

# TODOS SANTOS AND EL PESCADERO: SOCIO-DEMOGRAPHIC AND ENVIRONMENTAL OVERVIEW

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## PREFACE

This report was commissioned by Colorado State University Todos Santos Center. The aim of this report is to provide base information socio-demographic and environmental aspects of Todos Santos and El Pescadero regions in Baja California Sur, México.

The CSU Todos Santos Center campus is located in the town of Todos Santos, Baja California Sur. El Pescadero, a rural village nearby is strongly connected to Todos Santos, and therefore both localities were considered as the focus regions for the present report.

The information provided here in addition to the community-based participatory research conducted by the CSU Todos Santos Center, will contribute to the process of identifying the principle priorities and challenges that the communities in the focus regions are facing. In turn, this will help prioritize research and educational programs that the CSU Todos Santos Center could offer to the CSU and local communities.

The sources of the present information were derived mainly from published documents, national public databases (i.e. The National Institute of Statistics and Geography *INEGI*), and in some cases, through official information requests to regional governmental institutions. A major source of information is the " subregional Program for Urban Development in Todos Santos - El Pescadero - Las Playitas" developed by the Center of Urban Studies and Architecture *CEURA* and published at the Official Bulletin of the Government of the State of Baja California Sur in 2020. All the information provided here is referenced appropriately and open to the general public. There are no personal opinions or communications included in this report.

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## 1. CONTEXT

### 1.1 THE STATE OF BAJA CALIFORNIA SUR

Baja California Sur (BCS) represents one of thirty-two federal entities in Mexico. Baja California Sur is located in the Northwest region of the Mexican Republic and represents half of the Baja California Peninsula (Longitude 115°13' 26.40" W/ 109°24' 46.80" W - Latitude 22°52'.19.20" N/ 28° 00' 00.00" N)<sup>1</sup>. It covers a total area of 73,909 km<sup>2</sup> (3.8 % of the national territory) and 2,220 km coastline including the Gulf of California and the Pacific Ocean (22% of the nation's coastline and the largest littoral zone extension in the country, 1400 on the Pacific Ocean, 820 on the Gulf de California)<sup>2</sup>. BCS is bordered by Baja California to the north, Gulf of California to the east, and Pacific Ocean to the south and west (figure 1). The extension of territorial waters, including both the Pacific Coast and Gulf of California, makes BCS region with the country's highest fishing potential, estimated at 164,266 tons annually (2018, latest study)<sup>2</sup> representing 38% of the national production.



Fig. 1. Location of Baja California Sur (Source: Instituto Nacional de Estadística y geografía (INEGI) <http://cuentame.inegi.org.mx/>).

**Climate.** Baja California Sur is characterized by a desert or arid climate, (BW, according to the Koppen climate classification). The climate ranges are very dry (92%), dry and semi-dry (7%), temperate sub-humid (1 %). The highest average temperature is 35°C (95 °F) during July and August while the lowest average temperature is 9°C (48°F) during January. The mean annual temperature ranges from 18°C (64°F) to 22°C (72°F) along the coastline. Precipitation is very scarce and present primarily during the summer season. The mean annual precipitation is less than 200 mm. Precipitation patterns are occasionally modified by hurricanes. There is natural water scarcity in the region <sup>2</sup>.

**Demography.** The total population size of BCS is 637,026 inhabitants (including 392,568 women and 405,879 men) mostly distributed in urban (91%) compared to rural (9%) areas. The regional population size corresponds to 0.6% of the national population<sup>1</sup>. Baja California Sur has the lowest population density per-km <sup>2</sup> within the country (11 people per km<sup>2</sup>) • The total regional population size has doubled during the last 25 years, having its highest increase between 2000 and 2010 (Table 4). This proportion has slightly grown over time<sup>2</sup>. Between 2015 and 2020, 26,996 people left Baja California Sur to live in other states mostly to Baja California, Sinaloa, Jalisco. Also, between those years 72,475 people arrived to Baja California Sur mainly from Guerrero, Sinaloa and Estado de Mexico. In 2020, 1998 Mexicans left BCS to live in another country, 67 of every 100 moved to the United States. Baja California Sur had 6.5% of the national immigrant and foreigners' entries to the country that year.

**Economy.** The main industry in Baja California Sur is derived from tertiary economic activities defined as activities involving commerce, services and transportation, mostly tourism-related activities (i.e. trade, lodging services, food and drink services), representing 70%, in 2020, of the annual gross domestic product in the state <sup>1</sup> followed by secondary activities including construction and industrial manufacturing, services

according to INEGI), and primary (defined as activities involving the use of natural resources including agriculture, farming, forestry, fishing and mining according to INEGI) economic activities representing, respectively, 28.2% and 4.1% of the annual gross domestic product in the state<sup>1</sup>. The economic structure of the different economic sectors in Baja California Sur is shown in Table 7.

Baja California Sur is acknowledged for having the highest number of research institutions focused on marine sciences within Latin America; the cleanest coastal waters in the country as revealed by diverse, systematic water quality monitoring; 213,100 hectares of coastal lagoons, bays and estuaries; fisheries such as squid, lobster and aquaculture; organic agriculture development; salt exploitation ; a leader position in gypsum production within the national mining sector; and a privileged natural environment<sup>2</sup>.

More detailed information on the socio-demographic indicators in Baja California Sur can be found in Annex I.

## 1.2 BAJA CALIFORNIA SUR MUNICIPALITIES

Baja California Sur is administratively structured in five municipalities: Mulege, Comondu, Loreto, La Paz, and Los Cabos (figure 2) including a municipal seat per municipality (Table 1). Mulege covers the largest area while Los Cabos covers the smallest area (Table 1).



Fig. 2. Municipality and Boroughs division in Baja California Sur. Source: Datos básicos de Baja California Sur 2012. Gobierno del Estado de Baja California Sur, Secretaría de Promoción y Desarrollo Económico, y Dirección de informática y Estadística

Table 1. Municipality division of Baja California Sur.

Municipality	Municipal Seat	Area (km <sup>2</sup> )
<b>Mulegé</b>	Santa Rosalía	33,092.21
<b>Comondú</b>	Cd. Constitución	12,547.30
<b>Loreto</b>	Loreto	4,311.00
<b>La Paz</b>	La Paz	20,274.98
<b>BCS</b>		<b>73,677.00</b>

Source: Instituto Nacional de Estadística y Geografía (INEGI)

The number of boroughs (delegación) and sub-boroughs (sub-delegación) within each municipality in Baja California Sur is shown in Table 2. Municipalities (municipios) represent the second-level administrative division and are responsible for public services. Each municipality is administratively autonomous. The citizens elect a municipal president who heads a municipal council (Ayuntamiento). The municipal council consists of a chairman (cabildo) with a syndic and several trustees (regidores). If the municipality covers several towns or localities, a single one is elected as a seat of the municipal government (cabecera municipal) while the rest elect representatives to an auxiliary presidency or council (junta auxiliar). Boroughs (delegaciones) represent the third-level administrative division and in some cases, they pertain to the urbanized areas of the municipality. Boroughs are sub- divided into sub-boroughs that are comprised by small populations from different localities.

Table 2. Number of boroughs, sub-boroughs, and localities per municipality

Municipality	No. Borough	No. Sub-borough	No. Localities
<b>Mulegé</b>	6	28	459
<b>Comondú</b>	7	32	651
<b>Loreto</b>	0	8	147
<b>La Paz</b>	6	49	1,044
<b>Los Cabos</b>	4	51	549
<b>BCS</b>	<b>23</b>	<b>168</b>	<b>2,850</b>

Source: XIII Cense de Población y Vivienda 2010, Resultados definitivos. Instituto Nacional de Estadística y geografía (INEGI) <http://www.inegi.org.mx>

Total population size, including urban and rural, per municipality in Baja California Sur is shown in Table 3. Los Cabos represents the most populous municipality, reaching a total population size of 330,312 inhabitants followed by La Paz reaching a total population size of 301,961 inhabitants<sup>3</sup>.

Table 3. Population size per municipality in Baja California Sur

Population size (number of inhabitants)				
Municipality	2010	2015	2020	** (people/km
Mulege	59,114	60,171	67,727	2.2
Comondu	70,816	72,564	83,051	4.5
Loreto	16,738	18,912	21,657	5.1
La Paz	251,871	272,711	301,961	19.08
Los Cabos	238,487	287,671	330,312	87.5
<b>BCS</b>	<b>637,026</b>	<b>712,029</b>	<b>804,708</b>	<b>11.0</b>

Source: XIII Censo de población y Vivienda 2020, Resultados definitivos. Instituto Nacional de Estadística y geografía (INEGI)

The distribution of the population per municipality in Baja California Sur over the last 25 years is shown in Table 4. The highest population growth rate is observed in Los Cabos municipality, where a two-fold increase in population size was shown in a ten-year period (2000-2010).

Table 4. Population distribution per municipality in Baja California Sur

Population size (number of inhabitants)					
Municipality	2000	2005	2010	2015	2020
Mulege	45,989	52,743	59,114	60,171	67,727
Comondu	63,864	63,830	70,816	72,564	83,051
Loreto	11,812	11,839	16,738	18,912	21,657
La Paz	196,907	219,596	251,871	272,711	301,961
Los Cabos	105,469	164,162	238,487	287,671	330,312
<b>BCS</b>	<b>424,041</b>	<b>512,170</b>	<b>637,026</b>	<b>712,029</b>	<b>804,708</b>

Source: XI, XII Y XIII Censo General de Población y Vivienda 2010 y 2020; Instituto Nacional de Estadística y geografía (INEGI) <http://www.inegi.org.mx>

Changes in the population structure of the municipalities are derived from changes in birth and fecundity rates of the population. However, the largest changes are attributed to the population flow and migration patterns. During 2005, 9.8% of the resident



population in Baja California Sur was considered as recent immigrants for being arrived during the last five years <sup>2</sup>. According to CONAPO (Consejo Nacional de Población). Some of the main reason why people immigrate are looking for work, reunite with family, change or job offer and study. (Table 5)

Table 5. Immigration reasons percentages by Municipality.

Cause	Municipality	Percentage
Looking for work	Los Cabos	46.3%
Change or Job offer	Loreto	24.9%
Study	La Paz	11.1%
Family reunion	Comondú	37.8%

Source: Values estimated from Consejo Nacional de Población CONAPO, based on XII Censo General de Población y Vivienda 2020, Resultados definitivos. Instituto Nacional de estadística y geografía (INEGI)

Table 6. Number of immigrants and emigrants registered per municipality in Baja California Sur 2010 - 2021

Number of Immigrants and Emigrants				
Municipality	2010	2011	2015	2021
	Immigrants	Emigrants	Immigrants	Emigrants
Mulege	0	0	0	0
Comondu	0	0	1,344	1,249
Loreto	249	231	273	398
La Paz	136	120	2,365	2,378
Los Cabos	4,307	3,884	25,153	7,758
<b>BCS</b>	<b>4,692</b>	<b>4,235</b>	<b>29,135</b>	<b>11,783</b>

Source: Instituto Nacional de Migración (INM) in: Datos básicos de Baja California Sur 2020. Gobierno del Estado de Baja California Sur, Secretaría de Promoción y Desarrollo Económico, y Dirección de informática y Estadística.

The municipalities of La Paz (home of the State Capital) followed by Los Cabos (main tourism region) show the most economically active populations within Baja California Sur focused mainly on tertiary economic activities (i.e. trade, lodging and food/drinks services) <sup>1</sup> <sup>2</sup>. The economic structure and its GDP of the different sectors in Baja California Sur is shown in Table 7.

Table 7. Gross domestic product by sector (GDP) in Baja California Sur per activity. (Million Pesos)

Sector		GDP
Total of the sectors		
Primary	Agriculture, farming, forestry, fisheries and hunting	7,222
Secondary	Mining	6,976
	Electricity water and gas	8,363
	Construction	76,569
	Manufacturing	2,879
Tertiary	Trade	41,214
	Transportation and Storage	11,534
	Financial services and insurance	4,961
	Accommodation and A&B	30,280

Censos Económicos 2019, Resultados Definitivos. Instituto Nacional de Estadística y Geografía (INEGI)

### 1.3 LA PAZ MUNICIPALITY

The municipality of La Paz hosts the capital city of Baja California Sur. It is comprised of seven boroughs (and their corresponding sub-boroughs) as shown in Table 8. The main localities within La Paz municipality are La Paz (Municipal seat), **Todos Santos**, El Centenario, Chamelta and **El Pescadero**<sup>1</sup>. Todos Santos and El Pescadero are the focus regions of the present report.

Table 8. Sub-boroughs, Boroughs, and Municipality Heads within La Paz Municipality

<b>Population size</b>			
<b>Sub-boroughs</b>		<b>2010</b>	<b>2020</b>
<b>Todos Santos</b>	El Pescadero, El Veladero, Texcalama, Ejido Plutarco Elias Calles, Saltito de los Garcia, El Aguaje, San Andres, El Refugio, Los Horconcitos, Santa Gertrudis, Las Playitas, Matancitas, San Venancio	5,148	11,649
<b>San Antonio</b>	El Triunfo , El Rosario, Palo de Arco, San Antonio de la Sierra, El Valle Perdido, Palos Verdes	463	914
<b>Los Dolores (Las Pocitas)</b>	San Hilario, Santa Mada de Toris, La Soledad, San Pedro de la Presa, El Caporal, Santa Rita, San Fermin, Santa Fe, El Paso de Iritu , Puerto Chale	345	938
<b>San Juan de Los Planes</b>	El Ancon, Agua Amarga, El Sargento	902	2322
<b>Los Barriles</b>	El Coro, El Cardona I, San Bartolo	1,174	2,422
<b>El Valle del Carrizal</b>	San Blas, Col. Alvaro Obregon, La Matanza, Ejido Melit6n Albanez, La Trinidad	618	3,476
<b>La Paz</b> (Head municipality)	El Centenario, Chametla, San Juan de la Costa Alfredo V. Bonfil, El Pro greso, Conquista Agraria, San Pedro, La Fortuna, San Evaristo	215,178	259,868

Conteo de Población y Vivienda 2020; XIII Censo de Población y Vivienda 2020, Resultados definitivos  
 Instituto Nacional de Estadística y geografía (INEGI) <http://www.inegi.org.mx>

More detailed information on socio-demographic indicators in La Paz municipality can be found in Annex II.

## 2. TODOS SANTOS AND EL PESCADERO

### 2.1 LOCATION

Todos Santos (founded in 1723 by Jesuit missionaries) is a traditional colonial town located in a plateau at the foothills of the Sierra de La Laguna Mountains. It is located 73 km north of Cabo San Lucas and 80 km south of the city of La Paz (geographic reference coordinates: 23° 26' 57.8" N, 110° 13' 22.9" W, figure 3). Todos Santos has become a home for many local and international artists. The Secretary of Tourism of Baja California Sur named Todos Santos a federally designated, "Pueblo Mágico" in 2006. Todos Santos borough, within its urban and rural surrounding areas, is known for its agricultural areas. Coastal plains characterize the local landscape with rolling hills creating the foothills between the coast and the Sierra de La Laguna Mountain range. These plains have been shaped by surface water runoff and wind erosion and are comprised by alluvial deposits and a long stretch of coastal dunes on the Pacific coast<sup>2</sup>.

El Pescadero is a small rural town about 8 km south to Todos Santos, located at km 64 of the Transpeninsular highway. It is 64 km north of Cabo San Lucas and 94 km south of La Paz City (geographic reference coordinates: 23° 20' 44" N, 110° 9' 22" W, figure 3). El Pescadero is bordered by Todos Santos borough to the north, Los Cabos municipality to the south, Santiago borough to the East and the Pacific Ocean to the West.

The topographic map of Todos Santos and El Pescadero (scale 1:50,000) <sup>1</sup> is shown in anexo III



Fig. 3. Original map derived from Google maps <https://mail.google.com>

## 2.2 SOCIO-DEMOGRAPHIC INDICATORS

### Demography

Todos Santos has a total population size of 7,185 inhabitants representing the second largest locality within the municipality of La Paz. Todos Santos borough is comprised of fourteen sub-boroughs including Todos Santos town and thirteen additional sub-boroughs, as shown in Table 9. The population distribution per subboroughs is shown in Table 9. El Pescadero shows a total population of 4,245 inhabitants (including 2176 males and 2096 females), representing the second largest locality within the Todos Santos borough. The age structure for the total population of Todos Santos and El Pescadero is shown in Figure 4. The main population variables for Todos Santos and El Pescadero are summarized in Table 10.

Table 9. Population distribution of Todos Santos borough and surrounding localities (sub-boroughs) in 2010 and 2020.

Name	Seat	2010	2020
<b>Todos Santos</b>	Borough	5,148	7,185
<b>El Pescadero</b>	Sub borough	2,338	4,245
<b>El Veladero</b>	Sub borough	2(2005)	4(2010) **
<b>Texcalama</b>	Sub borough	20	11
<b>Ejido Plutarco Elias Calles</b>	Sub borough	102	111
<b>Saltito de los Garcia</b>	Sub borough	26	21
<b>El Aguaje</b>	Sub borough	10	8
<b>San Andres</b>	Sub borough	16	10
<b>El Refugio</b>	Sub borough	8	1
<b>Los Horconcitos</b>	Sub borough	6	12
<b>Santa Gertrudis</b>	Sub borough	41	5
<b>Las Playitas (El Batequito)</b>	Sub borough	23	6
<b>Matancitas</b>	Sub borough	10	12
<b>San Venancio</b>	Sub borough	1	4
		7,751	11,635

Fuente: Censo de Población y Vivienda, 2020, Resultados Definitivos; XIII Censo de Población y Vivienda 2020, Resultados definitivos. Instituto Nacional de Estadística y geografía (INEGI) <http://www.inegi.org.mx> \*\* (2020 did not include this sub-boroughs)

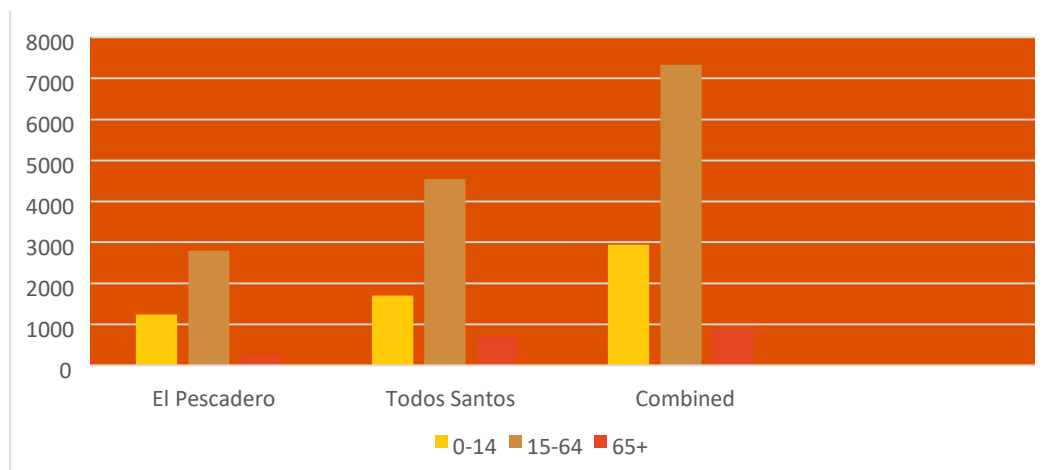


Fig. 4. Age structure of total population in Todos Santos, El Pescadero and combined populations. Source: XIII Censo de Población y Vivienda 2020, Resultados definitivos. Instituto Nacional de Estadística y geografía (INEGI) <http://www.inegi.org.mx>

Table 10: Main population variables for Todos Santos and El Pescadero

Variable	Description	Todos Santos	El Pescadero	Both
<b>Total Population</b>	Total number of residents			11,430
Male population		3,676	2,176	5,852
Female population		3,509	2,069	3,778
Average live births	Average live births per woman	1.99	2.09	
Native population	People born in the location	5,265	2,516	7,781
Non-native pop	People born in other states	1,275	1,542	1,717
Economically Active Population	12+ yr olds who had a job or were looking for a job during the survey week	3,415	2,199	5,614
Economically Active males		2,112	1,370	3,482
Economically Active females		1,303	829	2,132
Non-Economically Active Population	12+ yr olds who are retired, students, staying at home, or with a disability that impedes to work.	2,163	1,031	3,194
Non-Economically Active males		738	313	1,051
Non-Economically Active females		1,425	718	2,143
Affiliated to at least one health service	Affiliated with the health services from IMSS, ISSSTE, PEMEX, SEDENA, SEMAR or SSA	10,688	6,102	16,790
Not affiliated to any health service		1,617	1,210	2,827
Number of homes	Homes are inhabited private units (Houses, apartments, mobile units, etc.)	2,065	1,150	3,215
Homes with male head of household		1,377	849	2,226
Homes with female head of household		688	301	989

Population in homes	Homes are inhabited private units (Houses, apartments, mobile units, etc.)	7,108	4,208	11,316
Population in homes (male head of household)		4,907	3,100	8,007
Population in homes (female head of household)		2,201	1,108	3,309
Total houses	Houses = inhabited and not inhabited houses, temporary and collective	2,762	1,432	4,194

Secretaría de Marina-Armada de México; SSA Secretaría de Salud. XIII Censo de Población y Vivienda 2020, Resultados definitivos. Instituto Nacional de Estadística y geografía (INEGI) <http://www.inegi.org.mx>

## Economy

The economic activities in Todos Santos and El Pescadero follow different patterns. While Todos Santos economic activities are based in the tertiary sector (mainly trade and services), El Pescadero economic activities rely on the primary sector (primarily agriculture) The economic structure of different sectors in the focus regions is shown in table 11.

Table 11. The economic structure at the different sector activities in Todos Santos and El Pescadero

<b>Economic structure</b>				
<b>Entity</b>	<b>Employees</b>	<b>Primary</b>	<b>Secondary</b>	<b>Tertiary</b>
<b>BCS</b>	138,565	11.90 %	20.30%	64.80%
<b>La Paz</b>	56,051	2.20%	19.70%	74.90%
<b>Todos Santos</b>	1,376	22.20%	18 .50%	55.70%
<b>El Pescadero</b>	533	50.80 %	15 .00%	25.70%

Source: Centro de Estudios de Urbanismo y Arquitectura SA de CV (CEURA) based on data from XII Censo de Población y Vivienda 2020, Resultados definitivos. instituto Nacional de Estadística y geografía (INEGI) <http://www.inegi.org.mx>



The economic activities in Todos Santos correspond to tertiary sector including tourism (37% national and 63% international), trade and services, followed by the primary sector such as agriculture and fishing. Harvest products for exportation include fresh herbs, strawberries and bell pepper<sup>10</sup>. The number of economic units registered in Todos Santos are shown in table 12.

The main economic activities in El Pescadero correspond to the primary sector including agriculture and fishing, followed by the tertiary sector including handcraft production, alternative tourism, regional sweet production and food-derived products<sup>2</sup>

Table 12. Economic units in Todos santos, Baja California Sur

<b>NE</b>	<b>Economic activity</b>
<b>2</b>	Agriculture, animal breeding, forestry, fishing and hunting
<b>0</b>	Mining
<b>1</b>	Generation, transmission and distribution of electricity, water and gas by pipeline to the final consumer
<b>2</b>	Construction
<b>34</b>	Manufacturing industries
<b>9</b>	Wholesale trade
<b>202</b>	Retail trade
<b>6</b>	Transport, postal services and warehousing
<b>7</b>	Mass media information
<b>6</b>	Financial services and insurance
<b>18</b>	Rental real state and personal property and intangible services
<b>10</b>	Professional, scientific and technical services
<b>0</b>	Corporate

2	Support services to businesses and waste management and remediation services
11	Educational services
16	Health and welfare services
11	Recreational, cultural and sporting services
96	Providers of temporary accommodation and preparation of food and drink
61	Other services excluding government activities
15	Legislative and government activities, administration of justice and international and extraterritorial organizations

Directorio estadístico Nacional de Unidades económicas (DENUE); Detailed information per economic activity shown in Annex IV. Institute Nacional de Estadística y Geografía (INEGI)

### **Infrastructure of basic public services**

According to the Sub-regional Program for Urban Development in Todos Santos - El Pescadero - Las Playitas, Todos Santos and El Pescadero show a high coverage (>90%) in basic services including water supply, electricity, and telephone, except for the sewage system. Approximately, 74% and 51% of the housings in Todos Santos and El Pescadero, respectively, has access to municipal sewer systems in these localities. The deficit in connections is mitigated using septic tanks <sup>2•</sup>

The water supply, sewage and sanitation in the municipality of La Paz are attended by OOMSAPA Organismo Operador Municipal del Sistema de Agua Potable y Alcantarillado de La Paz SAPA. SAPA has water supply networks in Todos Santos borough and El Pescadero suborough. Some other localities without a water supply network have support from the "Ejido" agricultural water using tanker trucks.

The main source of water supply in Todos Santos and El Pescadero comes from groundwater extracted directly from deep wells. Todos Santos water is supplied by two wells San Ignacio and El Manguito while El Pescadero water is supplied by one well Pescadero<sup>12</sup>. The groundwater extraction volumes for each of the wells are shown in

Table 13. The wells in Todos Santos are located within the agricultural area, and the water is used mainly for agriculture irrigation and domestic use <sup>2</sup>.

Table 13. Groundwater extraction volumes from wells 2014.

Locality	Wells name	Extraction volume (l/s)
<b>Todos Santos</b>	San Ignacio	16
	El Manguito	35
<b>El Pescadero</b>	Pescadero	7

Source: H. XIV Ayuntamiento de La Paz 2011-2015. Organismo Operador Municipal del Sistema de Agua Potable y Alcantarillado de La Paz (SAPA), see Annex V.

Mean water consumption per day per person is estimated 712 liters in Todos Santos and 441 liters in El Pescadero <sup>2</sup>.

The sanitary sewer network in Todos Santos and El Pescadero has an approximate coverage of 74% and 51% of households, respectively. In El Pescadero, this network consists of a gravity-fed system of pipes and collectors that conduct the wastewater directly to the treatment plant. In Todos Santos the wastewater is routed to a water collecting sump basin and pumped to the treatment plant <sup>2</sup>. There is a local private sewage service "Septicktruck " employed by the current borough-administration that participates in the pumping process of septic tanks. Specific information on the available wastewater treatment plants is shown in Table 14. According to OOMSAPA, there are a total of 829 households units connected to the water supply/sewage system, in addition to 174 units connected in Todos Santos that are not specified<sup>12</sup>.

Table 14. Sewage treatment plants in Todos Santos and Pescadero

Locality	Name	Process	Capacity (l/s)	Treated flow(l/s)	Receptor	Observations
Todos Santos	Cala de Ulloa	Activated sludge	15	13	Wash (no name)	Private initiative, started in 2009
Todos Santos	Todos los Santos	Waste stabilization pond	20	10	Subsoil infiltration (by the sea)	Poor operation condition
Pescadero	El pescadero	Activated sludge	3.5	1.5	Green area palm tree	

Inventario nacional de plantas municipales de potabilización y de tratamiento de aguas residuales en operación, Diciembre 2019. Comisión Nacional del Agua, CONAGUA.  
<http://sina.conagua.gob.mx/sina/tema.php?tema=plantasTratamiento&ver=mapa&o=0&n=nacional>

According to the State Program for Prevention and Solid Waste Management in Baja California Sur, the infrastructure to accommodate adequate solid waste management in Baja California Sur is insufficient<sup>13</sup>. The sub-regional Program for Urban Development in Todos Santos - El Pescadero - Las Playitas, recognized that the main environmental challenges faced by the five municipalities of Baja California Sur are related to the lack of an adequate solid waste management. Those challenges include poor management and solid waste disposal, agrochemical pollution, solid waste pollution, contamination from tire rubber, construction and demolition waste, contamination from open garbage dumps (tiraderos de cielo abierto), and waste from fisheries<sup>2</sup>.

The solid waste production per municipality in Baja California Sur is shown in Figure 15. Todos Santos and El Pescadero combine to be the second largest urban solid waste producers (12,272 ton/yr.) within the La Paz municipality<sup>13</sup>. The waste collection system and infrastructure in Todos Santos is shown in Table 16. Todos Santos has one recycling collection center, "Punto Verde." Todos Santos and El Pescadero share the same waste disposal site - an open garbage dump, which is periodically burned. Some characteristics of the final disposal are shown in Table 17. At the open garbage dump, there is no management for the different types of waste, which includes construction

residues, sewage treatment sludge, hazardous residues from hospitals, or agricultural and fishing waste. There is a proposed landfill construction in Todos Santos that will be regulated according to the Mexican Official Law NOM-083-SEMARNAT-2003.

Table 15. Solid waste production per municipality

<b>Municipality</b>	<b>Ton/yr</b>	<b>Proportion (%)</b>
<b>La Paz</b>	179,381	38.6
<b>Los Cabos</b>	204,286	44
<b>Loreto</b>	8,950	1.9
<b>Comondu</b>	47,333	10.1
<b>Mulege</b>	24,536	5.2
<b>Total</b>	<b>464,479</b>	<b>100</b>

Source: Programa Estatal para la Prevención y Gestión Integral de Residuos para el Estado de Baja California Sur. Dirección de Planeación Urbana y Ecología. enero 2011. Centro de Estudio de Urbanismo y Arquitectura SA de CV (CEURA).

The original landfill plan shows a controlled site that follows landfill specifications in terms of infrastructure and operation system but does not follow waterproofing specifications <sup>13</sup>.

According to the State Program for Prevention and Solid Waste Management in Baja California Sur, there is no integrated solid waste management (i.e. strategies to reduce, reuse and recycle the solid waste and to address storage, collection, treatment and final disposal of solid waste) in Todos Santos or any other town in Baja California Sur <sup>13</sup>. The primary potential environmental issues related to the current state of solid waste in Todos Santos include: air pollution derived from the open burning of unwanted materials such as plastics and tires particularly in rural areas; and water and soils pollution derived from open garbage dumps (without any environmental regulation) as well as agriculture and ranching (by agrochemicals) <sup>13</sup>.

Table 16. Waste collection system and infrastructure in La Paz (city) and Todos Santos

	La Paz (City)	Todos Santos	Pescadero
<b>Number of trucks</b>	25	3	1
<b>Weekly frequency</b>	2	2	7
<b>Coverage (%)</b>	100	90	100
<b>Garbage trucks</b>	1	9	6
<b>Collection employees</b>	154	9	14
<b>Street sweepers employees</b>	145	18	6
<b>Mechanic sweeper</b>	1	0	0

Source: Programa Estatal para la Prevención y Gestión Integral de Residuos para el Estado de Baja California Sur. Dirección de Planeación Urbana y Ecología. 2021. [https://www.gob.mx/cms/uploads/attachment/file/187449/Baja\\_California\\_Sur.pdf](https://www.gob.mx/cms/uploads/attachment/file/187449/Baja_California_Sur.pdf) **Delegación de TDS | Subdelegación Pescadero**

Table 17. Solid waste disposal in Todos Santos y El Pescadero.

	La Paz (City)	Todos Santos	El Pescadero
<b>Final disposal</b>	dump	Currently share an open garbage dump	
<b>Volume per day (ton)</b>	450	22	9
<b>Surface (hectares)</b>	50	6	17
<b>Lifespan (years)</b>	12	0	0

Source: Programa Estatal para la Prevención y Gestión Integral de Residuos para el Estado de Baja California Sur. Dirección de Planeación Urbana y ecología. 2021. Centro de Estudio de Urbanismo y Arquitectura SA de CV (CEURA)

## Education

In Todos Santos, there are 13 educational establishments, including public and private schools from pre-school to high school, the number of establishments per type of school is shown in Table 18. The name and location of the corresponding schools are shown in Annex IV. In 2007 a total of four educational establishments were registered in El Pescadero. According to the Secretary of Social Development, the number of registered educational establishments does not entirely cover the educational needs in Todos Santos and El Pescadero <sup>2</sup>.

Table 18. Education Infrastructure in Todos Santos

Type of School	Number of schools
Public Pre-school	3
Private Pre-school	2
Public Primary	3
Public Secondary	3
Public High School	1
Special Needs School	1
Libraries	2

Source: XII I2021, delegación todos santos y Subdelegación pescadero 2021: Programa Subregional de Desarrollo Urbano de Todos Santos - El Pescadero - Las Playitas, La Paz B.C.S. 2021.

A great proportion of the population between 6-11 years (primary students) attend school, however, school attendance tapers off with age, as shown in Figure 5.

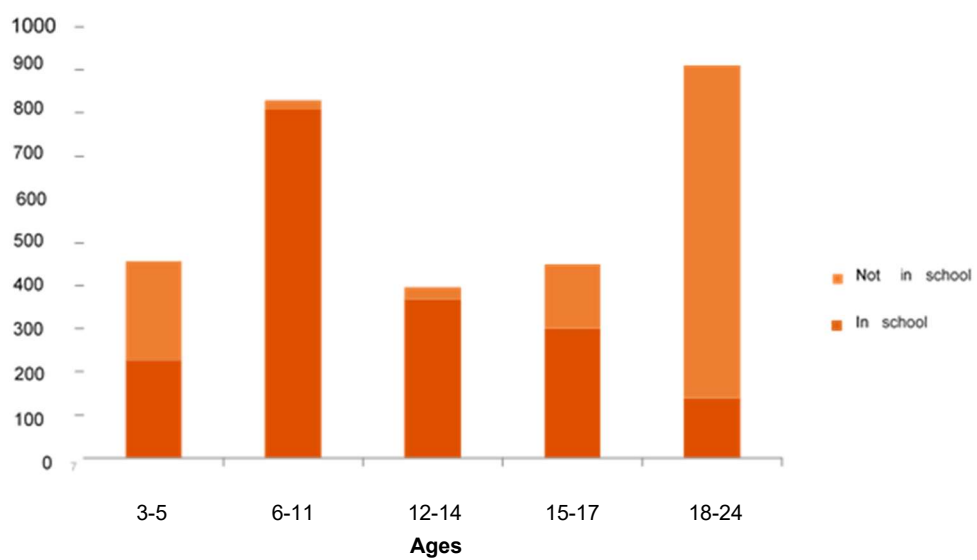


Fig. 5. Population distribution by age attending and not attending school in Todos Santos and El Pescadero. (Source: XIII Censo de Población y Vivienda 2010, Resultados definitivos. Instituto Nacional de Estadística y geografía INEGI <http://www.inegi.org.mx> ).

Some other education indicators in the study area are shown in Tables 19 and 20.

Table 19. Educational condition of the population from Todos Santos and El Pescadero

Educational condition	Description	Todos Santos	El Pescadero	Both
<b>Illiterate 8-14 yr olds</b>		10	7	17
<b>Illiterate 15+ yr olds</b>		60	50	118
<b>15+ yr olds without school degrees or just pre-school</b>		71	61	132
<b>15+ yr olds without primary school</b>		394	253	647
<b>15+ yr olds with primary school only</b>		657	403	1060
<b>15+ yr olds with</b>		884	339	1283



<b>secondary school only</b>				
<b>18+ yr olds with post- basic school</b>	High school, technical or commercial studies, university, masters or doctorate degree	1355	336	1691

XIII Censo de Población y Vivienda 2010, Resultados definitivos. Instituto Nacional de Estadística y geografía (INEGI) <http://www.inegi.org.mx>

Illiteracy in Mexico is defined as the population over 15 who does not read or write 1. Todos Santos and El Pescadero, and Baja California Sur state fare well below the national average of 8%, see table 20. Still, the micro-region surrounding these 2 localities have 6+ % of illiteracy.

Table 20. Comparative illiteracy with state and national average

<b>Location</b>	<b>Percentage of Illiteracy</b>
<b>Todos Santos &amp; El Pescadero</b>	1.06 %
<b>Baja California Sur</b>	2.3 %
<b>Mexico (national)</b>	4.7 %

XIII Censo de Población y Vivienda 2010, Resultados definitivos. Instituto Nacional de Estadística y Geografía (INEGI) <http://www.inegi.org.mx>

## Health

In this section, information is provided regarding the health services infrastructure in Todos Santos and El Pescadero, the primary diseases in Todos Santos and El Pescadero and the main causes of adult and infant mortality in La Paz and Baja California Sur.

Health services infrastructure. The main health centers for Baja California Sur are located in the capital city, La Paz. In addition to a few private hospitals and clinics, the publicly affiliated hospitals Instituto Mexicano del Seguro Social (IMSS), Instituto de Seguridad y Servicios Sociales de los Trabajadores del Estado (ISSSTE), and

(Secretaría de Salubridad SSA), are based in La Paz. There are no-fully equipped hospitals available in Todos Santos and El Pescadero, but there are health care clinics, see Table 21.

Table 21. Hospitals and Clinics in Todos Santos and El Pescadero

Unit	No. of doctors	No. of nurses	Dentists
<b>Todos Santos</b>			
ISSSTE Clinic	2	2	1
SSA Health Center	4	7	0
<b>El Pescadero</b>			
SSA Rural Health center	1	1	0

No. refers to number; ISSSTE "Instituto de Seguridad y Servicios Sociales de los Trabajadores del Estado"; SSA "secretaria de Salud". Source: Programa Subregional de Desarrollo Urbano de Todos Santos - El Pescadero - Las Playitas, La Paz B.C.S. 2021.

Health Factors. The primary reported diseases in Todos Santos and El Pescadero between 2010 and 2015 are shown in Table 22. The data was derived directly from health institutions in Todos Santos and Pescadero and collected by the National Health System.

Table 22. Reported diseases in Todos Santos y Pescadero 2010 - 2020

Condición	Todos Santos		El Pescadero	
	casos	ranks	casos	ranks
Acute Respiratory Infections	11290	1	2776	1
Intestinal infections	1759	2	453	2
Urinary infections	1714	3	352	3
Ulcers, gastritis and duodenitis	604	4	78	5
Acute otitis media	366	6	176	4
Gingivitis and periodontal diseases	490	5	11	13
Asthma	201	7	44	6
Chickenpox	194	8	44	6
Other	149	9	27	9
Pneumonia and bronchopneumonia	136	10	30	8
Urogenital candidiasis	108	11	8	14
Helmintiasis	87	12	12	12
I High BP	63	14	35	7
Diabetes mellitus*	64	13	24	10
Dog bites	38	15	18	11
Burns	31	17	12	12
Mild malnutrition	35	16	1	19
Intestinal amoeba	26	19	7	16
Helmintiasis	87	12	12	12
Conjunctivitis	18	20	8	15
Dengue fever	18	20	1	20
Giardiasis	16	21	0	
Infectious parotitis	10	22	2	19
Intoxication/animal poison	2	26	9	14
Moderate malnutrition	8	23	0	
Non-dog mammal bites	7	24	1	20
Enterobiasis	7	24	0	
Cervical dysplasia	0		4	17
Ischemic heart disease	0			
Tuberculosis	3	25	0	

Severe malnutrition	0		2	19
Alcoholic liver disease	0		2	19
Sequels from other effects	0		2	19
Cerebrovascular diseases	0		2	19
Urogenital trichomoniasis	2	26	0	
Scorpion stings	0		1	20
Acute hepatitis A	0		1	20
Syphilis	0		1	20
Veneral lymphogranuloma chlamydia	0		1	20
Covid 19	255	21	39	6

<sup>1</sup> non-insuline dependant; Source: Dirección General de Epidemiología, Secretaría de Salud . Sistema Nacional de Salud. <https://coronavirus.bcs.gob.mx/casos-covid-19/>

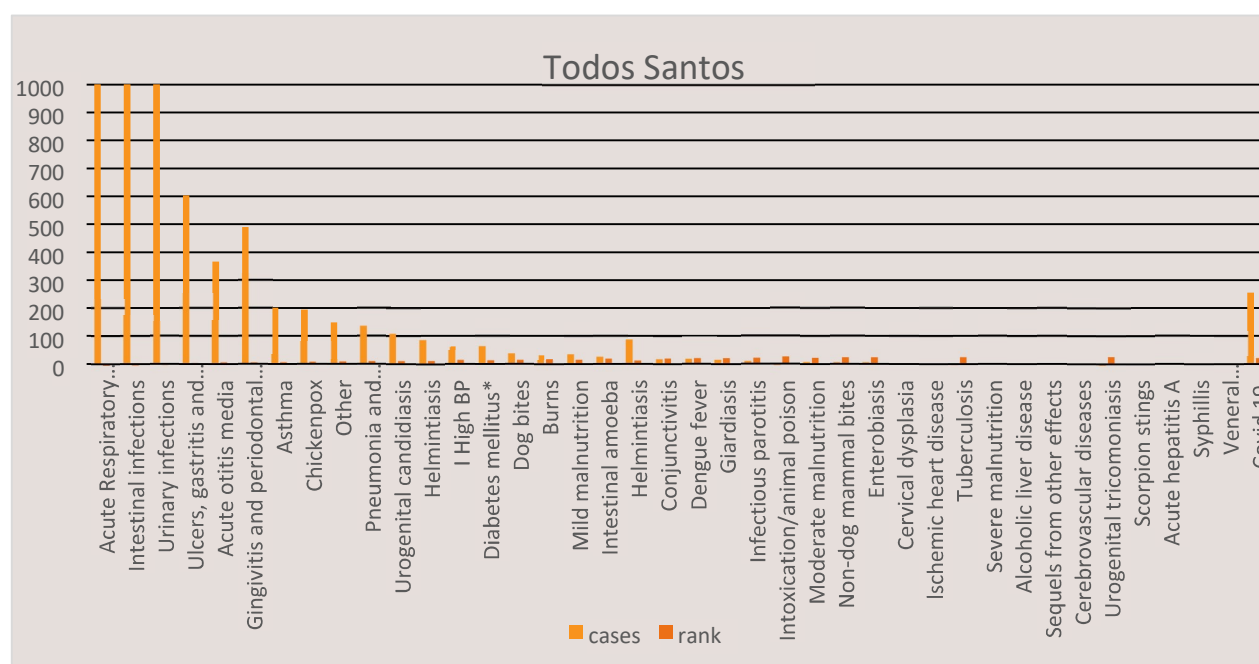


Fig. 6. Mortality rate by cause in Baja California Sur and La Paz municipality 2010-2011. (Source: Subdirección de Estadística. Secretaría de Salud en el Estado de Baja California Sur. in: Datos básicos de Baja California Sur 2012. Gobierno del Estado de Baja California Sur, secretaria de Promoción y Desarrollo Económico, y Dirección de informática y Estadística.

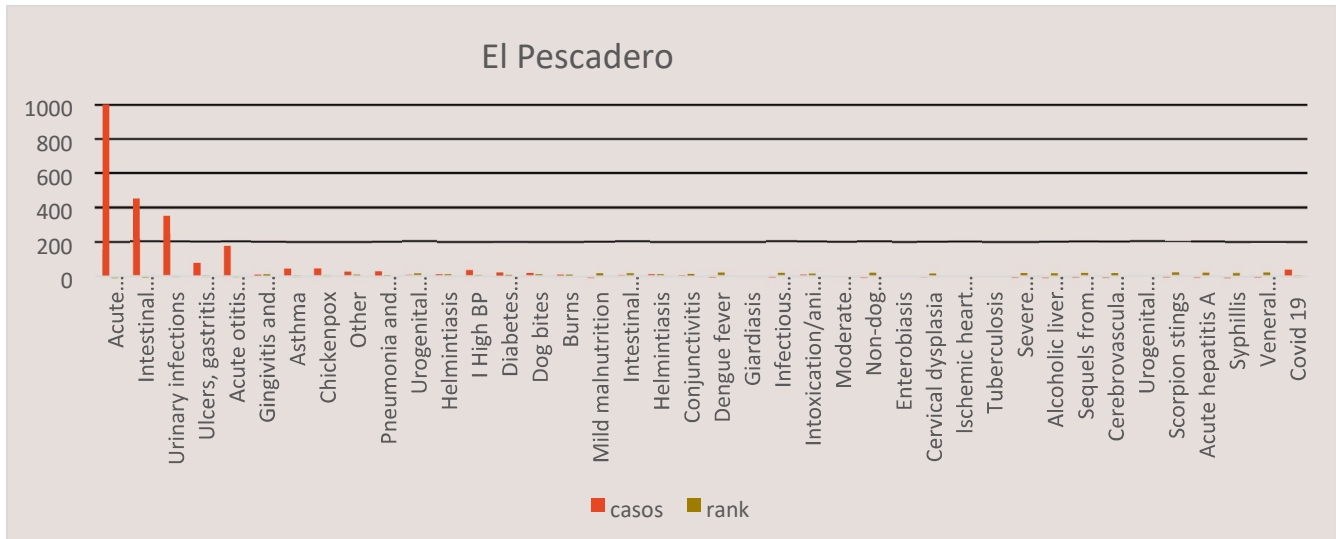


Fig. 7. Infant mortality causes per-1000 live-registered-births in BCS 2010-2011. (Source: Subdirección de Estadística. Secretaria de Salud en el Estado de Baja California Sur. *in*: Datos básicos de Baja California Sur 2012. Gobierno del Estado de Baja California Sur, secretaria de Promoción y Desarrollo Económico, y Dirección de informática y Estadística.

\*According to the National Public Health Institute, acute intestinal diseases (in children under five) and acute respiratory diseases (in children under 10) were also reported as relevant health issues in children from Baja California Sur. State prevalence rates are 15.4% and 44.3% respectively, which is higher than the national mean<sup>15</sup>. In relation to degenerative chronic diseases, it is important to mention that the prevalence value for hypertension in BCS (16%) is slightly higher than the mean national (15.9%) whereas the prevalence value for diabetes in BCS (8.5%) is slightly lower than the mean national (9.2%). Finally, the prevalence values for overweight (26.2%) and obesity (23.0%) in children (5-11 years) were considerably higher compared to the national mean (19.8% and 14.6%, respectively). In general, 49% of children in primary school are considered to be overweight at some level. In BCS, overweight and obesity are considered serious public health problems affecting 8 out of 10 men and women above the age of 20. Anemia also represents a serious problem in BCS in children under 5, and if even more prevalent within 12 and 24 months olds<sup>15</sup>.

**Mortality.** Information on the main causes of mortality for Todos Santos and El Pescadero area was not available. Information on adult mortality in Baja California Sur and in La Paz municipality is shown in Figure 6 and the state infant mortality information is shown in Figure 7

## 2.3 ENVIRONMENTAL INDICATORS

### **Abiotic characteristics**

Todos Santos and El Pescadero belong to the Baja California peninsula province and the Cape Region sub-province. The Cape Region occupies the southern tip of Baja California peninsula. It is crossed by the Tropic of Cancer {23°27' N), and, like the Mediterranean ecosystems of the north, it receives more precipitation than the mid-peninsula deserts. Rainfall in the Cape region, however, is mostly derived from tropical cyclonic storms that reach the peninsula in late summer and fall. The Sierra de La Laguna, a granite mountain range reaching 2200 m in its highest peak, transverses the Cape Region from north to south; sediments derived from its granitic rocks have formed most of the soils of the peninsular Cape<sup>23</sup>. A summary of geographic characteristics of the study area are shown in Table 23.

### **Climate**

The climate in Todos Santos and El Pescadero is considered a desert climate. The climate is heavily influenced by the Pacific Ocean which moderates the temperatures year-round. According to the Koppen-Geiger climate classification, the climate is classified mostly as very dry and semiarid in the wettest regions of the Cape Mountains with summer and winter seasons of precipitation. The mean annual temperature range is 22°C (71.6° F) - 24° C (75.2° F). A desert is considered by definition an area where precipitation is less than 250 mm per year. The mean annual precipitation in Todos Santos and El Pescadero is 161mm<sup>2</sup>.

Table 23. General geographic characteristics of Todos Santos and El Pescadero

Todos Santos and El Pescadero		
<b>Physiography</b>		
<b>Province</b>	Baja California Peninsula	
<b>Sub-province</b>	Batolito de Los Cabos Sub province (Cape Region)	
<b>Climate</b>	Coastline BW (h') hw (x') Dry, semiarid	Mountainous region (Sierra) C(Wo) Temperate, sub-humid
<b>Temperature</b>	Coastline	Mountainous region ("Sierra")
Mean annual	22' C (71.6°F)	18°C (64.4°F)
Nov-Apr (mean range)	12 ' C (53 .6' F) min. 27°C (80.6°F) max.	6°C (42 .8' F) min. 75.2' C (1 62.5' F) max.
May-Oct (mean)	33' C (91.4' F)	
<b>Precipitation</b>		
Mean annual	161 mm	
<b>Soils</b>	Regosols (mostly) and Fluvisol (to a lesser extent)	
<b>Hydrography</b>		
Hydrologic region	RH3 " Baja California Suroeste (Magdalena plains)	
Water sheds	Caracol wash - Candelaria wash; Venancio wash - Salado wash, Mezquita wash - Comondú wash	
<b>Geomorphology</b>	Coastal plains and valleys	Mountainous range
<b>Elevation</b>	0 - 400 m above sea level	
<b>Geology</b>	igneous rocks, metamorphic rocks, arsenic rocks, Mesozoic and Cenozoic conglomerates.	

Source: Programa Subregional de Desarrollo Urbano de Todos Santos - El Pescadero - Las Playitas, La Paz B.C.S. 2012. Centro de Estudio de Urbanismo y Arquitectura SA de CV (CEURA).

## Water

There is naturally occurring water scarcity in Todos Santos and El Pescadero, characterized by low levels of precipitation in summer season occasionally supplemented by hurricanes. Surface runoff is intermittent and disappears through soils infiltration or towards the coastal plains. According to a published study on groundwater availability in Todos Santos conducted by the National Water Council (CONAGUA) <sup>16</sup> the presence of hurricanes has an important effect on the aquifer's recharges, leading in many cases, to a fast recovery of the groundwater levels.

Todos Santos aquifer is in the Southeast of Baja California Sur, covering an area extension of 151 km <sup>2</sup>

Mean elevation of the aquifer is 300 m above sea level and 100 m above sea level in the valley. It borders with the Canada Honda aquifer in the north, El Pescadero aquifer in the southeast, and the Pacific Ocean in the west (figure 8). The aquifer falls within the municipality of La Paz <sup>16</sup>.



Fig. 8. Location of Todos Santos aquifer (Source: Determinación de la disponibilidad de agua en el acuífero 0313 Todos Santo, Estado de Baja California Sur. 2009. Comisión Nacional del Agua (CONAGUA). Subdirección General Técnica. Gerencia de Aguas subterráneas. Subgerencia de Evaluación y Ordenamiento de Acuíferos).

El Pescadero aquifer spans an area of 439 km<sup>2</sup>. Mean elevation of the aquifer is 500m above sea level and 100 m above sea level in the valley. It borders with Todos Santos aquifer in the north, Plutarco Elías Calles aquifer in the south, San Jose del Cabo and Santiago to the east, and the Pacific Ocean to the west (figure 9). The aquifer is located mostly within La Paz municipality and a small portion of the mountainous region (East) belongs to Los Cabos municipality<sup>17</sup>.





Fig. 9. Location of El Pescadero aquifer (Source: Determinación de la disponibilidad de agua en el acuífero 0314 El Pescadero, Estado de Baja California Sur. 2009. Comisión Nacional del Agua (CONAGUA). Subdirección General Técnica. Gerencia de Aguas subterráneas. Subgerencia de Evaluación y Ordenamiento de Acuíferos).

The main water use in Todos Santos is domestic and for livestock El Pescadero utilizes its water primarily for agriculture and domestic use. There is no Irrigation district or unit but a Technical Committee of Underground Waters (COTAS), "Valle de Todos Santos-El Pescadero", since 2000. Both aquifers belong to the Council of the Baja California Sur.

### Hydrology.

The hydrology of the watershed is comprised by intermittent rivers and washes (surface runoff is present less than 50% of the time during rainy seasons). All rivers in the watershed originate at the highest elevations of the watershed mostly in the Sierra de La Laguna Mountains, where most of the fresh water is captured. The mean annual surface runoff derived from the mountains varies from 20-30 mm at elevations above 1000 m, 10 mm at elevations between 400-1000 m, to less than 10 mm at elevations under 400 m. The most relevant washes comprising the fluvial network in the watershed are "El Salado," "Las Piedritas" (which flows into the sea) and "Grande" (which flows into the "Santa Ines" dam)<sup>2</sup>. The structure and hydraulic behavior classify the Todos

Santos and El Pescadero aquifers as "free" type, constituted by alluvial sediments deposited in the washes and the coastal plain. In both aquifers permeability is medium-low based on clay soils. Groundwater recharge comes directly from the rain and surface runoff filtration along the valley. Natural discharge occurs through groundwater drainage to the ocean and evapotranspiration on. Artificial discharge occurs through capture extraction <sup>16 17</sup>.

The main surface runoff in the Todos Santos watershed is La Reforma coming from the "Santa Ines" dam, which runs along the Todos Santos valley to ultimately reach the Pacific Ocean. There are several runoffs that originate in the mountains and separate the El Pescadero aquifer from San Jose del Cabo and Santiago. The most important washes for this aquifer are Arroyo Grande, Santa Rosa, El Palmar de En Media and El Refugio, which all run towards in the Pacific Ocean <sup>16</sup>.

There is no hydraulic infrastructure for capturing and storing water surface runoff in the region. Transmissivity values for the aquifers from southwest region of Baja California Sur vary from 2.6 to  $84 \times 10^{-3} \text{ m}^2/\text{s}$  (estimated values in 2007) <sup>2</sup>. The static water depth level has been relatively constant during the last three decades for Todos Santos and El Pescadero aquifers.

**Water quality tests.** The value for total dissolved solids is 1000mg/l. This value is above the maximum allowable concentrations (according to the Mexican laws) for drinking water due to its high content of sodium, calcium, and chloride. The values estimated for metals concentration (i.e. bromide, iodine, strontium, boron, lithium, and arsenic) and silica are below the maximum allowable concentrations according to Mexican and international laws<sup>1617</sup>

The Todos Santos aquifer is the smallest of those located in the southeast region of Baja California Sur, however it gets a considerable recharge during spring discharge. Considering the small water catchment area of the basin and the precipitation scarcity,

it is assumed that the aquifer feeds additionally from the recharge areas located in vicinity basins <sup>16</sup>.

**Groundwater availability.** According to CONAGUA, the groundwater availability was estimated at 725,371 m<sup>3</sup> annually in El Pescadero aquifer, and 4,797,040 m<sup>3</sup> annually in Todos Santos aquifer during 2015. <sup>16</sup> <sup>17</sup> Recently, the groundwater availability was estimated at 4.797040 m<sup>3</sup> annually in Todos Santos aquifer during 2015 <sup>18</sup>. (See Table 24 and Annex VI)

Table 24. Groundwater availability in the Todos Santos and El Pescadero aquifers

<b>Groundwater (annual millions of cubic meters)</b>			
<b>Aquifer</b>	<b>Todos Santos</b>		<b>El Pescadero</b>
	2020	2015	2020
Mean annual natural groundwater recharge	18.4	18.4	8.3
Natural discharge comprometida	14.7	4.7	5.1
Concessioned groundwater volume	4,797,040m <sup>3</sup>	3.118040	138,006 m <sup>3</sup>
Extraction volume for technical studies	4.797040	4.4	3,061,994
Groundwater availability	-1.097040	0.581960	0.138006
Deficit	1,097,040	0.000000	

[https://sigagis.conagua.gob.mx/gas1/Edos\\_Acuiferos\\_18/BajaCaliforniaSur/DR\\_0313.pdf](https://sigagis.conagua.gob.mx/gas1/Edos_Acuiferos_18/BajaCaliforniaSur/DR_0313.pdf)  
 Actualización de la Disponibilidad de Agua en el Acuífero El Pescadero, estado de Baja California Sur 2020. Comisión Nacional del Agua (CONAGUA). Subdirección General Técnica. Gerencia de Aguas subterráneas. Subgerencia de Evaluación y Ordenamiento de acuíferos; Disponibilidad media anual de agua subterránea. Diario Oficial de la Federación. 2015. Segunda Sección. Poder Ejecutivo. Secretaría de Medio Ambiente y Recursos naturales.

## 2.4 THE AQUIFER IN TODOS SANTOS BY WILLIAM E. SANFORD, PROFESSOR DEPARTMENT OF GEOSCIENCES, COLORADO STATE UNIVERSITY<sup>27</sup>

In spite of the over-abstraction of groundwater in the Todos Santos region, the saline intrusion in this coastal sedimentary aquifer is still low, reaching values between 0.2 and 2.7%. The saline intrusion into the aquifer leads some geochemical processes, where some elements are mobilized from sediment to solution and other elements are removed from solution. The cation exchange process plays a key role in the dynamics of the alkali and alkali-earth elements, where the alkali-earth elements  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{Ba}^{2+}$  and  $\text{Sr}^{2+}$  are interchanged by  $\text{Na}^{+}$ ,  $\text{K}^{+}$  and  $\text{Rb}^{+}$  in the aquifer matrix. This fact leads to the mobilization of alkali earth elements and the removal of  $\text{Na}^{+}$ ,  $\text{K}^{+}$  and  $\text{Rb}^{+}$  from solution about the theoretical mixing line between freshwater and seawater. Conversely,  $\text{Li}^{+}$  shows an opposite behavior than that showed by the alkali elements, increasing its concentration over the seawater mixing line, probably by cationic exchange. Major anions such as  $\text{HCO}_3^-$  and  $\text{SO}_4^{2-}$  also increase them.

Major anions such as  $\text{HCO}_3^-$  and  $\text{SO}_4^{2-}$  also increase their concentration during seawater intrusion due to the carbonate mineral weathering, whereas the increase of groundwater  $\text{NO}_3^-$  in areas close to the Todos Santos town can be due to anthropogenic sources, specifically the infiltration of sewage. On the other hand, elements such as B and I also increase in concentrations toward the coastline, probably due to aquifer-matrix dissolution. The conservative anion  $\text{Br}^-$  shows concentrations that lie entirely around the theoretical mixing line, which indicates no source of  $\text{Br}^-$  in the aquifer matrix. This same behavior was shown by  $\text{DSi}$  and  $\text{F}^-$ . Both behave conservatively because the weathering of carbonate rocks dominates over the weathering of source rocks of both elements (silicates and fluorite) in the aquifer matrix, minimizing the Si and  $\text{F}^-$  dissolution. The trace elements Fe, Co, V, Se and Re are clearly mobilized during the saline water intrusion process. Fe, V and Co can be mobilized either by an increase in ionic strength and/or ion complexation, whereas Se and Re are mobilized because both elements are abundant in carbonate minerals and have a high solubility in well-oxygenated water. Other trace elements such as Mo, Ni, Cr, Ta and W

are not affected by seawater intrusion. These elements can behave conservatively because they are not removed from solution; however, their concentrations are not increased during the groundwater flow because they are not affected by the ionic strength increase due to saline intrusion. Several elements such as U, As, Ge, Sb, Cu and Mn displayed a variable behavior, showing mobilization and immobilization in different groundwater samples. Therefore, our results are not conclusive about the dynamics of these elements during the intrusion of seawater in this coastal sedimentary aquifer. Perhaps measurements of both chemical and biological parameters together (including the presence of metal-oxidizing bacteria) can help to better understand the biogeochemical process occurring during seawater intrusion in this arid aquifer. Similarly, sediment-column experiments and geochemical modeling with PHREEQC should also be considered. Even though the salinization of the Todos Santos aquifer has led to the increase of major ions and trace element in groundwater, they have increased by a few mg/L (major ions) or a few  $\mu\text{g L}^{-1}$  (trace elements), which indicates that Todos Santos groundwater does not pose a threat to consumers' health. However, the U and  $\text{NO}_3^-$  concentrations should be considered carefully because several wells showed concentrations very close to the maximum values recommended by the World Health Organization for safe drinking water. Similarly, the increasing groundwater salinization in the Todos Santos aquifer should be considered as a possible threat to human health because it can promote and enhance the mobilization of potential toxic trace elements to groundwater.

### **Land**

According to the Sub-regional Program for Urban Development in Todos Santos - El Pescadero - Las Playitas, the rapid increase in tourism and the ensuing demand for urban real estate in recent years have been intense drivers of land-use change in Todos Santos, coupled with the historic activities of agriculture and cattle ranching that have continued through the generations in this region<sup>2</sup>. The distribution of the land use in Todos Santos and El Pescadero (combined) are shown in Table 25.

Table 25. Structure of land use in Todos Santos and El Pescadero

Land use	Proportion (%)
Sarcocaulle scrub	3.59
Sarcocaullescent scrub	65.38
Mezquita.	0.15
Harvested grassland	4.69
Water bodies	2.48
Washes	9.41
Gallery vegetation	0.14
Irrigation zone	3.48
Federal zone	0.25
Urban area	9.69
Roadways	0.74
Total	100

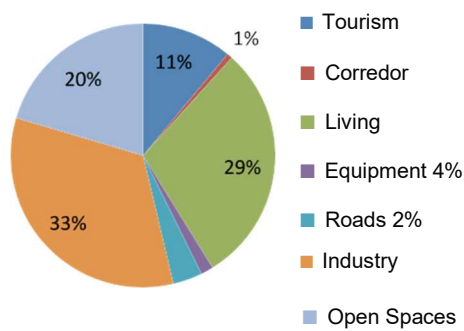
Source: Programa Subregional de Desarrollo Urbano de Todos Santos - El Pescadero - Las Playitas, La Paz B.C.S. 2019 Centro de Estudio de Urbanismo y Arquitectura SA de CV (CEURA).

**Land Tenure.** The region falls generally under three types of land ownership:

Ejidos, private property and "condueazgo". An ejido is an area of communal land used for agriculture on which community members individually possess and farm a specific parcel. The ejido land corresponds to three main area extensions including Ejido Frac. 2 La Matanza (north), Ejido Frac. Todos Santos (center), and Ejido Frac. Pescadero (south). Private property is comprised of three main properties including El Cardon, Agua Blanca Secc.1 and Las Playitas (north), La Bandera y La Tinaja (center), as well as four properties divided into three areas in the south. The Todos Santos borough owns 18 land areas corresponding to 67.8 hectares donated by the Todos Santos Ejido<sup>2</sup>

Land use in urban areas. According to the Sub-regional Program for Urban Development in Todos Santos - El Pescadero - Las Playitas, Todos Santos primary land-use activities include industry and living. The proportion of urban land use activities in Todos Santos and El Pescadero are shown in Figure 10. The affected native vegetation related to land use in urban areas of the focus regions correspond to Sarcocaulous shrubland and Crassicaulescent shrubland (Santiago-Leon *et al.* 2014).

### A. Urban land use in Todos Santos



### B. Urban land use in El Pescadero

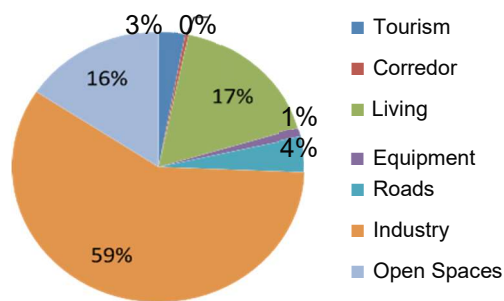


Fig. 10. Urban land use in A. Todos Santos and B. El Pescadero (Source: Programa Subregional de Desarrollo Urbano de Todos Santos - El Pescadero - Las Playitas, La Paz B.C.S. 2012. Centro de Estudio de Urbanismo y Arquitectura SA de CV (CEURA).

## 2.5 Biotic characteristics

### Vegetation

The forest resources in Todos Santos are mainly biotic communities in the arid and semi-arid zone including approximately 2,000 species of trees, shrubbery, and herbs (Fraga, 1986)<sup>2</sup>. The predominant vegetation is Foggy Sarcocaulous Scrubland, also known as coastal desert vegetation (i.e., Agave, Opuntia, Stenocereus, Pachycereus and Cephalocereus).

### Fauna

According to Nelson (1921) and Wiggins (1980), the localities lie within the faunistic zone of the Cabo District, in the Arid Tropical Region (E4). This is a large region, which extends from north of the city of La Paz to the southern tip of the peninsula. The Cabo District fauna has a biogeographical affinity with the Sonoran Desert (Nearctic Ecozone), although it presents an important number of species from the Neotropical Ecozone. Due to human development in both localities and the presence of natural areas, it is considered a semi-urbanized location. A detailed list of fauna species presents in Todos Santos, El Pescadero and immediate surroundings could not be found, but extensive listings can be found associated with information on the Sierra de La Laguna Natural Protected Area.<sup>20</sup> From these listings a remarkable characteristic is the high presence of endemism, given the geological history of the peninsula. In the Sierra de La Laguna and surroundings, several species have been threatened due to illegal activities and habitat destruction, including Cougar (*Puma concolor*), rattlesnakes (*Crotalus spp.*), red tail hawk (*Buteo jamaicensis*) and other prey birds, Coyote (*Canis latrans*), Grey Fox (*Urocyon cinereoargenteus*), Bura deer (*Odocoileus hemionus*) and Lynx (*Lynx rufus*)<sup>2</sup>.



Todos Santos has more than 35 km of beaches where sea turtle nest, particularly the Olive Ridley Sea turtle (*Lepidochelys olivacea*), Leatherback Sea turtle (*Dermochelys coriacea*), Galapagos green turtle (*Chelonia agassizii*), Loggerhead Sea turtle (*Caretta caretta*) and Hawksbill Sea turtle (*Eretmochelys imbricata*). The nesting season is from July to November <sup>21</sup>. There is a local organization called Grupo Tortuguero de Todos Santos AC, which promotes sea turtle research and conservation in Punta Lobos to Boca del Carrizal in Todos Santos.

26. Table camp of the turtles

Quantity of camps	Name of the camp turtles in Todos Santos y El Pescadero
1	Grupo Tortuguero de Todos Santos AC
1	Tortugueros las playitas
1	Asupmatoma A.C
1	Grupo tortuguero pescadero A.C

### Areas of environmental value

According to the Sub-regional Program for Urban Development in Todos Santos - El Pescadero - Las Playitas, there are four main areas of environmental value within the Todos Santos borough: 1) Todos Santos Oasis (part of the local identity, unique flora and fauna, and clear springs); 2) La Poza (natural symbol of the entity, flora and fauna watching); 3) La Lobera (located at Punta Lobos beach, home to hundreds of sea lions); and 4) Sierra de La Laguna (unique tropical dry forest )<sup>2</sup>

CONABIO (National Council for Biodiversity) has defined priority regions as aquatic and terrestrial ecosystems where a high biodiversity is concentrated. The Sierra de La Laguna (protected natural area since 1994, CONABIO) is considered a priority region. It is known as a vegetation "island" within the arid surroundings of the Baja California Peninsula which is a result of geological processes. The region shows high endemism and was recently considered an evolution center. It comprises most of the described natural species and the highest biological diversity within Baja California Sur. Detailed information on "Sierra de La Laguna" can be found in the Management Plan of the corresponding natural protected area <sup>20</sup>.

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## **ANNEX**

### **Annex I**

Socio-demographic overview of Baja California Sur. XIII Censo de Población y Vivienda 2010. Instituto Nacional de Estadística y geografía (INEGI) . Original Document

### **Annex II**

Data base on socio-demographic indicators from La Paz municipality. Information retrieved from Directorio Estadístico Nacional de Unidades Económicas (DENUE). Instituto Nacional de Estadística y geografía (INEGI) <http://www.inegi.org.mx>

### **Annex III**

Topographic map of Todos Santos and El Pescadero Escale 1:50,000

### **Annex IV**

Data base on Economic Units in Todos Santos. Information retrieved from Directorio estadístico Nacional de Unidades Económicas (DENUE). Instituto Nacional de Estadística y geografía (INEGI) <http://www.inegi.org.mx>

### **Annex V**

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### **Annex VI**

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