Economic analysis of the Channel Independence, D.R. 014, Colorado River

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Abstract

The Independence Channel is operated by the first unit of irrigation and supply water to the modules 4, 5, 6, 14, 15 and 16; covering an area of 58,739 hectares, of which 35,386 hectares are water gravity, 23,354 hectares per federal well, located in the northern part of Irrigation District 014, Río Colorado.

The objective of this work is calculate the economic value of Independence Channel, operating costs and the scope in productive activities where water is used for the period from 2006 to 2009.

The methodology will characterize the users in this channel, estimating water consumption by sector; calculate the productive value of water use, according to their implementation and to analyze their operation and maintenance costs.

Key words: Water, Economy, Hydraulics.

Introduction

Irrigation District 014, Río Colorado is located in the municipality of Mexicali, State of Baja California, Mexico. This region is part of the Colorado River Basin, which is divided into two regions: higher and lower basin. Colorado River belongs to "Lower Basin" in which includes States California, Arizona, and Nevada for the U.S. section, and Baja California in Mexico. This geographical area is located in a portion of the basin characterized by the proximity to the coast in the east central portion and the coastal plain in an arid area, where average rainfall is 63.8 mm per year, as shown in Figure 1. Unites States Bureau Reclamation, (USBR, 2009)

The Irrigation District 014, Colorado River has 208,223 hectares. Water rights reach 15,894 for agricultural users. The available water volume is 2'747.59 million cubic meters each year: Source of this water is the Colorado River with 1,850 million cubic meters per year and aquifer with 700 million cubic meters per year. This irrigation district is divided into three irrigation units, for operational purposes. At the same time, this district is divided into 22 irrigation modules, which are managed and operated by users, Agricultural and Development Secretariat, 2009 (SEFOA, 2009).

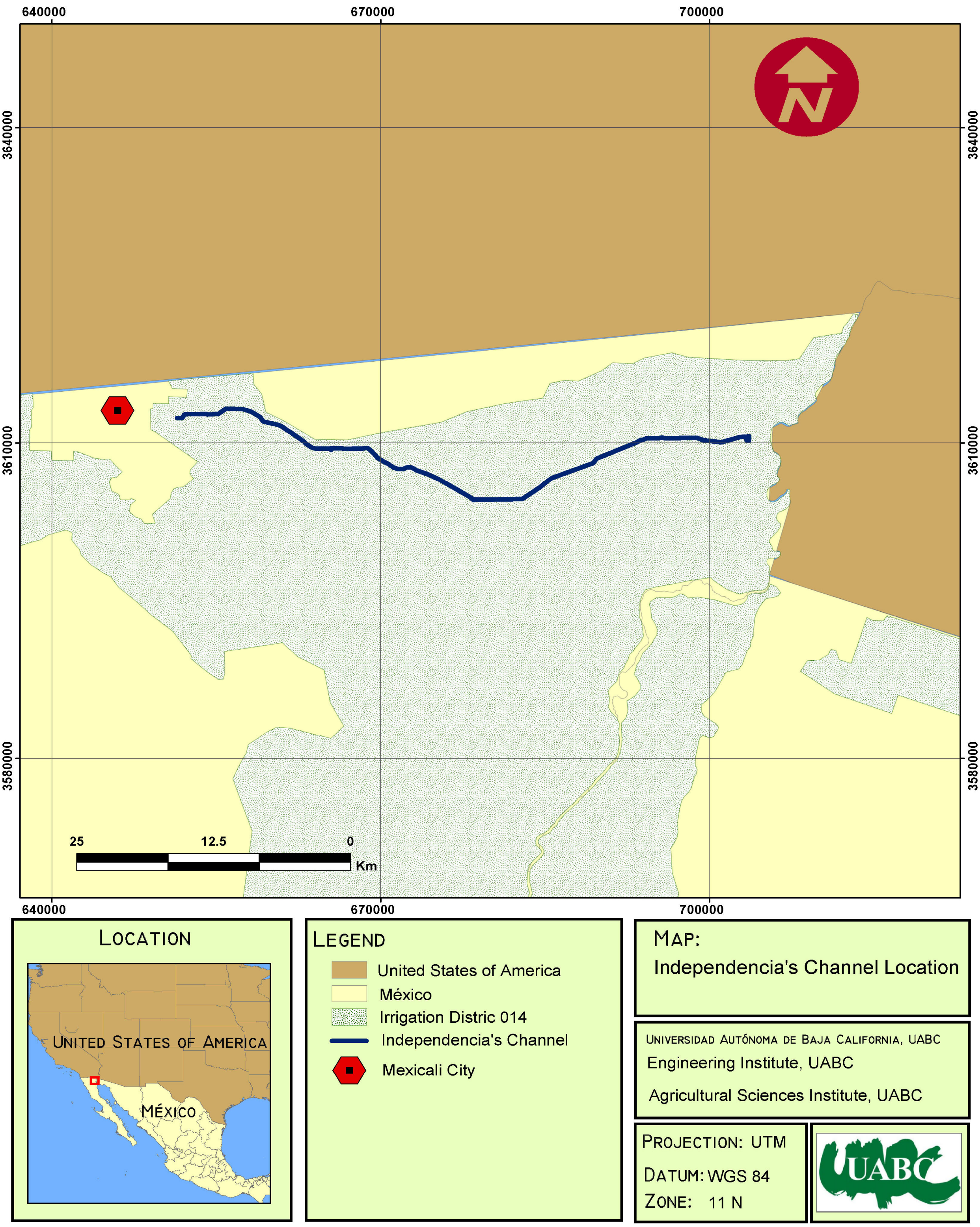

Figure 1. Location of irrigation district and Independencia's Channel.

The selected study area is located in the first unit of irrigation, which operate Independencia's channel and delivers water to the modules 4, 5, 6, 14, 15 and 16 for agriculture and finally to the city of Mexicali for urban use as shown in Figure 2, and It is located in the northern part of Irrigation District 014, Colorado River covering an area of 58,739 hectares.

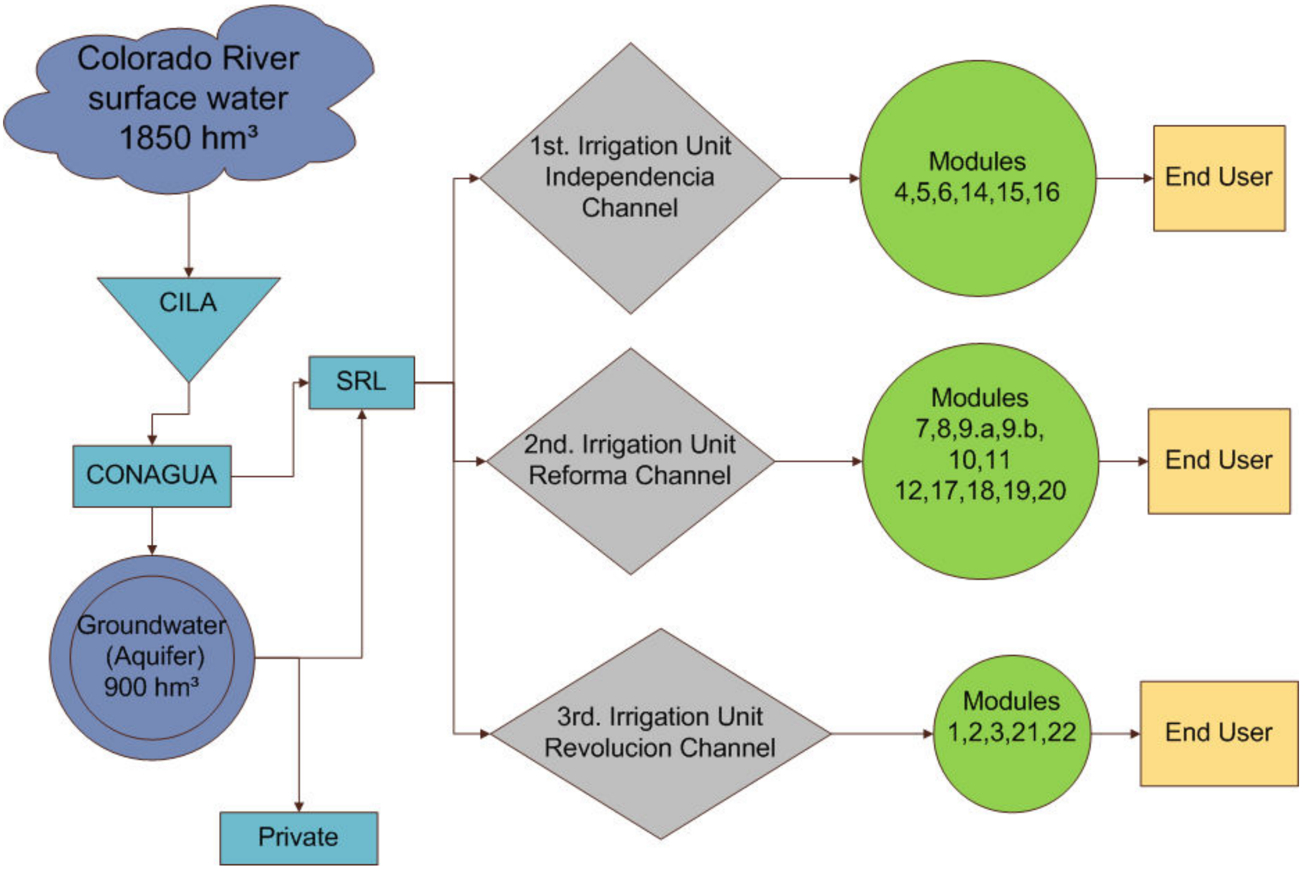

Figure 2. Scheme operation in Irrigation District # 14 Colorado River.

Methodology.

The methodology used in this study was in characterizing the users of Independencia's channel and their water consumption, for do this we required information from different sources as follows in (Figure 3):

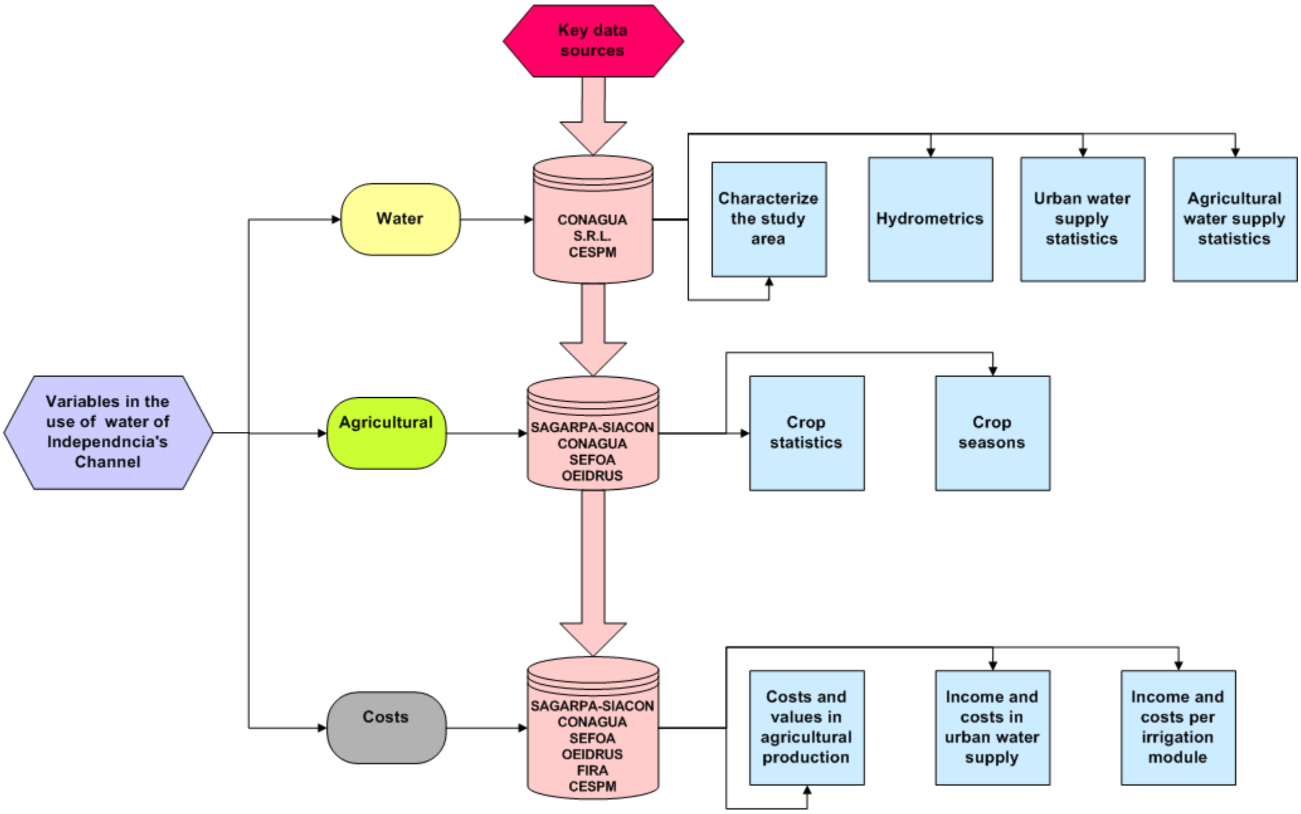

Figure 3. Information sources.

- Characterize the study area.
- Analyze the costs and values in agricultural production for each cycle and processing the information.
- Analyze the Crop statistics.
- Analyze the Crop seasons.
- Get the hydrometrics of operation of Independencia's Channel.
- Analyze and processing the income and costs in urban water supply.
- Analyze and processing the income and costs per irrigation module.
- Analyze and processing the urban water supply statistics.

Findings and discussion.

Land use in agriculture.

The study area has a net land use in agriculture of 58, 739 hectares, all with water rights. From this 35'386 hectares are irrigated by gravity, and the rest are irrigated by wells. Gravity water rights are distributed in the irrigation modules 4,5,6,14,15 and 16. This information is shown in Table 1.

Table 1. Study area.

	Irrigation by gravity (ha)	Irrigation by wells (ha)
Module 4	227	9,537
Module 5	113	9,259
Module 6	1,997	4,132
Module 14	8,896	0
Module 15	12,680	10
Module 16	11,473	416
Total=	**35,386**	**23,354**

Source: Prepared by authors based on the information provided by SEFOA.

Total land for agriculture irrigated per gravity were 35'251 hectares during period 2006-2007; 35'473 hectares 2007-2008; 35,322 hectares 2008-2009, where were planted the following crops: safflower, barley, chives, wheat, cotton, grain sorghum, forage sorghum, corn, alfalfa, asparagus, grape, bermuda grass.

The most representative crops for these agricultural cycles are: wheat in period autumn-winter, while cotton crop during spring-summer and the alfalfa in perennial.

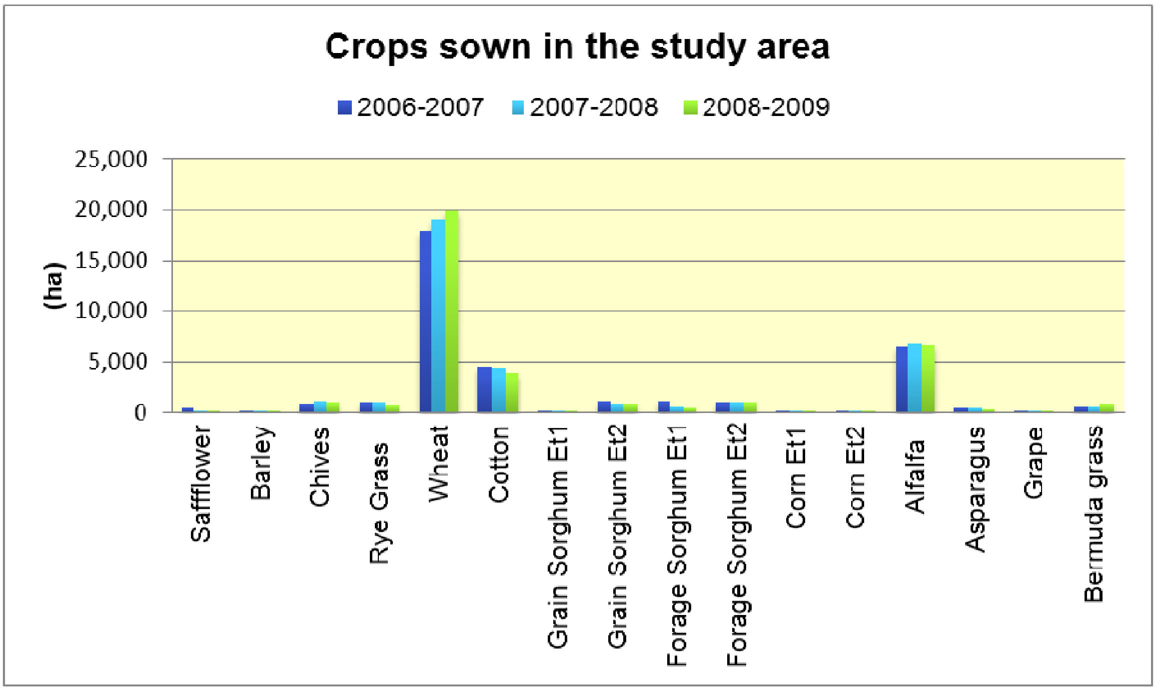

Figure 4. Crops most representatives.

Agricultural and urban water users.

Water use for agricultural and urban is supplied by Independencia's Channel, which belongs to the main network. In this structure, irrigation modules 4, 5, 6, 14, 15, 16, receive their water rights per gravity, and the first unit of irrigation is responsible for operating, managing, and supplies of water in delivery sites (Figure 5).

Water requirements have a behavior marked by the agricultural cycles and the demand needed by the city of Mexicali mainly in the summer period in this case the irrigation module 16 supplies the water utility for urban use and agricultural, but operating costs of Independencia's Channel are paid by this module.

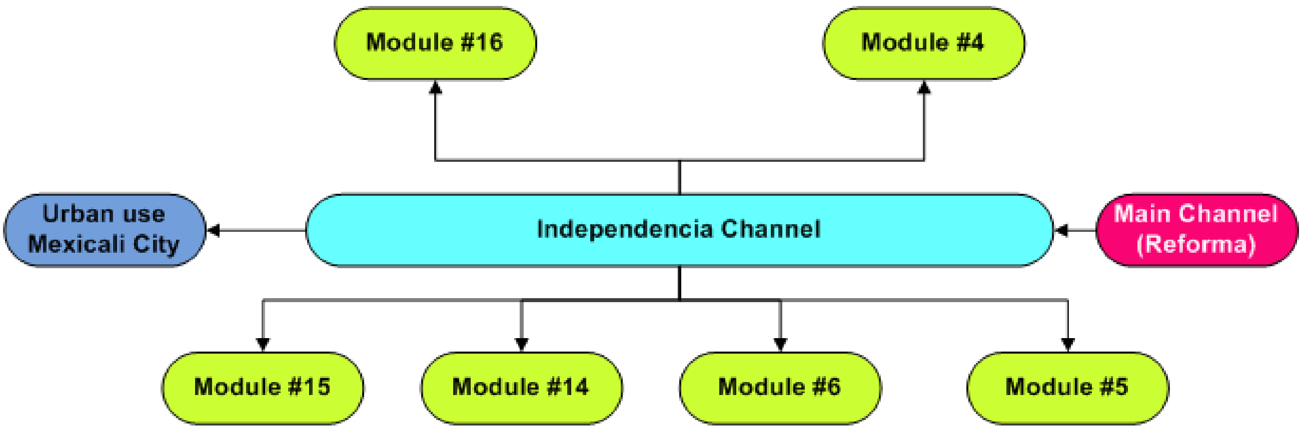

Figure 5. Water balance water Independencia's Channel.

Independencia's Channel and their flows by operation are variable during the year, but the period of maximum demand are very marked in the course of the year and are mainly three:

The total water received at the delivery sites for each cycle is shown in the Figure 6. This information tells us those irrigation modules 14, 15, 16 are the largest consumers of water, and then follow the city of Mexicali, and finally the modules 6, 5, 4. The water consumption in irrigation modules 14, 15, 16 are higher than irrigation modules 6, 5 and 4, because they have fewer wells and in their geographical location they are the users located in the last 20 kilometers in order to receive this resource that is leads through this channel

First period is to supply water to crops in the agricultural cycle autumn-winter, which is planted mostly with wheat and some vegetables. According to statistical information, provided by Agricultural and Development Secretariat, this period begin in October and the end of January.

Second period is to supply water to crops at the agricultural cycle spring-summer, which is planted mostly with cotton, sorghum and corn. This period starts in March and finish in July.

Third period is for supply water to urban use during summer time. This period starts in June and finish in September, as shown in Figure 7.

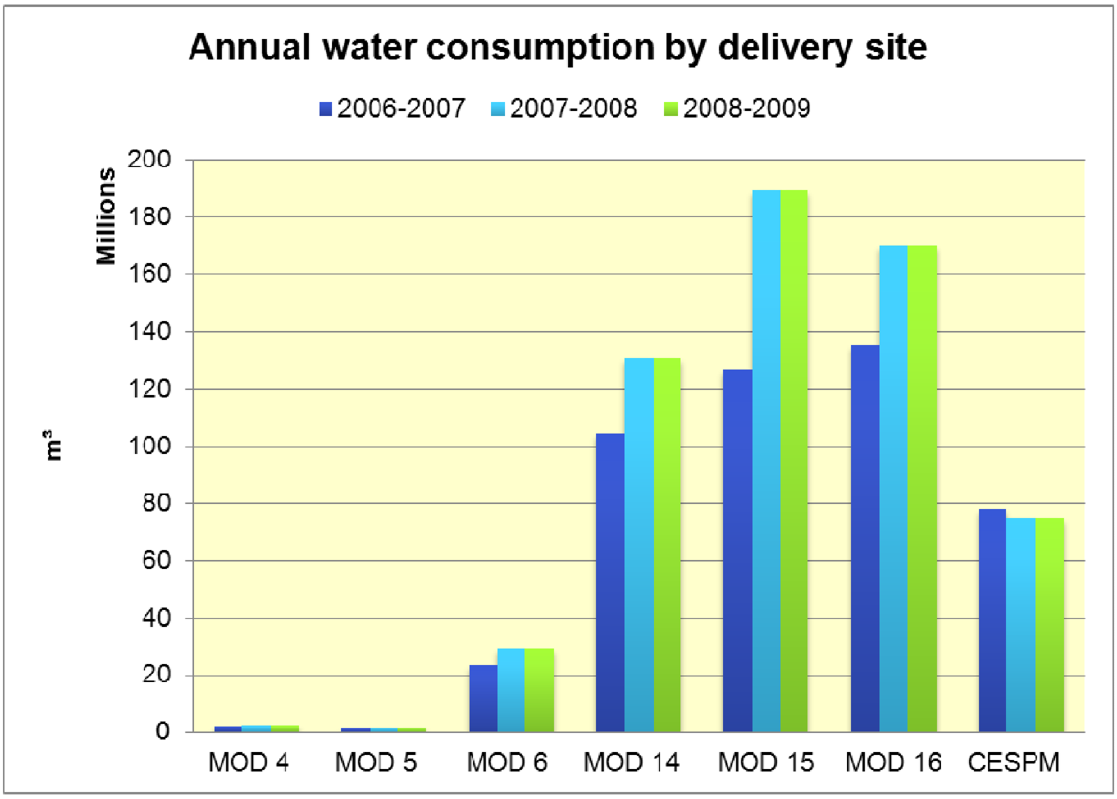

Figure 6. Annual water consumption.

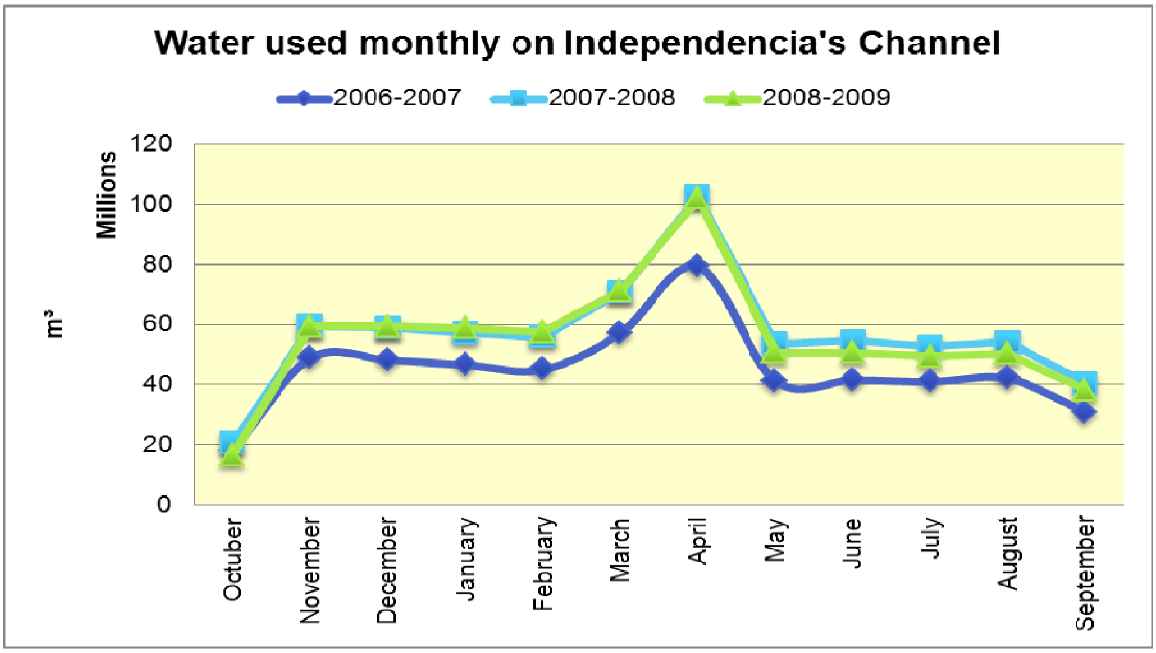

Figure 7. Water used monthly.

The amount of water for each crop is determined according to the following aspects: soil type, crop type and season of the year. Figure 8 shows water consumption by crop type and also show the highest water consumption were 84.33 for the agricultural cycle 2006-2007, while during 2007-2008, water consumption were 86.24, and finally, during period 2008-2009 were 87.15% of total water received.

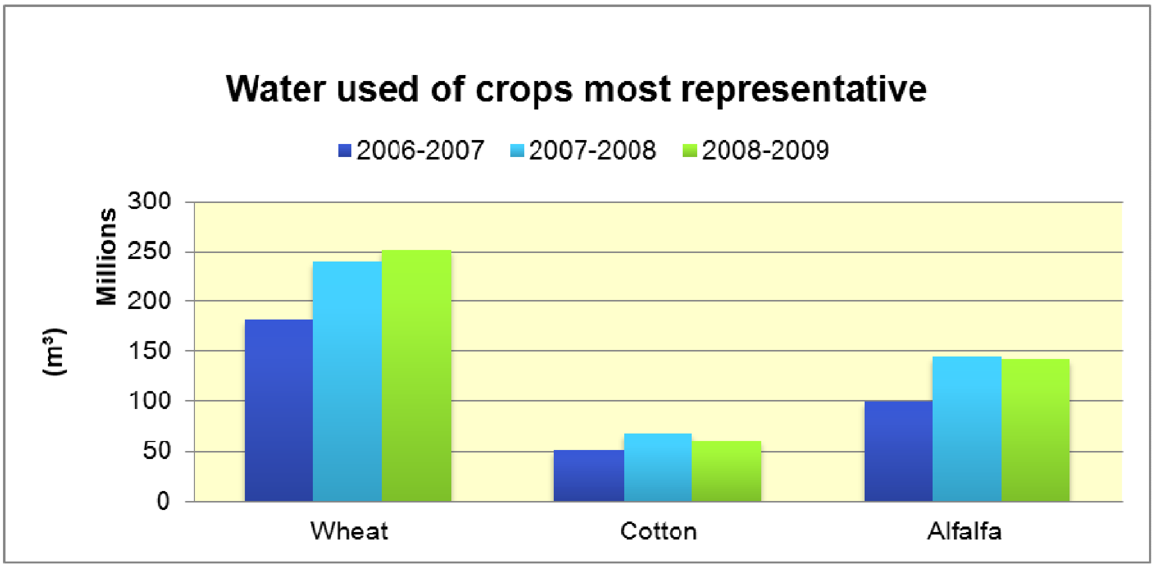

Figure 8. Water consumption by crops.

Economic factors

Agricultural producers receive irrigation services and the volumes of water to carry out their productive activities for get this, they must make a payment, provide their crop pattern and present their volumetric water requirements according to the crop, the irrigation module has the function to establish the schedule of water for agricultural producers and receive the money of them to do the activities of operation, conservation and management of hydraulics structures.

Operational economical costs in irrigation modules are distributed as follows: 24.42% operation, 59.64% in conservation and 15.82% in administration, these costs allows to irrigation modules set the tariff to water use for each agriculture cycle and include the required infrastructure to serve and collect water (Figure 9).

Figure 9. Required Infrastructure to serve and collect water

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Water tariffs by the water use established by irrigation modules are expressed in liters per second in twenty four hours. Water rate utilized in this study is one liter per second in twenty four hours. This represent to a volume of eighty six point cubic meters per day. Water cost for each agriculture cycle and their incomes are shown on Table 2. Total costs for operational in irrigation modules are shown on Table 3.

Table 2. Cost of water for each agriculture cycle and their incomes.

	2006-2007			2007-2008			2008-2009		
	Water use (m^3/year)	Bill for water use (m^3)	Amount ($)	Water use (m^3/year)	Bill for water use (m^3)	Amount ($)	Water use (m^3/year)	Bill for water use (m^3)	Amount ($)
MOD 4	2,091,410	24,206	181,546	2,622,628	30,354	258,013	944,179	10,928	103,816
MOD 5	1,325,880	15,346	115,094	1,662,654	19,244	163,571	8,832,240	102,225	971,138
MOD 6	23,232,420	268,894	2,016,703	29,133,455	337,193	2,866,138	21,044,966	243,576	2,313,972
MOD 14	104,185,560	1,205,851	9,043,885	130,648,692	1,512,138	12,853,170	108,862,531	1,259,983	11,969,839
MOD 15	126,667,042	1,466,054	10,995,403	189,258,495	2,190,492	18,619,181	117,889,862	1,364,466	12,962,427
MOD 16	213,012,046	2,465,417	18,490,629	244,614,229	2,831,183	24,065,057	170,111,578	1,968,884	18,704,398
Total=	**470,514,358**	**5,445,768**	**40,843,260**	**597,940,153**	**6,920,604**	**58,825,131**	**427,685,357**	**4,950,062**	**47,025,589**

Source: Prepared by authors based on the information provided by General coordination of Irrigation Modules.

Table 3. Total costs of operate in irrigation modules

	2006-2007	2006-2007	2006-2007
Operation ($)	9,891,230	14,225,685	11,485,826
Conservation ($)	24,439,313	35,266,784	28,044,134
Management ($)	6,417,874	9,197,870	7,441,394
Total ($) =	**40,748,416**	**58,690,339**	**46,971,353**

Source: Prepared by authors based on the information provided by General coordination of Irrigation Modules.

The water use for each agricultural cycle generates a net income from agricultural production, which depends on their production costs and values according to the type of crop and the market that consumes these products whether national or international, such as for cotton and wheat crops.

The values and costs for the most representative crops are shown on Table 4.

Table 4. Production-Costs values.

	Wheat		Cotton		Alfalfa	
	Production Value ($/ha)	Production Cost ($/ha)	Production Value ($/ha)	Production Cost ($/ha)	Production Value ($/ha)	Production Cost ($/ha)
2006	13,017.40	12,052.32	34,803.20	20,652	19,831	8,619
2007	25,189.52	14,250.20	35,205.97	21,566	20,795	9,038
2008	14,280.70	13,221.95	34,803.20	20,652	19,831	8,619

Source: Prepared by authors based on the information provided by SAGARPA.

Finally, gross profit, net income from agricultural production obtained by the use of water is shown in Table 5.

Table 5. Surface production and income per crop.

	Wheat			Cotton			Alfalfa		
	Surface production (ha)	Gross profit ($)	Net income ($)	Surface production (ha)	Gross profit ($)	Net income ($)	Surface production (ha)	Gross profit ($)	Net income ($)
2006-2007	17,893	232,926,444	17,268,629	4,480	155,919,381	63,400,015	6,405	127,011,799	71,812,780
2007-2008	18,976	477,986,594	207,580,308	4,345	152,963,327	59,263,542	6,646	138,199,476	78,138,319
2008-2009	19,933	284,651,930	21,103,674	4,480	155,919,381	63,400,015	6,405	127,011,799	71,812,780

Source: Prepared by authors based on the information provided by SAGARPA.

The Independencia's Channel has an economical value for Mexicali city, because this channel delivers at the same time, water for different users, mainly for supplying domestic sector. In order to estimate the economical value for water in urban users, it is necessary to define the relationship between income-expenses, made by the city water department. This information is shown in Table 6.

Table 6. Income and costs for Mexicali Water Deparment.

	Own revenue ($)	Personal Services ($)	Materials and Supplies ($)	General Services ($)	Real Estate ($)	Suppliers and creditors ($)	Total ($)	Net income ($)
2006-2007	468,233,702	227,438,884	38,038,773	109,151,155	9,045,956	15,380,270	399,055,038	69,178,664
2007-2008	498,443,877	254,686,579	38,563,445	114,246,610	6,880,772	45,041,176	459,418,581	39,025,296
2008-2009	549,647,502	277,446,595	40,730,624	115,813,433	8,360,828	42,334,175	484,685,655	64,961,847

Source: Prepared by authors based on the information provided by CESPM.

Water productivity

Independencia's channel has an important value in agricultural and urban sector, because delivers water for each activity, with the impact in the municipality, the net income from agricultural and urban uses, minus operations cost are shown on Table 7.

Table 7. Net income agricultural and urban water use.

	Agriculture use Import ($)	Urban use Import ($)	Operation Costs Import ($)	Value of Channel Import ($)
2006-2007	152,481,424	69,178,664	40,843,260	180,816,827
2007-2008	344,982,169	39,025,296	58,825,131	325,182,334
2008-2009	156,316,468	64,961,847	47,025,589	174,252,726

Source: Prepared by authors based on the information provided.

The water economical value generated of this channel produces income for the rural economy to benefit agricultural producer in Mexicali Valley and is the water supply for Mexicali city is shown on Figure 10.

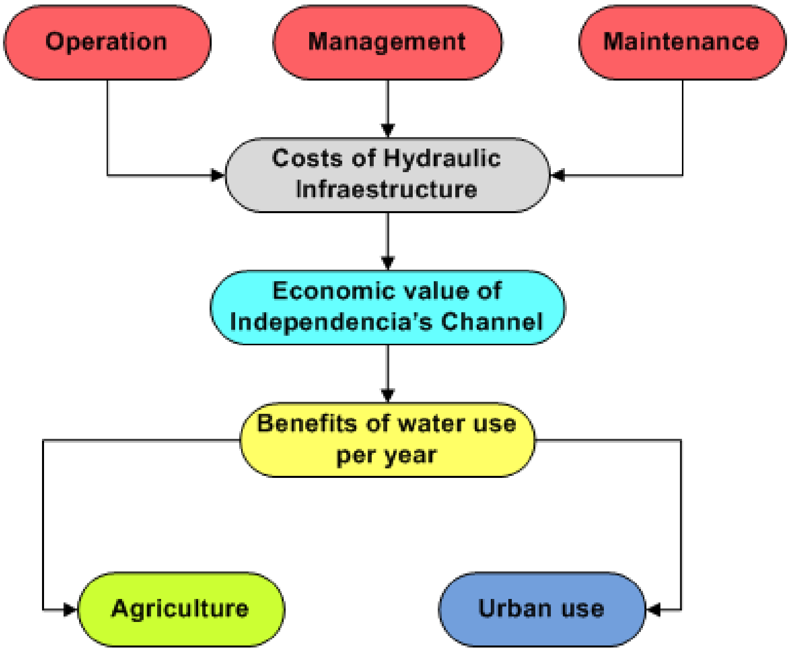

Figure 10. Flow for economic analyses.

It is very important to understand that water productivity, according its use, in this case for crops wheat, alfalfa and cotton, in each agricultural season, have a value of productivity quantifiable in monetary amounts related to the water consumption and gives us, an economical value indicator, in order to compare with other activities where this resource utilized, as shown on Tables 8 and 9.

Table 8. Water productivity agriculture use.

	Wheat			Cotton			Alfalfa		
	Water consumption (m³)	Net income ($)	Productive water value ($/m³)	Water consumption (m³)	Net income ($)	Productive water value ($/m³)	Water consumption (m³)	Net income ($)	Productive water value ($/m³)
2006-2007	181,498,899	17,268,629	0.10	50,781,073	63,400,015	1.25	99,171,061	71,812,780	0.72
2007-2008	238,752,211	207,580,308	0.87	68,794,006	59,263,542	0.86	143,746,104	78,138,319	0.54
2008-2009	250,793,464	21,103,674	0.08	60,500,443	63,400,015	1.05	141,593,191	71,812,780	0.51

Source: Prepared by authors based on the information provided.

Table 9. Water productivity agriculture use

	Urban use		
	Water consumption (m³)	Net income ($)	Productive water value ($/m³)
2006-2007	77,577,947	69,178,664	0.89
2007-2008	74,632,598	39,025,296	0.52
2008-2009	64,739,520	64,961,847	1.00

Source: Prepared by authors based on the information provided.

Conclusions

One of the main factors for the realization of this article was the consistency of official information of agricultural production for cyclic and perennial crops in the study area, developed by public agencies of the government of Mexico.

Crops such as wheat, cotton and alfalfa require large volumes of water in each agriculture cycle. The wheat planting starts in November, cotton in March and alfalfa in April, although each one have their own irrigation schedule from the point of view of water delivery of this channel, all of them are required to operate with the maximum flows due to the incorporation of crops for spring-summer and perennial.

Crops with higher productivity in water use are cotton with average price 1.05 $/m^3$, alfalfa with average price 0.59 $/m^3$ and finally with the wheat 0.35 $/ m^3$, but comparing it with the chives that can have a 5 $/m^3$ productivity and requires less is recommended to switch to crops more productive in their use to make best advantage of this resource, due the pressure that exists between the use of urban-agricultural water.

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