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URBANIZATION IN THE LOWER RIO GRANDE VALLEY

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BACKGROUND

The Lower Rio Grande Valley refers to the three county area immediately west of the Rio Grande outlet into the Gulf of Mexico (Cameron, Willacy, and Hidalgo Counties). This is one of the most densely farmed regions in south Texas but also a region experiencing rapid population growth. The region primarily relies on the water of the Rio Grande for both domestic and irrigation water. Additional resources, like brackish groundwater and recycled water, are becoming more common but because of the high cost still represent a very small portion of the regional supplies.

The Rio Grande is operated using the Amistad and Falcon Reservoirs to store and manage the water supplies used on both the US and Mexico sides of the border. The TCEQ Watermaster rules dictate how water is allocated to users from the storage pools of the reservoirs. Municipal, Industrial, and Domestic users (DMI) are given the highest priority and irrigation users are designated the remaining water. Irrigators in the Valley like to say that they're the 'users of last resort.' As a result, DMI demand has a direct impact on availability of water for irrigation. Water can be converted permanently from Irrigation use to DMI use both as land is developed and by a process called 'exclusion.'

Almost 85% of the water that is used from the Rio Grande is delivered by irrigation districts. In the Lower Rio Grande Valley, 26 separate districts serve almost all irrigators and municipal users through their own networks of canal and pipeline. The networks were initially built over 100 years ago, and are designed to deliver large volumes periodically, to suit irrigation needs. However, these same networks are used to deliver water to municipal and industrial users, which require water more frequently and in smaller volumes. Each of the

Figure 1. Irrigation Canal and Sluice Gate in Hidalgo County

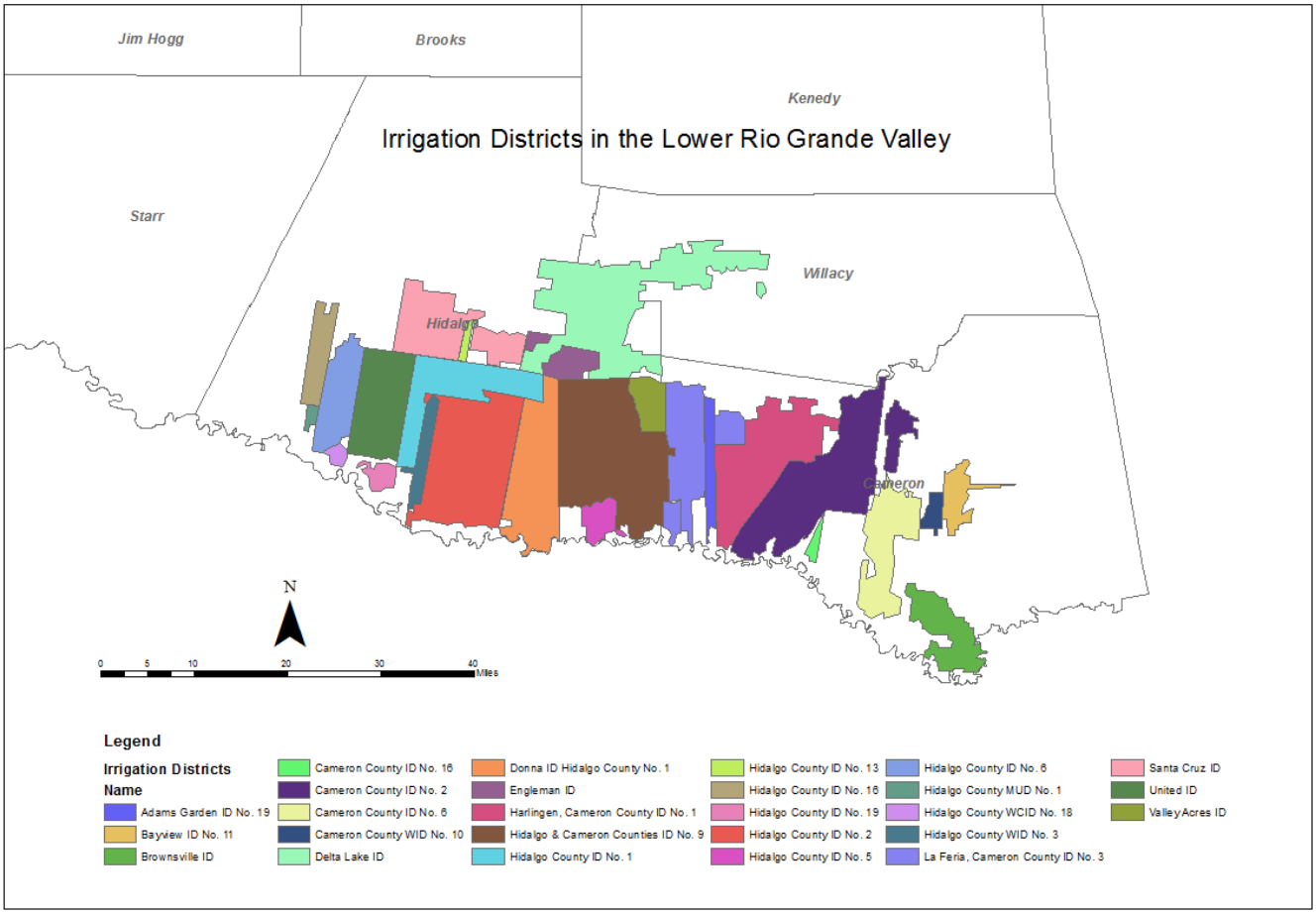

Figure 2. Irrigation District Service Areas in Cameron, Willacy, and Hidalgo Counties

irrigation districts requires an operational minimum in order to charge the canals. In years of severe drought, as a result of the way that water is apportioned to rights holders, irrigators may not have access to water for 30 or 60 days. This can jeopardize access to water for those cities that rely on irrigation water to make the Irrigation District delivery systems operational. In some districts, a city may be required to purchase 'push water,' which is the term for emergency water purchased just to charge the canals so that a city can access water from their water right account. The assumption is that the push water is almost entirely lost in the delivery process.

Some Districts are more vulnerable to a 'push water crisis' because of the type and distribution of their water rights. Those districts which serve primarily irrigation, but have a small portion of municipal customers are the most vulnerable. Additionally, a couple of districts serve cities that are much further away from the Rio Grande, and therefore require much more push water in order to charge their canals.

As districts become more urbanized, their customer base changes from irrigation users to municipal users. The result of urbanization on these districts vulnerability to push water is examined here using estimates for rates of urbanization, distribution of water rights within each district (irrigation versus municipal), and the overall size of the district.

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PUSH WATER VULNERABILITY ESTIMATE

Three metrics were used to compare the vulnerability of each irrigation district to a push water crisis. Irrigation Districts that serve primarily irrigation and only deliver a small amount to cities were considered the most vulnerable in terms of water rights. In addition to the current distribution of water rights, the impact of projected urbanization on the distribution of water rights was taken into consideration. For instance, areas that are urbanizing rapidly may transition from a district with very little municipal water (high risk) to a district with significantly more municipal water, which may put the district at lower risk of requiring push water.

HISTORICAL URBANIZATION EVALUATION

Irrigation district boundaries were used to create a shapefile based on the Water District Database[1] at the Texas Commission on Environmental Quality website (where available), and compared with irrigation district maps produced by Texas A&M University.[2]

The National Land Cover Dataset was evaluated for 1992, 2001, and 2011 within the bounds of the Irrigation Districts.

The classifications of land cover have changed slightly between each of the datasets, and the land use types aggregated into 'developed' or 'cultivated' are shown in Table 2. Because the intent is to isolate the rates of development, rather than specific physical characteristics of land cover, it is reasonable to distill the detailed classifications into two aggregated categories for developed and cultivated land.

Table 1. Land Use Classifications Aggregated into Developed and Cultivated Classification

1992	2001	2011
Developed	Developed	Developed
Low Intensity Residential	Developed, Open Space	Developed, Open Space
High Intensity Residential	Developed, Low Intensity	Developed, Low Intensity
Commercial/Industrial/Transportation	Developed, Medium Intensity	Developed, Medium Intensity
Urban /Recreation Grasses	Developed, High Intensity	Developed, High Intensity
Cultivated	Cultivated	Cultivated
Orchards/Vineyards/Other	Pasture/Hay	Pasture/Hay
Pasture/Hay	Cultivated Crops	Cultivated Crops
Row Crops		
Small Grains		

[1] Texas Commission on Environmental Quality, Water District Database (WDD) https://www.tceq.texas.gov/waterdistricts/iwdd.html

[2] "Regional Irrigation District Maps: Lower Rio Grande River Basin," from http://idea.tamu.edu/gis.php

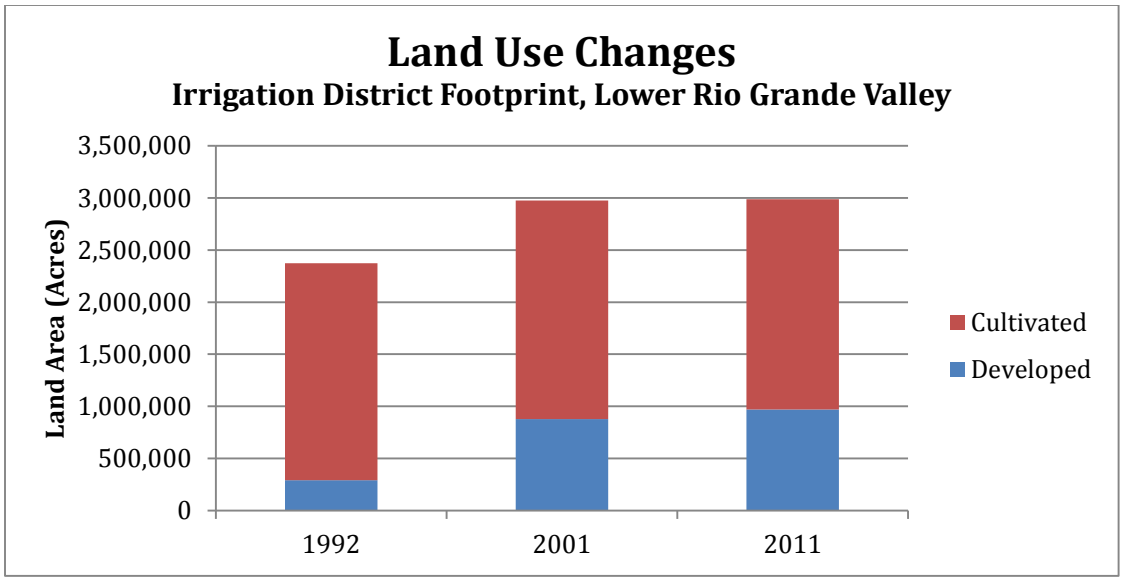

Figure 3. Historical land use, aggregated for cultivated (including orchard, hay or alfalfa, and row crops), and developed (low-intensity to high-density), based on evaluation of National Land Use Database (U.S. Geologic Survey).

The classification changes appear to have impacted the accuracy of evaluating the land cover change between 1992 and 2001, and may account for the dramatic increase in developed land area. For comparison, census data for the three county area is shown in Figure 3, indicating that the dramatic increase in developed land area is likely an artifact of the land area classification system rather than a jump in population.

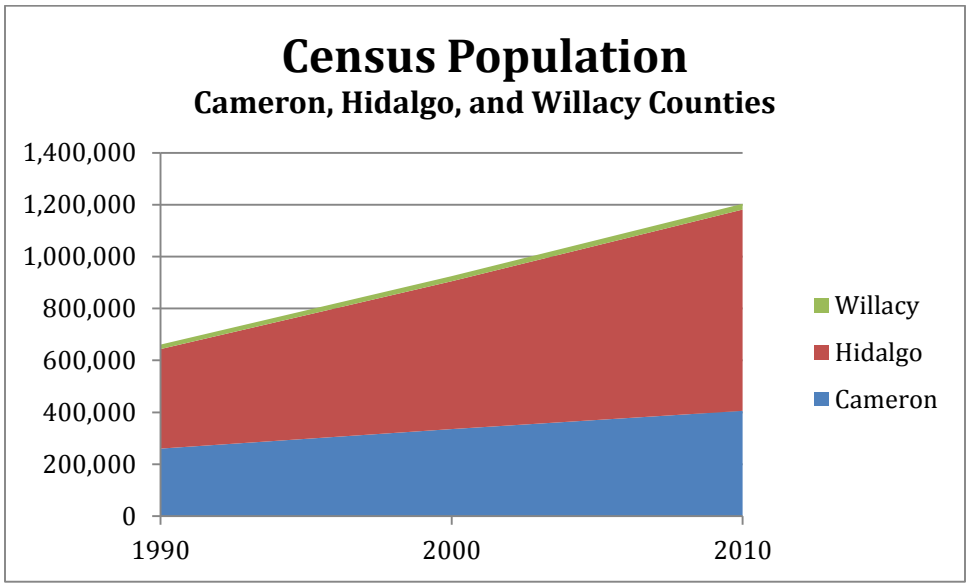

Figure 4. Population in the Lower Rio Grande Valley, 1990 - 2010

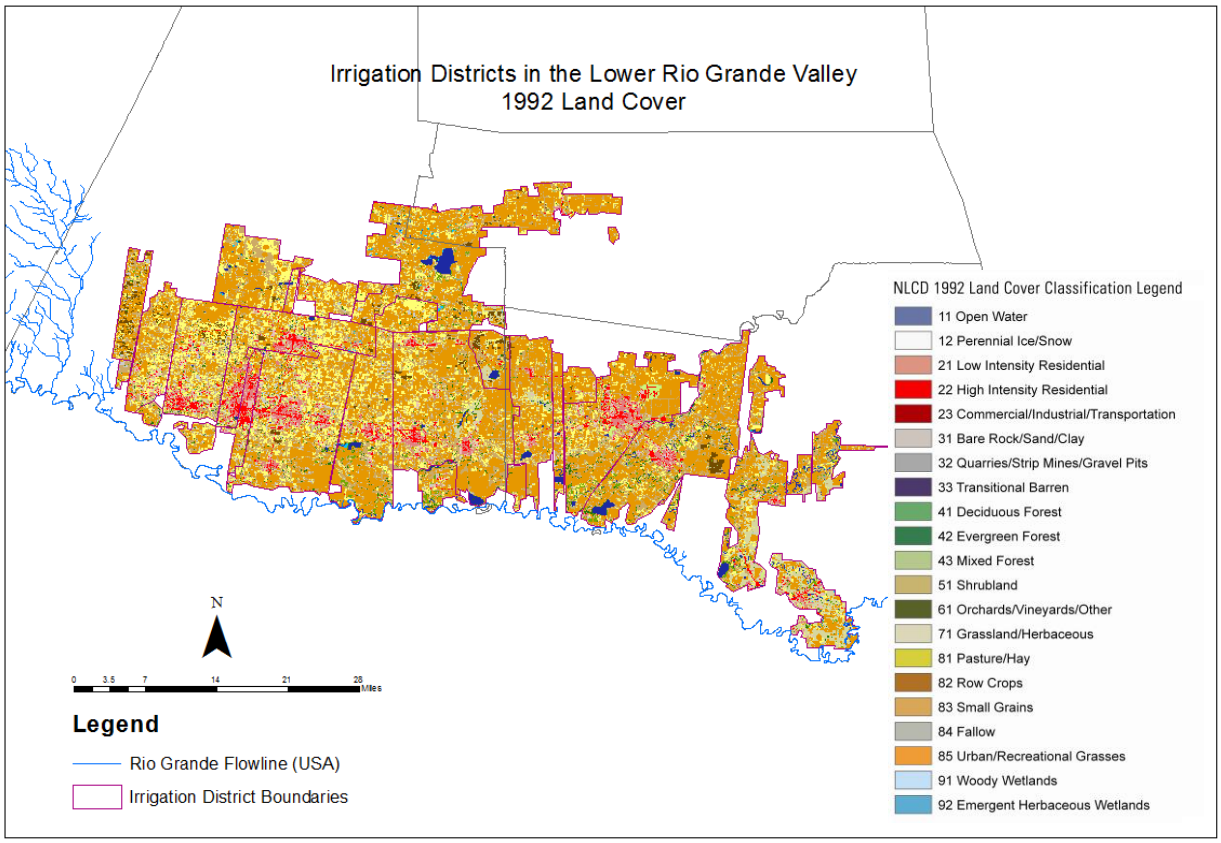

Figure 5. Lower Rio Grande Valley Irrigation Districts, 1992 Land Cover

Initially, the land cover changes for each irrigation district were evaluated with the intention of developing a unique rate of historical urbanization for each district. However, many of the smaller districts showed significant decadal shifts in land use, which are unlikely to be realistic predictors of future urbanization. Instead, the average rate of urbanization from the footprint of all 26 irrigation districts was used. Compared with previous evaluations which evaluated county-wide changes in land use, isolation of the irrigation district footprint is expected to result in a more reliable estimate of urbanization rates.

Table 2. Historical Urbanization Rate Estimates, based on land cover data.

	1992	2001	2011
Developed Acreage	290,063	877752	969739
Cultivated Acreage	2,083,025	2,096,609	2,017,371
Change in Agricultural Land Use		0.65%	-3.78%
Change in Municipal Land Use		202.61%	10.48%

Given the uncertainty associated with the 1992 data, the urbanization rate estimated between 2001 and 2011 will be applied to the irrigation water rights for the push water evaluation.

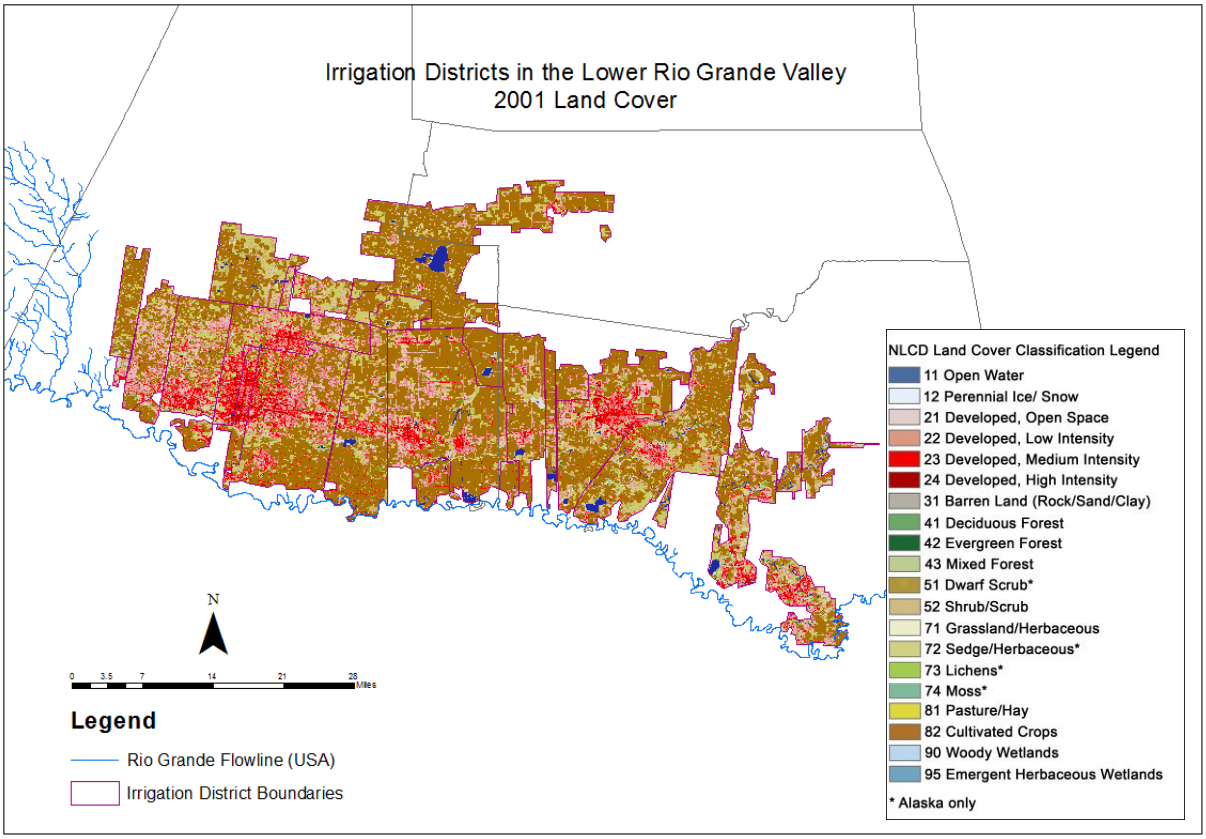

Figure 6. Lower Rio Grande Valley Irrigation Districts, 2001 Land Cover

Projected Urbanization and Water Rights Distribution

Current water supply data was used from the Initially Prepared 2016 Region M Water Plan for each irrigation district. The projected agricultural supplies for each irrigation district were calculated based on the portion of water available to irrigators in a drought year. The total municipal water rights are used directly as a result of their 'guaranteed' reliability under the Rio Grande operating rules. Appendix A includes a summary of the total agricultural and municipal water rights for each irrigation district. From the existing data, Table 3 shows that, of the anticipated diversions from each irrigation district, about half have less than 26% of their expected diversion based on domestic, municipal, and industrial (DMI) water rights.

Table 3. Percentage of DMI water rights in total expected drought year diversions for each Irrigation District, averaged across the Lower Rio Grande Valley

Percentage of ID water rights for DMI users	2020 WR Amount	2030	2040	2050	2060	2070
Max	82%	83%	83%	84%	84%	85%
Min	0%	0%	0%	0%	0%	0%
Median	26%	27%	27%	28%	29%	30%
Average	28%	29%	29%	30%	30%	31%

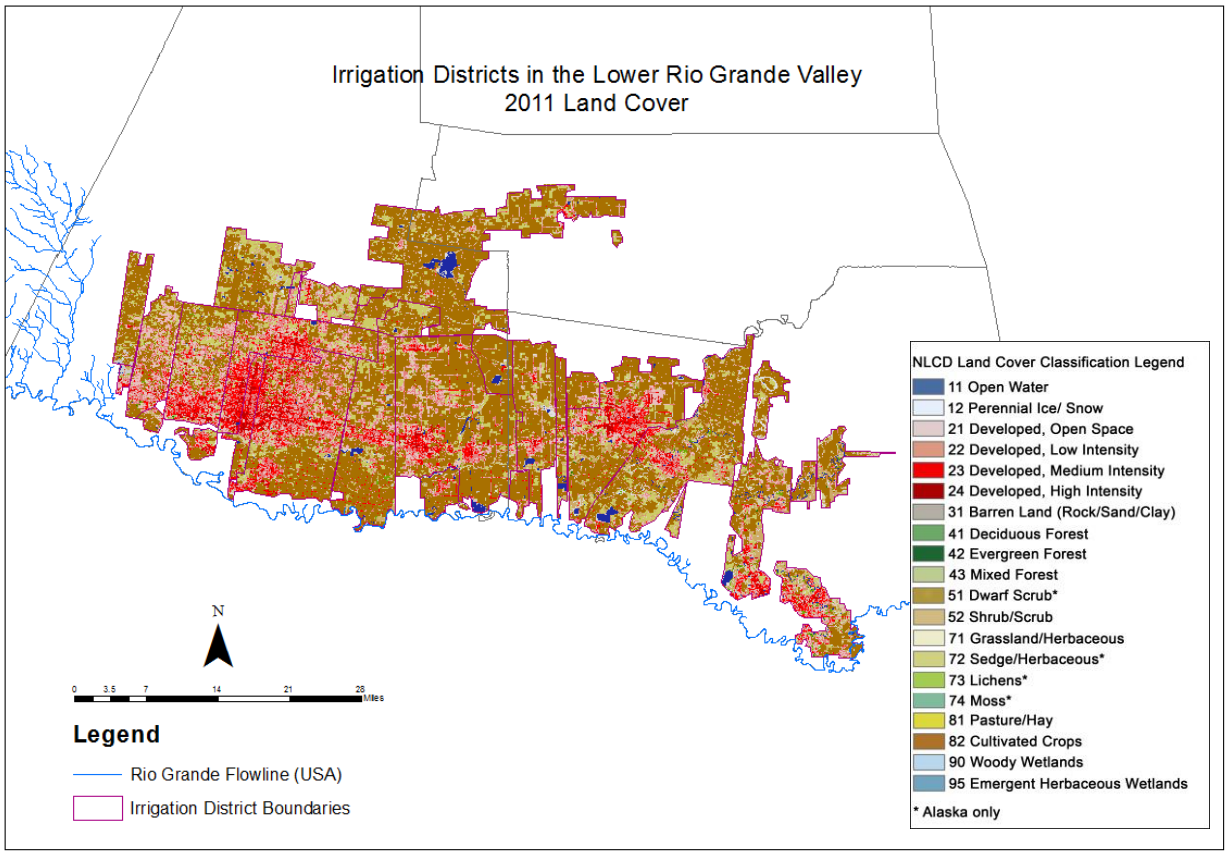

Figure 7. Lower Rio Grande Valley Irrigation Districts, 2011 Land Cover

VULNERABILITY RANKING

In order to compare the irrigation districts to one another simply, each district was assigned a score that indicates their susceptibility to requiring push water in order to deliver to municipal customers based on the percentage of DMI water that is delivered as a part of their total water supply. Those districts that solely serve irrigation customers are not impacted by the push water issue.

Table 4. Guideline for relating the percentage of an ID's diversion that is DMI water to the level of concern regarding possible need for push water

% DMI	Total Area Compared with Average District (%)	Level of Risk
0%		N/A
>10%	>200%	Very High Risk
11-25%	100-200%	High Risk
26-50%	50-100%	Medium Risk
50-100%	0-50%	Low Risk

These values were established for each irrigation district and are shown alongside a general risk factor associated with the total size of the Irrigation District in Table 5.

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Table 5. Total Push Water Crisis Risk Score for each Irrigation District, based on Area and Water Rights Type

NAME	Area (AC)	Percent of Average District Area	District Area Risk Factor	Water Rights Type Risk	Total Risk Score
Adams Garden ID No. 19	8,578	29%	1	0	0
Bayview ID No. 11	11,114	38%	1	2	1.5
Brownsville ID	22,844	79%	2	0	0
Cameron County ID No. 16	2,180	7%	1	0	0
Cameron County ID No. 2	80,548	277%	4	3	3.5
Cameron County ID No. 6	32,490	112%	3	3	3
Cameron County WID No. 10	4,272	15%	1	0	0
Delta Lake ID	88,325	304%	4	3	3.5
Donna ID Hidalgo County No. 1	47,274	162%	3	3	3
Engleman ID	11,037	38%	1	0	0
Harlingen, Cameron County ID No. 1	57,079	196%	3	2	2.5
Hidalgo & Cameron Counties ID No. 9	88,414	304%	4	3	3.5
Hidalgo County ID No. 1	37,832	130%	3	2	2.5
Hidalgo County ID No. 13	2,232	8%	1	0	0
Hidalgo County ID No. 16	14,025	48%	1	3	2
Hidalgo County ID No. 19	5,005	17%	1	0	0
Hidalgo County ID No. 2	72,316	249%	4	2	3
Hidalgo County ID No. 5	8,208	28%	1	0	0
Hidalgo County ID No. 6	22,979	79%	2	2	2
Hidalgo County MUD No. 1	1,734	6%	1	2	1.5
Hidalgo County WCID No. 18	2,435	8%	1	0	0
Hidalgo County WID No. 3	9,098	31%	1	1	1
La Feria, Cameron County ID No. 3	40,850	140%	3	4	3.5
Santa Cruz ID	39,110	134%	3	4	3.5
United ID	35,960	124%	3	1	2
Valley Acres ID	10,562	36%	1	4	2.5

The irrigation districts with the highest risk of needing push water are Cameron County Irrigation District No. 2, Delta Lake ID, Hidalgo and Cameron County No. 9, La Feria ID, and Santa Cruz ID.

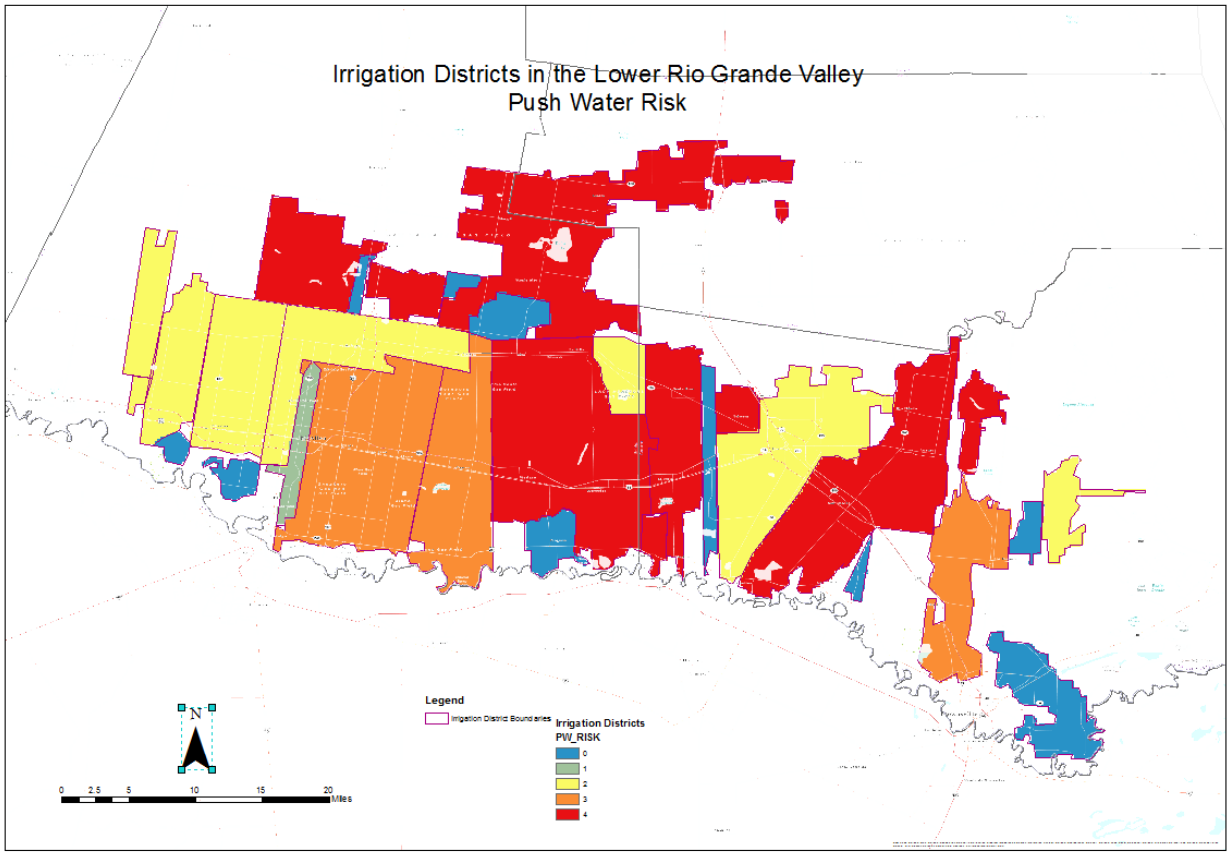

Figure 8. Push Water Risk for each Irrigation District in the Lower Rio Grande Valley

Conclusions and Recommendations for Further Work

While urbanization is certainly a factor in water distribution systems in the Valley, including the risk of requiring push water to be purchased in order to meet basic needs, it does not have a significant enough overall impact to be impactful in this analysis. Localized system evaluations and urbanization studies may help to identify specific areas that will see increased push water concerns.

Whether or not increased development increases the risk of a push water crisis significantly, the associated increase in population does mean that the costs to an irrigation district or city would be greater. If a city can't guarantee secure water supplies from the supplying irrigation district, there are likely to be significant public health and economic impacts.

A larger sample size of land use data would lead to a better understanding of long-term land use trends.

The overall distance between a district or a customer and the Rio Grande diversion point on which it depends may be a better metric for risk than overall size of district. Also, water that is passed through multiple districts was not evaluated specifically as having an increased vulnerability, although that's a reasonable assumption.

Appendix A: Water Rights Distribution Calculations

ID	Water Supply	2020	2030	2040	2050	2060	2070
Adams Garden	Agricultural	7,915	7,616	7,328	7,051	6,785	6,528
	Municipal & Industrial	-	-	-	-	-	-
	Percent Municipal & Industrial	N/A	N/A	N/A	N/A	N/A	N/A
Bayview ID	Agricultural	8,104	7,797	7,503	7,219	6,946	6,684
	Municipal & Industrial	5,156	5,156	5,156	5,156	5,156	5,156
	Percent Municipal & Industrial	39%	40%	41%	42%	43%	44%
Brownsville ID	Agricultural	15,499	14,913	14,350	13,807	13,285	12,783
	Municipal & Industrial	-	-	-	-	-	-
	Percent Municipal & Industrial	N/A	N/A	N/A	N/A	N/A	N/A
CCID #2	Agricultural	64,421	61,986	59,643	57,388	55,219	53,132
	Municipal & Industrial	13,939	13,939	13,939	13,939	13,939	13,939
	Percent Municipal & Industrial	18%	18%	19%	20%	20%	21%
CCID #6 (Los Fresnos)	Agricultural	22,675	21,818	20,993	20,200	19,436	18,701
	Municipal & Industrial	10,180	10,180	10,180	10,180	10,180	10,180
	Percent Municipal & Industrial	31%	32%	33%	34%	34%	35%
CCID #16	Agricultural	1,663	1,600	1,540	1,482	1,426	1,372
	Municipal & Industrial	-	-	-	-	-	-
	Percent Municipal & Industrial	N/A	N/A	N/A	N/A	N/A	N/A
CCWID #10	Agricultural	3,365	3,238	3,116	2,998	2,885	2,776
	Municipal & Industrial	-	-	-	-	-	-
	Percent Municipal & Industrial	N/A	N/A	N/A	N/A	N/A	N/A
Delta Lake ID	Agricultural	83,882	80,711	77,661	74,725	71,900	69,183
	Municipal & Industrial	16,705	16,705	16,705	16,705	16,705	16,705
	Percent Municipal & Industrial	17%	17%	18%	18%	19%	19%
Donna ID/Hidalgo Co. No. 1	Agricultural	40,808	39,266	37,781	36,353	34,979	33,657
	Municipal & Industrial	6,893	6,893	6,893	6,893	6,893	6,893
	Percent Municipal & Industrial	14%	15%	15%	16%	16%	17%
Engleman ID	Agricultural	7,879	7,582	7,295	7,019	6,754	6,499
	Municipal & Industrial	-	-	-	-	-	-
	Percent Municipal & Industrial	N/A	N/A	N/A	N/A	N/A	N/A
Harlingen ID	Agricultural	41,418	39,852	38,346	36,896	35,502	34,160

Appendix A: Water Rights Distribution Calculations

ID	Water Supply	2020	2030	2040	2050	2060	2070
	Municipal & Industrial	25,084	25,084	25,084	25,084	25,084	25,084
	Percent Municipal & Industrial	38%	39%	40%	40%	41%	42%
Hidalgo and Cameron Co. ID No. 9	Agricultural	73,262	70,493	67,828	65,264	62,797	60,424
	Municipal & Industrial	18,496	18,496	18,495	18,494	18,494	18,493
	Percent Municipal & Industrial	20%	21%	21%	22%	23%	23%
Hidalgo Co. ID No.1 (Edinburg)	Agricultural	33,198	31,943	30,736	29,574	28,456	27,381
	Municipal & Industrial	24,125	24,125	24,125	24,125	24,125	24,125
	Percent Municipal & Industrial	42%	43%	44%	45%	46%	47%
Hidalgo Co. ID No. 2 (San Juan)	Agricultural	60,251	57,973	55,782	53,673	51,644	49,692
	Municipal & Industrial	30,663	30,663	30,663	30,663	30,663	30,663
	Percent Municipal & Industrial	34%	35%	35%	36%	37%	38%
Hidalgo Co. ID No. 5 (Progreso)	Agricultural	6,273	6,036	5,807	5,588	5,377	5,173
	Municipal & Industrial	-	-	-	-	-	-
	Percent Municipal & Industrial	N/A	N/A	N/A	N/A	N/A	N/A
Hidalgo Co. ID No. 6 (Mission No. 6)	Agricultural	15,816	15,219	14,643	14,090	13,557	13,045
	Municipal & Industrial	6,309	6,309	6,309	6,309	6,309	6,309
	Percent Municipal & Industrial	29%	29%	30%	31%	32%	33%
Hidalgo Co. ID No. 13 (Baptist Seminary)	Agricultural	1,835	1,766	1,699	1,635	1,573	1,514
	Municipal & Industrial	-	-	-	-	-	-
	Percent Municipal & Industrial	N/A	N/A	N/A	N/A	N/A	N/A
Hidalgo Co. ID No. 16 (Mission No. 16)	Agricultural	13,983	13,454	12,946	12,456	11,986	11,532
	Municipal & Industrial	4,216	4,216	4,216	4,216	4,216	4,216
	Percent Municipal & Industrial	23%	24%	25%	25%	26%	27%
Hidalgo Co. Water Control and Improvement District No. 18	Agricultural	266	256	246	237	228	219
	Municipal & Industrial	-	-	-	-	-	-

Appendix A: Water Rights Distribution Calculations

ID	Water Supply	2020	2030	2040	2050	2060	2070
	Percent Municipal & Industrial	N/A	N/A	N/A	N/A	N/A	N/A
Hidalgo Co. Water Improvement District No. 3	Agricultural	3,657	3,519	3,386	3,258	3,135	3,016
	Municipal & Industrial	16,950	16,950	16,950	16,950	16,950	16,950
	Percent Municipal & Industrial	82%	83%	83%	84%	84%	85%
Hidalgo MUD No. 1	Agricultural	503	484	466	448	431	415
	Municipal & Industrial	273	273	273	273	273	273
	Percent Municipal & Industrial	35%	36%	37%	38%	39%	40%
La Feria ID (CCID#3)	Agricultural	36,589	35,206	33,875	32,595	31,363	30,177
	Municipal & Industrial	3,050	3,050	3,050	3,050	3,050	3,050
	Percent Municipal & Industrial	8%	8%	8%	9%	9%	9%
Santa Cruz Irrigation District No. 15	Agricultural	31,625	30,430	29,280	28,173	27,108	26,083
	Municipal & Industrial	3,280	3,280	3,280	3,280	3,280	3,280
	Percent Municipal & Industrial	9%	10%	10%	10%	11%	11%
Sharyland ID, Hidalgo Co. No. 19	Agricultural	3,734	3,593	3,457	3,326	3,200	3,079
	Municipal & Industrial	-	-	-	-	-	-
	Percent Municipal & Industrial	N/A	N/A	N/A	N/A	N/A	N/A
United ID	Agricultural	22,271	21,430	20,620	19,840	19,090	18,369
	Municipal & Industrial	33,730	33,730	33,730	33,730	33,730	33,730
	Percent Municipal & Industrial	60%	61%	62%	63%	64%	65%
Valley Acres ID	Agricultural	7,004	6,739	6,484	6,239	6,003	5,776
	Municipal & Industrial	300	300	300	300	300	300
	Percent Municipal & Industrial	4%	4%	4%	5%	5%	5%