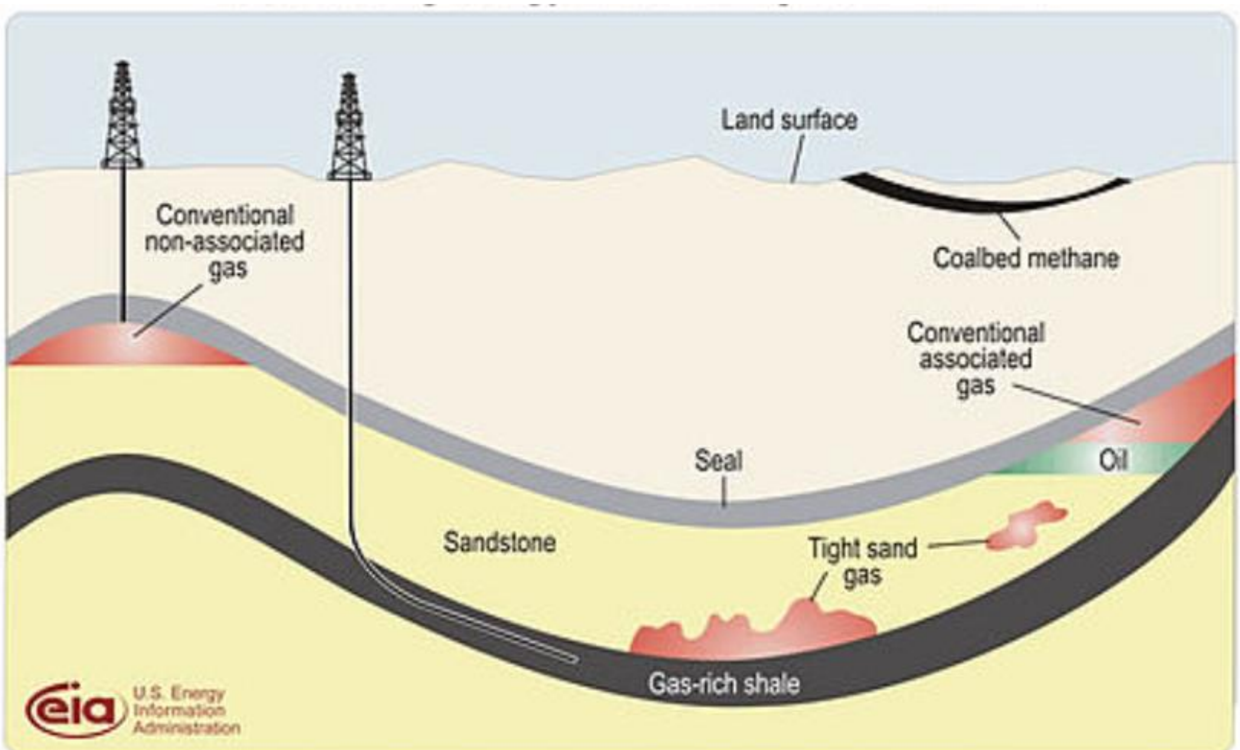
<u>Shale and economic development in Mexico</u>

Shale gas can be defined as the natural gas trapped within shale formations. Its existence has been known for more than 100 years but it was commercially unviable to extract it as it is trapped within very small pores and as such hard to release. Yet, it was not until 1986 that the procedure known as hydrolic fracturing or fracking became commercially viable.

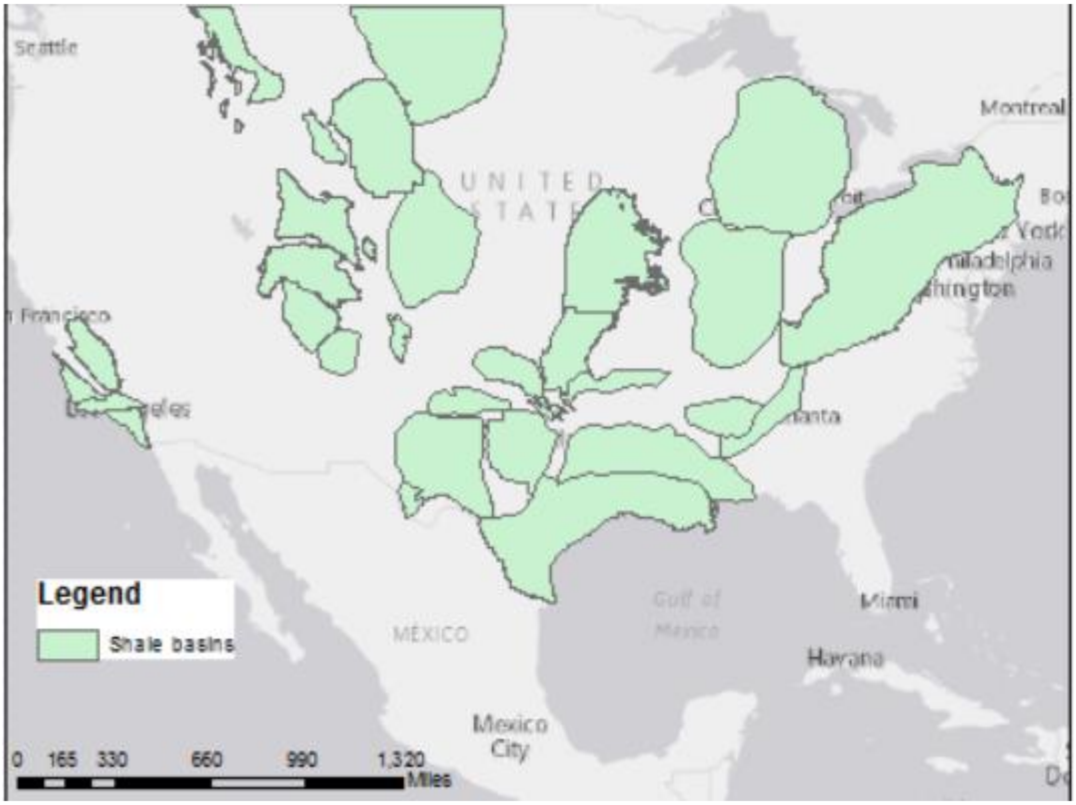
Figure 1-Diagram showing shale formations



Source: EIA 2014

As it can be seen in the diagram shale gas is trapped usually at a deeper distance than conventional gas and oil and as such is difficult to extract. Hydrolic fracturing is a procedure where water and chemicals are injected into the shale formations causing tiny fracturings of the rocks and thus releasing the gas within it. The United States has enjoyed a fracking bonanza in the last 15 years, due to having large shale deposits in the North and South.

Figure 2- Shale Basins in the United States

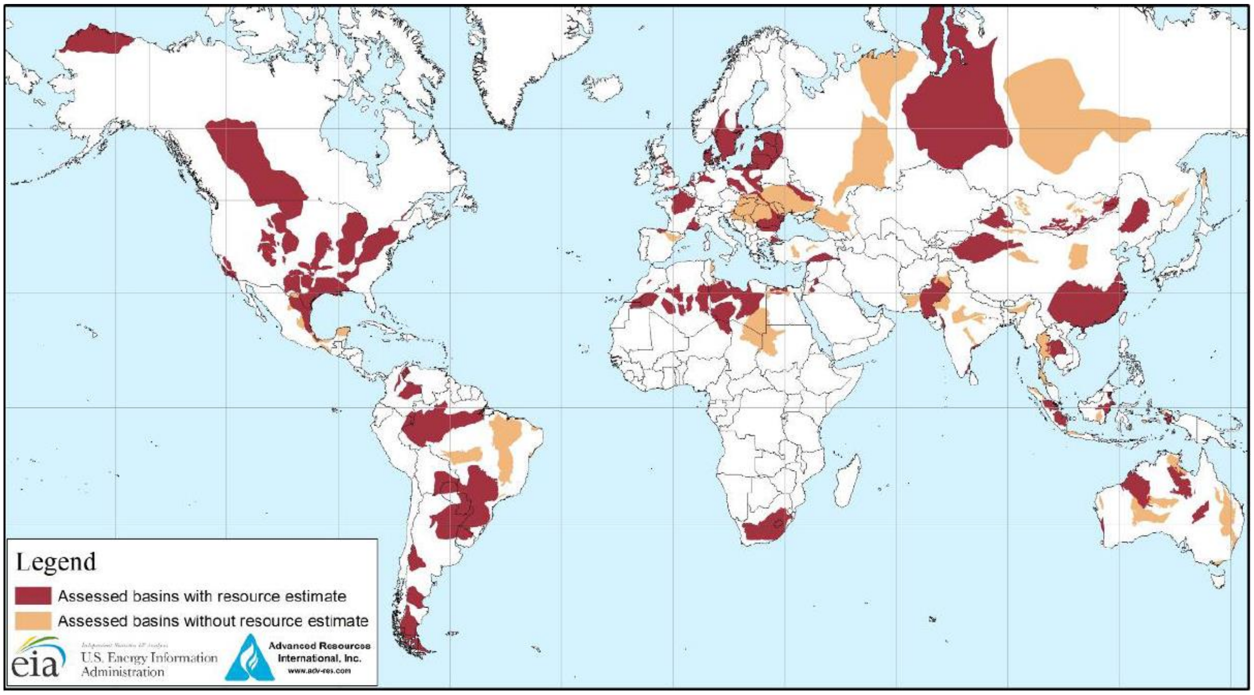


Source: Own creation with data from EIA 2014

As we can see the US has various fields in North Dakota, Pennsylvania, Texas and Louisiana to name a few. In fact it has the highest unconfirmed shale gas reserves in the world, at about 1161 trillion cubic feet. The success in the United States has taken other countries to look for their shale formations, which are quite substantial as well.

A report published by the EIA shows the following distribution of shale resources around the world:

Figure 3- Shale formations around the world



Source: EIA 2014

In terms of proven resources the EIA estimates the following information:

Table 1- Shale gas resources (top 10)

Rank	Country	Shale gas (trillion cubic feet)	
1	China	1,115	
2	Argentina	802	
3	Algeria	707	
4	U.S.[1]	665	(1,161)
5	Canada	573	
6	Mexico	545	
7	Australia	437	
8	South Africa	390	
9	Russia	285	
10	Brazil	245	
	World Total	**7,299**	(7,795)

[1] EIA estimates used for ranking order. ARI estimates in parentheses.

Shale gas advocates have spoken about its many economic advantages. Shale rich counties in the United States have seen a bonanza in both jobs creation as well as increased revenues for services and taxes which have seen increases on education (Institute for Economic Development, 2014). Its detractors speak about its infrastructure costs, as it tends to devastate roads and other county infrastructure (Pittsburgh State Univeristy, 2011). Yet, many local dwellers have been greatly benefited from selling their shale rich lands to oil companies.

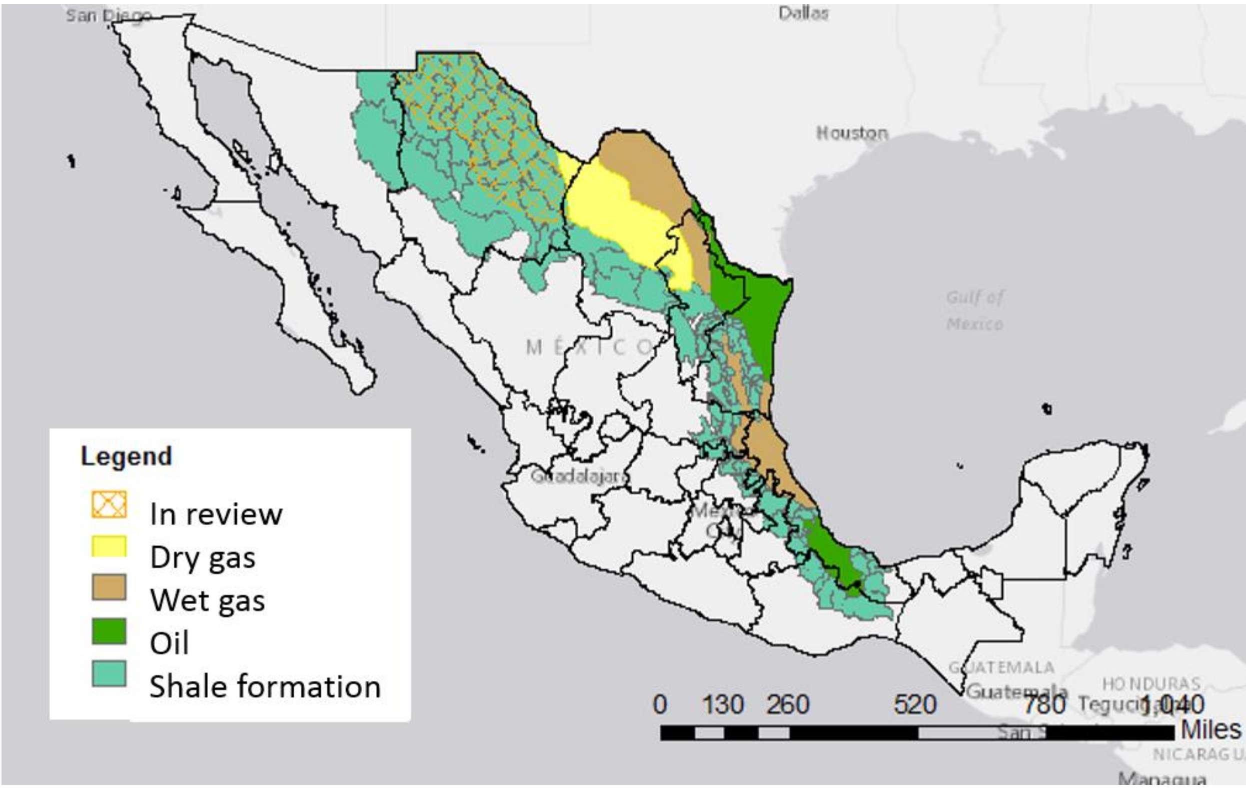
Furthermore, there are various studies that show potential environmental impacts. Most of the arguments are centered around two main problems: firstly, shale gas requires about 1% of the water of a specific area and uses dangerous chemicals that if left untreated could cause cancer. Secondly, there is little known on the long term effects of hydraulic fracturing and many believe this could increase the probability of earthquakes on a given region.

Mexico

Mexico is a country which owns half of the Eagle Ford Shale basin of the United States. As such it has the 6^{th} largest proven shale reserves in the world. As it can be seen in figure 4 it has resources in its northern border, limiting the Eagle Shale basin as well as in the gulf coast. However, it has not started drilling in any of this areas, mostly due to the lack of economic resources to do so. Unlike the United States where underground energy resources belong to land owners, in Mexico Article 27 of the constitution clearly states that they belong to the nation.

Furthermore, article 28 also delineates that the State can appropriate any land necessary needed for national endeavors.

Figure 4- Mexican Shale basins



Source: Self elaboration with data from CONAGUA 2014

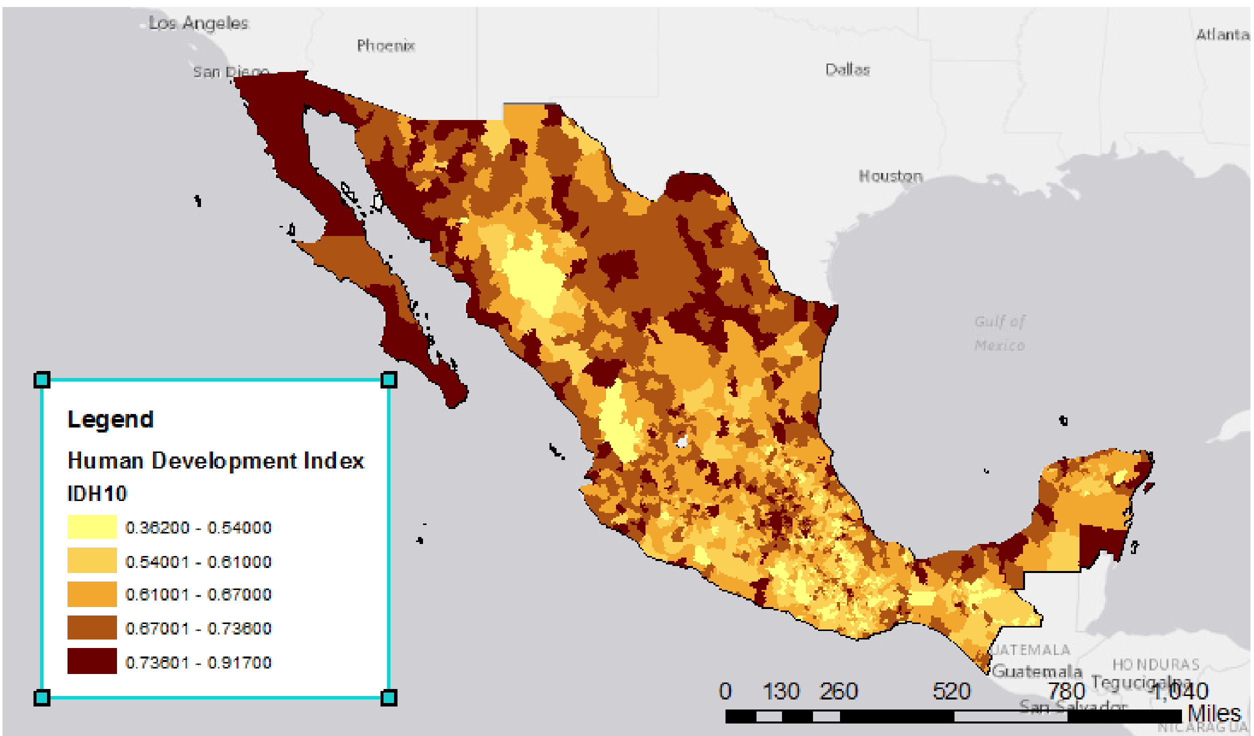
Mexico was until last month, the closest energy market in the world. Communist countries like North Korea and Cuba admitted private investment in their electricity and hydrocarbon industries, while Mexico expressly forbade it. The reasons behind this are early historical investments from foreign powers (mostly Great Britain) had made Mexico weary about allowing foreign intervention. March 18th, the day oil was nationalized is celebrated as a bank holiday with military parades around the country. This all came to end when in August, the congress finally approved the secondary legislation for the energy reform, which brought to an end a 75 year old total monopoly of the energy sector by the government.

Earlier this year it passed an energy reform that aims at allowing private investment. This energy reform has been the subject of a lot of speculation both inside and outside of Mexico. Most of the literature on the recent energy reform has focused on Pemex and the opening up of the market allowing for risk sharing agreements and private investment. The idea behind is that by opening up the market, the Mexican State can get enough resources for the infrastructure programs it needs to do the infrastructure programs that will take the country to its full potential, shale projects among them.

The Mexican government states that shale gas development will provide "rural development, job creation and a catapult for Mexico´s poorest" (Calderón, 2010). And that it will not have strong environmental effects. The purpose of this paper is to analyze whether or not shale gas counties need economic development and have enough water to endure this.

Mexico is a very unequal country. The North of Mexico is generally seen as developed, while the South, tend to be much poorer. An easy way to measure development is the human development index or HDI. It consists of a composite index taking into account average schooling, GDP per capita and life expectancy at birth, Mexico encloses municipalities like Chochoapa el Grande Guerrero with an HDI of .4, close to that of Zambia and Garza Garcia, the richest municipality in Latin America, with an HDI of .92, similar to Norway's.

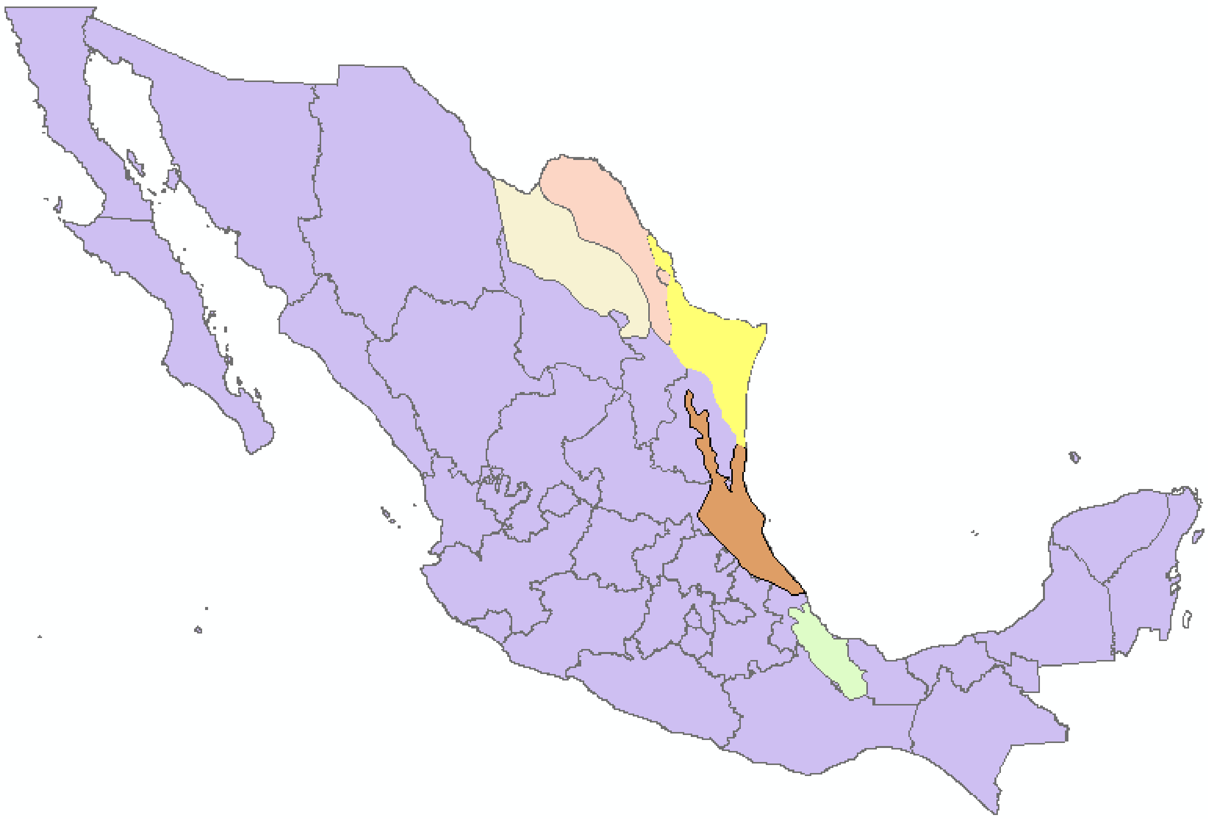
Figure 5- HDI per municipality



Source: Own elaboration with data from UN 2010

As it can be seen in this map, the Northern municipalities have much higher HDI's in general than their southern counterparts. If we digitalize the shale regions and specially correlate them to HDI's by municipalities we can see the following thing:

Figure 6- Digitalized shale formations



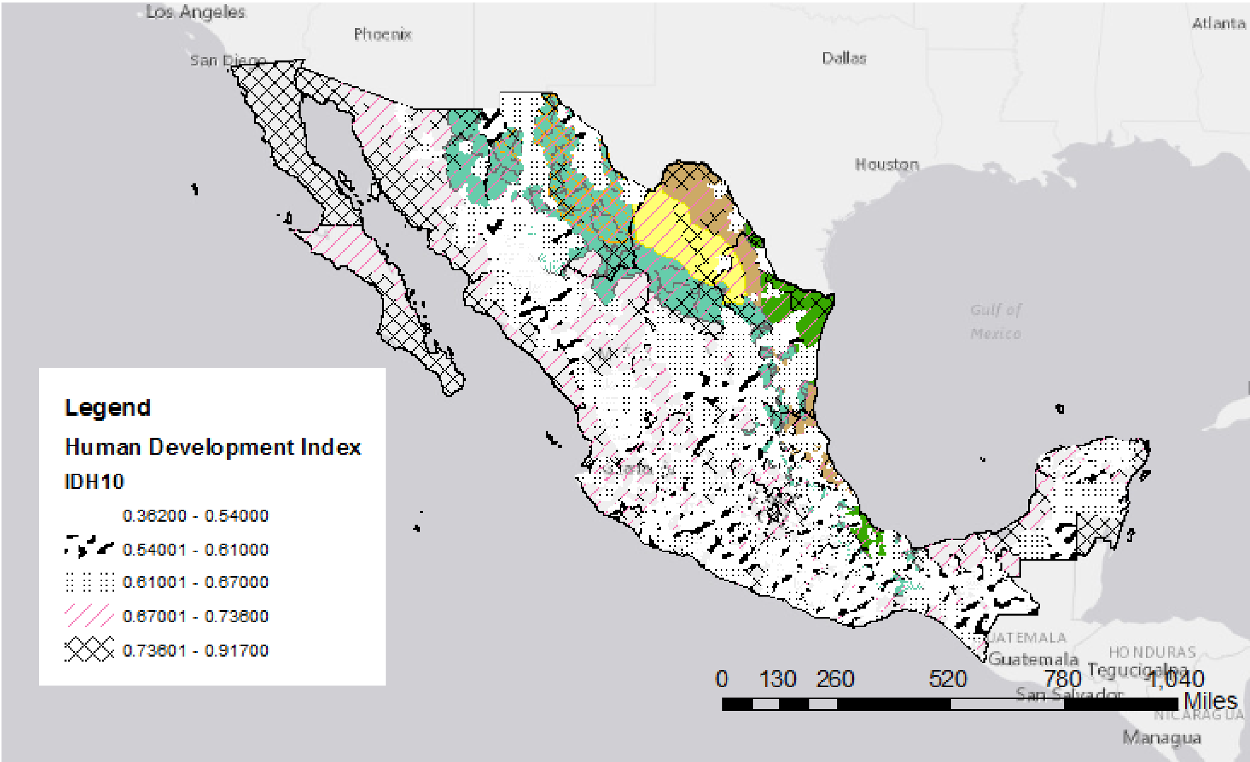
Source: Own creation

Table 2-HDI by area

Area	HDI
Dry Shale	0.7122
Shale wet North	0.7325
Shale wet South	0.6481
Oil North	0.6942
Oil South	0.6578
Mexican average	0.7104

As it can be seen, the HDI of the shale areas is higher than that of the Mexican average, as such economic development might serve better elsewhere. In general terms, Shale areas are much farther developed than their oil counterparts, as opposed to the rest of Mexico. This can also be seen when we overlap both layers:

Figure 6- HDI and shale gas areas.



Source: UN and CONAGUA

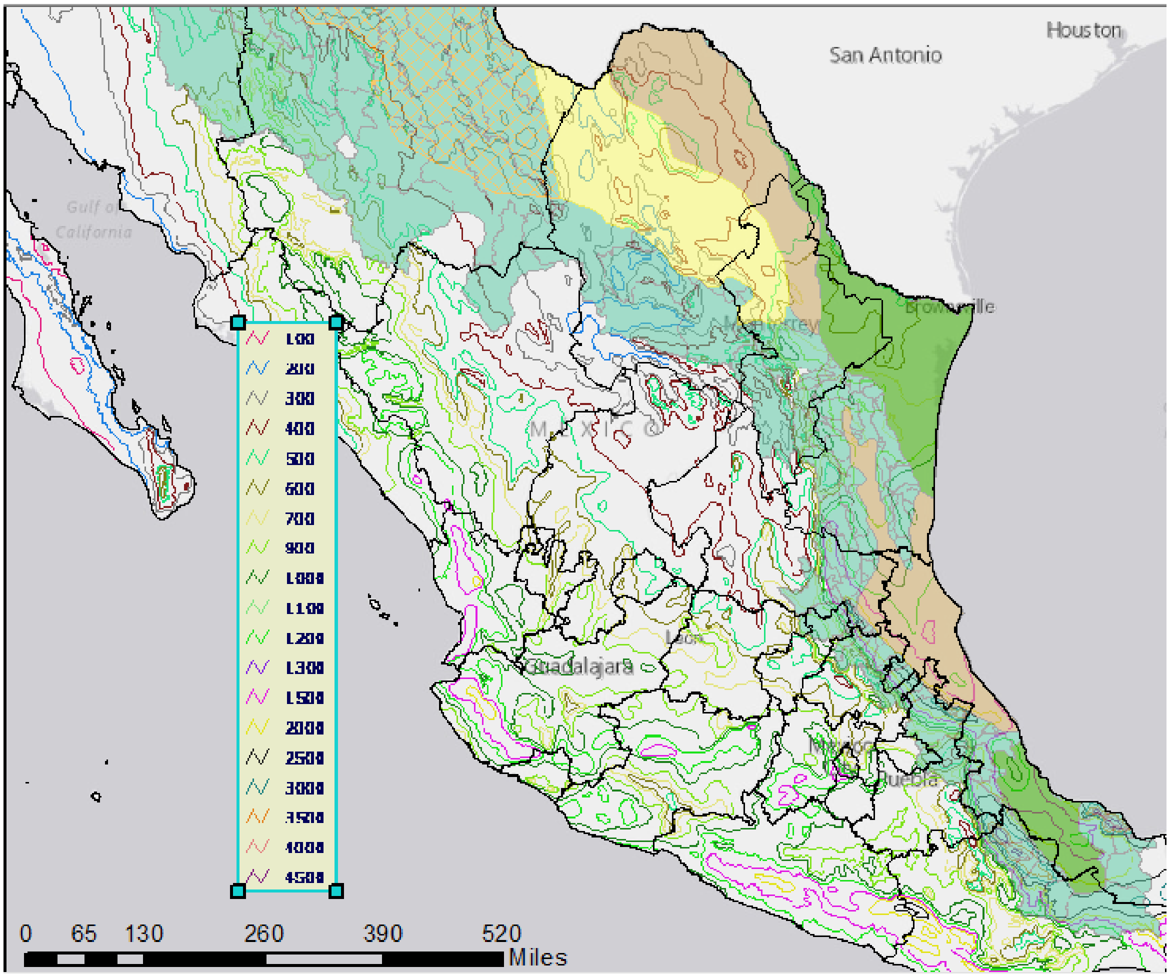
The next main question is whether or not Shale gas areas have a higher concentration of water and thus will be able to cope with the high water demand shale mining requires. To do this we again use the digitalized forms and spatially superimpose them to the average precipitation data.

Table 3-Average precipitation (mm) 2006-2012

Area	Annual Precipitation
Dry Shale	158
Shale wet North	263
Shale wet South	709
Oil North	859
Oil South	636

As it can be seen shale areas have a very low precipitation, as such the environmental impact of water might be very high as it will take away water needed for other activities. This can also be seen in the following map:

Figure 7- Average precipitation and Shale formations



Sources: Own creation with data from CONAGUA and INEGI

Conclusions

This study shows that the ideas behind shale fracking in Mexico, as a motor for economic development and as something without an environmental impact might not be true. This does not necessarily mean fracking is a bad idea, but it should be made knowing about the water issues and the fact that it is not really a solution to make Mexico a more equal society.

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