RiAT
Revista Interamericana de Ambiente y Turismo
Interamerican Journal of Environment and Tourism
Print version ISSN - 0717 - 6651, Online version ISSN - 0718 - 235X
http://dx.doi.org/10.4067/S0718-235X2021000200113
http://riat.utalca.cl
www.fen.utalca.cl

Monocultures in the Vinces river basin (Ecuador) and their relationship between the supply of water for irrigation

Monocultivos en la cuenca del río Vinces (Ecuador) y su relación con la oferta de agua para riego

Jose Luis Muñoz Marcillo [1]

[1] State Technical University of Quevedo - jsmunoz@uteq.edu.ec

Received: 2021-08-15 Accepted for publication: 2021-09-10 Published: 2021-12-31

ABSTRACT

The need to satisfy the food requirements of the Ecuadorian population added to the public policy of increasing the income of foreign exchange to maintain the economic model of the country through the export of agricultural products has increased the establishment of several monocultures in large areas of land, significantly increasing the use of water for irrigation of these crops. Thepresent worksor aimsto analyze the change in time and space of the use of agricultural land, the expansion of its border and the pressure on the water resource exerted by irrigation in the Vinces River basin in accordance with the water concessions granted by the governmental authority with competence in the basin. This research involved the collection of digital geoinformation, its subsequent processing in Geographic Information Systems, tabulation of official statistical information and verification in the field. The conceptual integration of Integrated Water Resources Management allows us to advance in the understanding of the complexity and difficulties to achieve a balance between the natural and social processes that affect us. The main agricultural coverageof the Vinces river basinrepresented by banana, cocoa and oil palm monocultures showed a remarkable and progressive temporo-spatial change (expansion of the cultivated area) and increase of the water pressure of the basin for irrigation in the long dry period. The historical concessions of water for irrigation extended in the Vinces river basinby theenvironmental authority do not reflect the true volume used by the agricultural sector in the summer stage, which is demonstrated by relating the volumes of water concessioned, the hectareas of crops planted and the real water requirements for the aforementioned crops. to achieve maximum productivity.

Keywords: *Agricultural products, Use of water, GIS, Irrigation, Vinces river basin*

RESUMEN

La necesidad de satisfacer los requerimientos alimentarios de la población ecuatoriana sumada a la política pública de incrementar el ingreso de divisas para mantener el modelo económico del país a través de la exportación de productos agrícolas ha incrementado el establecimiento de varios monocultivos en grandes extensiones de terreno, aumentando significativamente el uso de agua para el riego de estos cultivos. El presente trabajo tiene como objetivo analizar el cambio en el tiempo y espacio del uso de suelo agrícola, la ampliación de su borde y la presión sobre el recurso hídrico que ejerce el riego en la cuenca del río Vinces de acuerdo con las concesiones de agua otorgadas por la autoridad gubernamental con competencia. en la cuenca Esta investigación implicó la recolección de geoinformación digital, su posterior procesamiento en Sistemas de Información Geográfica, tabulación de información estadística oficial y verificación en campo. La integración conceptual de la Gestión Integrada de los Recursos Hídricos nos permite avanzar en la comprensión de la complejidad y dificultades para lograr un equilibrio entre los procesos naturales y sociales que nos afectan. La principal cobertura agrícola de la cuenca del río Vinces representada por los monocultivos de banano, cacao y palma aceitera mostró un notable y progresivo cambio temporo-espacial (expansión del área cultivada) y aumento de la presión hídrica de la cuenca para riego en el largo período seco. Las históricas concesiones de agua para riego otorgadas en la cuenca del río Vinces por parte de la autoridad ambiental no reflejan el verdadero volumen utilizado por el sector agropecuario en la etapa estival, lo cual se demuestra al relacionar los volúmenes de agua concesionados, las hectáreas de cultivos sembradas y el real requerimientos de agua para los cultivos antes mencionados. para lograr la máxima productividad.

Palabras clave: Productos agrícolas, Uso del agua, SIG, Irrigación, Cuenca del río Vinces

INTRODUCTION

Rapid population growth and growing international demand for tropical products have led to the conversion of large areas of land for intensive agricultural production of various monocultures inEcuador. For Gudynas (2013) the expansion of monocultures in regions of the world implies an exploitation of natural resources in large volumes or high intensity, essentially oriented to the export of raw materials without processing or with limited processing. The expansion of monoculture for export in Latin American countries is an example of the "extractive activities" or "extractivism" that neoliberalism promoted from the nineties (Gudynas, 2013; Seoane, 2013). Inthis way, transnational corporations received multiple incentives from the State on the assumption that they constitute the fastest route to economic progress (Svampa, 2009). In practice, the commodification and private appropriation of natural assets in territories with deficit environmental legislation was given way (Silvetti, Soto, Cáceres and Cabrol, 2013).

In Ecuador, agricultural production in the 1920s and 1930s was dominated by cocoa and from the 1950s to the present, bananas have been the most important agricultural export product. Thearea devoted to these export crops has been increasing, so that between 1980 and 2000 the harvest area has increased, reaching 165,000 hectares in bananas and 433,000 hectares for cocoa (MAGAP, 2012). In Argentina in the periods between 1990/1991 and 2011/2012, of the 14.4 million hectares that were incorporated into production nationwide, 95% were dedicated to soybean cultivation (Zeolla, 2013). Soybean production went from an implanted area of 5.9 million hectares to an implanted area of 19.7 million hectares. In Costa Rica, the cultivated area of pineapple went from 12,500 hectares in 2000 to 42,000 hectares in 2012 (SEPSA, 2001; 2013). Although the calculations of several environmental organizations show that the hectares dedicated to pineapple are much higher than the official figures and the expansion continues without adequate planning by the State (Chacón, 2012).

The Guayas River basin is the largest hydrographic basin of the Pacific coast of South America, it is divided into seven sub-basins, of which the sub-basin of the Vinces river stands out for its wide altitudinal gradient and high agricultural productivity, which make it up in the north part of the provinces of Santo Domingo de los Tsáchilas and Cotopaxi of the Sierra region and part of the province of Los Ríos in the coastal region. The basin of the Guayas River is formed by the confluence of its main rivers, the Daule and Babahoyo and their respective tributaries, draining a total area of 34,000 km2 distributed among various ecosystems that include mangrove areas, dry and humid forests, Andean paramo and territory used for agricultural activities.

The influence of the basin on Ecuadorian territory is veryimportant: in2010 the Guayas River basin covered 380,840ectarea h of irrigated land, being 57% of the irrigated agricultural area of Ecuador (CISPDR, 2014; CISPDR, 2015). The basin is under a humid tropical system comprising a rainy season from December to May and a wet one for the remaining months. There are variations in precipitation from the north (2,900 to 3,100 mm) to the south (300 to 700 mm) (CISPDR, 2015), the Guayas basin within the national agricultural production includes the most important crops of the region such as rice (96%), bananas (68%), sugar cane (97%), corn (55%), café (33%) and palm oil (19%) (MAGAP, 2015). Agricultural land covers 49% of the Guayas River basin, followed by forests (29%) and pastures (13%) (Frappart et al., 2017). The Guayas riverpresentsan annual discharge of 30 billion m3 of water, which would make available 8,847 m 3/ hb / year, higher than the world average of 6,783 m3/hb/year (INOCAR, 2010).

The population in Ecuador has grown from 4.5 million inhabitants in 1960 to 14.9 million inhabitants in 2010 (World Bank, 2018), as a consequence anthropogenic activity such as urban construction, industry, agriculture, aquaculture and deforestation have intensified (Damanik-Ambarita et al., 2018). Intensive and continuous grazing, a common practice in theGuayas river basin has shown negative impacts onwater quality, reducing riparian vegetation, modifying channels and streams, increasing runoff and erosion as well assedimentingumping (Raymond and Vondracek, 2011).

The objective of this research is to analyze the tempo-ro-spatial change of the use of agricultural land and the expansion of its border in the Vinces River basin during theperiod 1990-2014 due to the presence of the main agricultural monocultures in the area and the demand for water for irrigation by the same agricultural crops according to the water concessionsgranted by the governmental authority with competence in the basin.

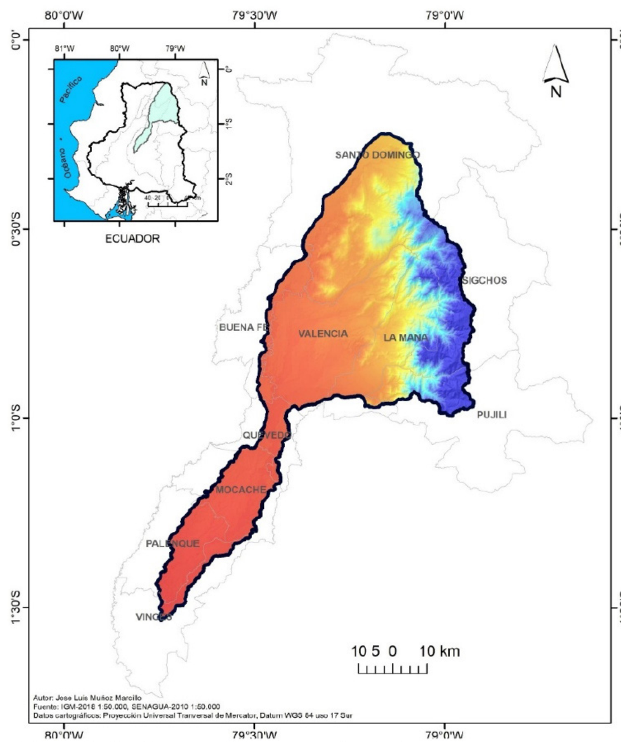
MATERIALS AND METHODS

Study area

The Vinces river basin is a sub-basin of the Guayas river basin that extends between theparallels 00º 14' S, 02º 27' S and the meridians 78º 36' W,80º 36' W, covering the partial or totalterritories of eight of the twenty-four Ecuadorian provinces: Guayas, Los Ríos, Manabí, Santo Domingo de los Tsachilas, Cotopaxi, Bolívar, Chimborazo, Cañar. In turn, the provinces of Guayas and Los Ríos together represent 48% of the area of the basin and 72% of its population. The total area covers approximately 32,219 km2 (Fig. 1). In addition to the Vinces river basin, the Guayas riverbasin is composed of 6 other sub-basins (SENAGUA, 2009), which are from north to south thesub-basins of the Daule, Macul, Babahoyo, Juján and Yaguachi rivers (Fig. 1).

The Vinces River basin is located from the north-eastern sector to the center of the Guayas River basin, extending for 426,800 hectareas and runs 267.96 km away in its main water axis following a north-south direction becoming an important part of theGuayas river basin. Aboat 57% of the surface of the province of Los Ríos, territory of the Ecuadorian coast eminently agricultural with presence of tropical and subtropical export crops such as abaca, rice, bananas, coffee, cocoa, corn, oil palm among others. The basin of the River Vinces takes its name fromthe River Vinces which crosses it in a north-south direction. Río that takes different names along its route,in such a way that in the northern part between the cantons Santo Domingo de Los Tsachilas and San Jacinto de Buena Fe is called Baba River and from there to the south of the basin takes the name of the canton through whichit crosses, so we have what is called, Quevedo River, Mocache River and Vinces River. The Quevedo River is formed from the convergence of three rivers, these being the Baba, Lulo and San Pablo rivers (Fig. 1).

Figure 1. Study area: Vinces river basin (Ecuador).



The determination of the change in the agricultural cover of the Vinces River basin was made from the compilation of land use cover studies generated by the Ministry of Agriculture and Livestock (MAG) and the Ministry of Agriculture, Livestock, Aquaculture and Fisheries (MAGAP) for the years 1980, 2002 and 2014. The 1980 land use and land cover map required a process of digitization and reprojection to be integrated with the land use covers of 2002 and 2014, all carried out in a Geographic Information Systems (GIS) environment using ArcGIS 10.4.1 software.

The determination of the demand for water for irrigation in the Vinces River basin was carried out based on the analysis of the concessions granted to the users of the basin by the Secretariat of Water (SENAGUA) in recent decades. Data were also taken from the Regional Hydraulic Plan of the Guayas Hydrographic Demarcation (CISPDR, 2016) regarding water supply and demand for agriculturalirrigation. These data were analyzed in conjunction with the area of intensive agricultural monocultures existing in the Vinces River basin (MAGAP, 2014) considering the irrigation requirements per ha/year in the summer season of intensive monocultures such as bananas, oil palm and cocoa, the latter requiring extensive field verification.

RESULTS

Land use

The analysis of the agricultural cover of the Vinces river-basinfor the years 1990, 2002 and 2014 shows an increase in agricultural coverage as a result of the expansion of the agricultural frontier from the establishment of several monocultures such as bananas, cocoa and palm and intensive short-cycle crops such as maize, rice, etc. (Fig. 2 and Table 1).

Figure 2. Agricultural overture in the Vinces river basin for 1990, 2002 and 2014.

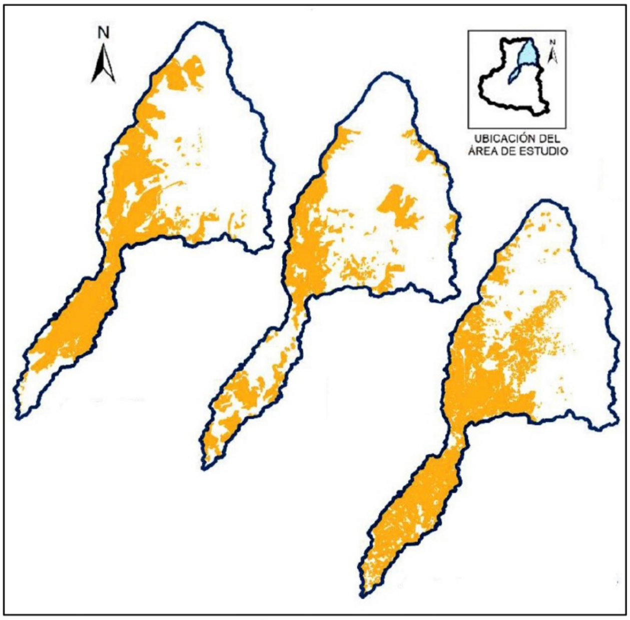


Table 1. Agricultural use in 1990, 2002 and 2014 in the Vinces River basin (Ecuador).

Land cover	year 1990 MAG Area (ha)	year 2002 MAGAP Area (ha)	year 2014 MAGAP Area (ha)
Tropical Arboriculture			
Short Cycle Crops		56586.61	
Banana Crops	11280.55	24843.77	23932.09
African Palm Crops	21399.05	15166.85	20543.46
Corn Crops	11401.8	3687.91	40484.22
Coffee Crops	35141.7	3413.40	
Rice Crops	5.760	1448.62	3444.17
Sugarcane Crops	2219.96	1002.33	27.82
Cocoa Crops	10983.950	841.89	36129.02
Coffee-Cocoa Cultivation	49332.790		
Abacá			595.67
Chia			58.13
Palm			762.61
Tobacco			1368.51
Total	**141.765,560**	**106.991,37**	**127.345,70**

Source: Own elaboration.

Of the agricultural coverage oftheVinces river basin, the permanent and intensive monocultures of bananas, cocoa and oil palm stand out because they require continuous and abundant irrigation during the eight months that the summer stage lasts in this region, added to the fact that it is precisely in the dry season where these exotic crops present the highest productive yields. The average irrigation need for banana production in banana farms in the province of El Oro is 27,500 m3 of water for irrigation per ha/year of cultivation (Erika Zarate & Derk Kuiper, 2013). On the other hand, cocoa and oil palm crops that have a woody plant structure, according to what was stated in oral communication by key informants of the sector, would demand approximately half of the water consumed by a banana sectorin production. The spatial distribution of bananas, cocoa and African palm in the Vinces river basin are presented in Figure 3. In the case of bananas, one of the main export crops of Ecuador, in the period presented it shows an expansion of 112 %. In the case of cocoa monoculture, it shows an expansion of 800%. On the other hand, the monoculture of oil palm or African palm presents a slight decrease of 0.04%.

Banana cultivation in 1990 occupied mostly the central part of the Vinces river basin while by 2002 it was extended to the southeast of the basin precisely next to the margin of the main course of the river or finally in 2014 it expanded significantly to the northern area of the basin where most of the river tributaries are located and also the altitude of the ground reaches the level 1000 msnm. This location presents good soil quality: very deep, porous and rich in organic matter.

In relation to the fine national aroma cocoa, in1990 the Vinces river basin had important covered areas whose plantations were mostly south of the sub-basin and in a small area in the northern sector of the basin. During the 2000s the plantations of finely aromad national cocoa ceased to be productive and were practically abandoned to later be replaced by the CCN51 cocoa clone which is the one that has now spread from the south, center and north of theVinces river basin thanks to itsproductive precocity and production intensity especially in summer.

The oil palm also known as African palm, for the year 1990 had a modest presence in the northwestern area of the basin in lands with a height that reached 600 meters above sea level, hence for the year 2014 it suffered an expansion from the south, center and north of the basin in lands with distances close to smaller surface courses of water without reaching the expansion that has had the crops of banana and cocoa.

Demand for water for irrigation

In relationto the volume of water for irrigation of agriculturalcrops, for the Vinces river basin according to (CISPDR, 2016) corresponds to 573.06 hm3 (Fig. 3), this volume was distributed according to the agricultural crops existing in the riverVinces (Fig. 4).

Figure 3. Dallocation of 573.06 Hm3 water for the rego of agricultural crops in the Vinces river basin.

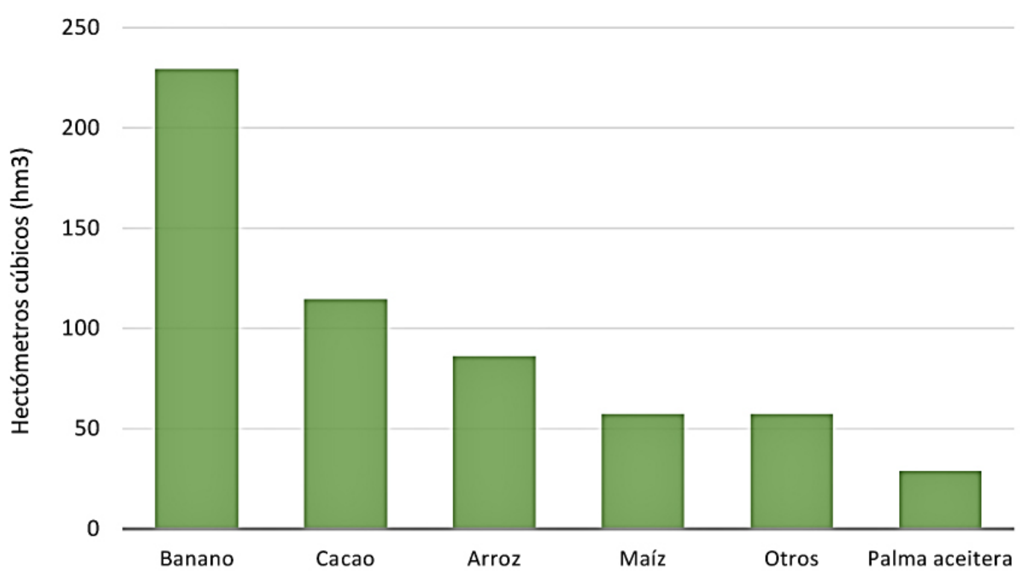
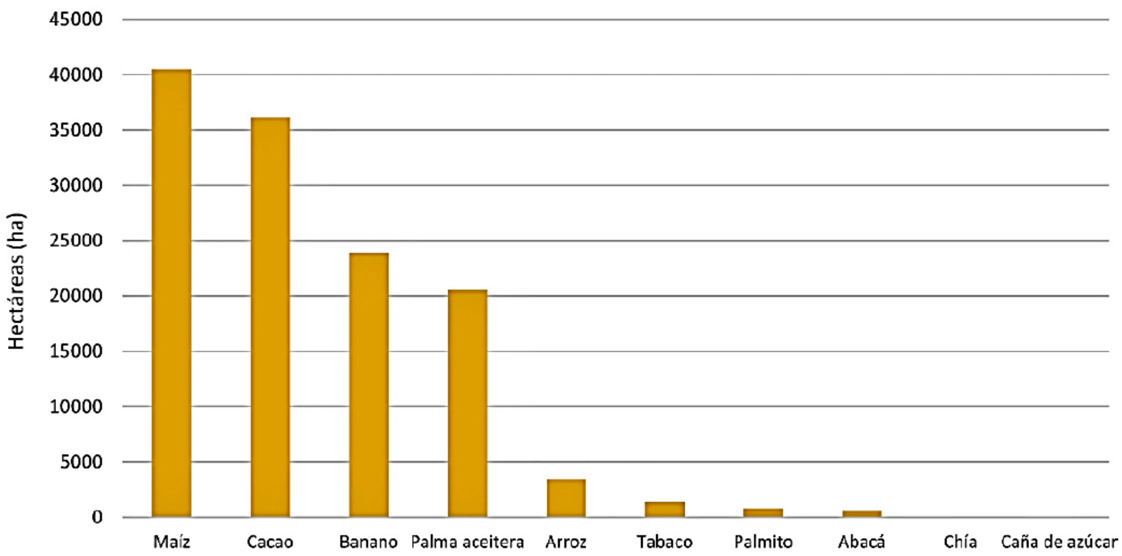


Figure 4. Distribution of agricultural crops in 127,345.70 ha in the Vinces River basin (MAGAP-2014).



The Secretariat of Water (SENAGUA) has granted water concessions for irrigation in the period between 1980 – 2018 for the Vinces River basin as indicated in Figure 5.

Figure 5. Water concessions (l/sg) for irrigation of agricultural crops in the Vinces river basin, for1980 - 2018.

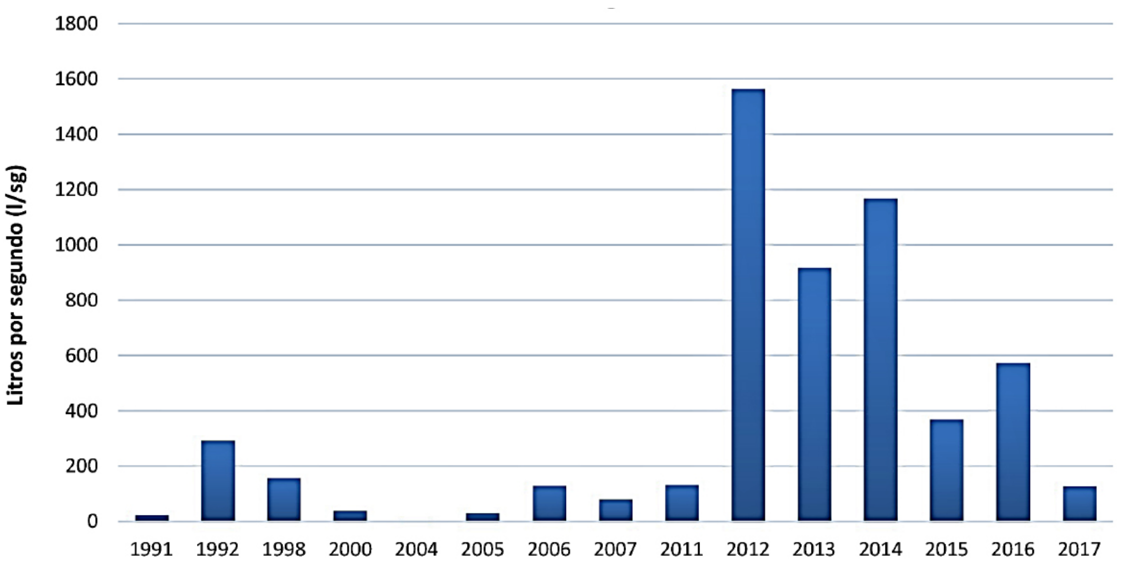


Figure 5 shows a significant year-on-year variation in water concessions by the Water Secretariat due to the lack of control for the period between1991 and 2011 due to the difficulty of this work for the control bodies. of a centralized nature, propitiating that in a clandestine way the water resource was abused for agricultural irrigation. Since 2008, when executive decree 1088 created the National Water Secretariat (SENAGUA), this situation changed thanks to the implementation of decentralized offices for citizen service,as is the case of the Quevedo customer service office, which began with a process of issuance and control of water concessions for irrigation in an equitable manner. in the Vinces river basin according to the extension of land area of agricultural producers (SENAGUA, 2011).

Ecuador's h ecursos areabundant. Thevolume of water provided by all the hydrographic systems in the national territory reaches 432,000 hm3 in the rainy season while in the dry season it reaches only 146,000 hm3 of which 115,000 hm3 corresponden to the Pacific slopeand 317,000 hm3 to the Amazon. However, the availability generates for the country is only34% or 146,000 hm3, this fluctuation in availability is due to the irregular spatial and temporal distribution of rainfall given that in the eight months of summer the precipitation is reduced in relation to winter by 90% (Galárraga, 2000 cited by MAGAP Ecuador, 2013).

Rainfall in the country is distributedin the winter and summer periods,according to data collected over 3 5 years in the PICHILINGUE eteorological period of the National Autonomous Institute of Agricultural Research (INIAP PICHILINGUE) located in the central part of theVincesriverbasin, the monthly average rainfall in the winter period from January to April is 423.78 mm, while in the summer season, from May to December the average is 67.70 mm so it is imperative to irrigate agricultural crops in the basin in the long summer period (Caicedo et al. , 2016).

According to communications from key informants engagedin banana production, a banana crop in production requires to be watered by subfoliating spray three times a week for two hours on each occasion. The subfoliation sprinklers reach a flow rate of 680.21 L/hour, their spacing between them being 12 m x 14 m, with application efficiency of 90% (Caicedo et al., 2015).

Theproduction of bananas for export in the Vinces river basin is associated with an uninsyfitable use of the water resource for irrigation. The cultivation of bananas requires large amounts of water, the study carried out in the center of theVinces river basin determined that a plant consumes approximately 30 liters of water daily on sunny days, 24 liters on semi-cloudy days and 12.5 liters on cloudy days, this may be necessary especially in dry season being applied by gravity, sprinkling, flooding or dripping and it is precisely in this last part that the lack of technical studies of the site result in the choice of an irrigation method that generates high rates of water waste (Rodríguez 2009).

The production of bananas for export in the Vinces river basin is associated with a non-optimized use of the water resource for irrigation. Banana cultivation requires large amounts of water, the study carried out in the center of the Vinces river basin determined that a plant consumes approximately 30 liters of water daily on sunny days, 24 liters on semi-cloudy days and 12.5 liters On cloudy days, this may be necessary especially in the dry season, being applied by gravity, sprinkling, flooding or dripping and it is precisely in this last part that the lack of technical studies of the site leads to the choice of an irrigation method that generates rates high levels of water waste (Rodríguez 2009).

Oil palm plantations in the Vinces River basin do not have an irrigation system for the most part because they are developed in moderately humid soils, however there is an important discussion around the fact that intensive oil palm plantations significantly reduce the levels of the surrounding aquifers and slopes. The cultivation of oil palm presents its optimal performance in regions with a rainfall of less than 2. 000 mm per year with a good distribution, the average monthly values in relation to good yields are above 150 mm. However, oil palm naturally has a great capacity to surviveprolonged periods of drought thanksto morphological and physiological characteristics in addition to the ability to abort the inflorescences, the seasonal variation in the peaks of cluster production and the mobilization of reserves that allow it to compensate for the lower rate of photosynthesis due to the closure of stomata (Nouy et al., 1999). In a study conducted on three hybrids variety of oil palm had, a positive effect of irrigation on the behavior of each of the hybrids under study was reported for the variables plant height, sex ratio and Production (Reinoso, 2008).

In figures 6a, 6b and 6c we can see the current land use of the Vinces river basin according to the cantons Valencia, Quevedo and Mocache that represent three realities of the upper, middle and lower part of the basin.

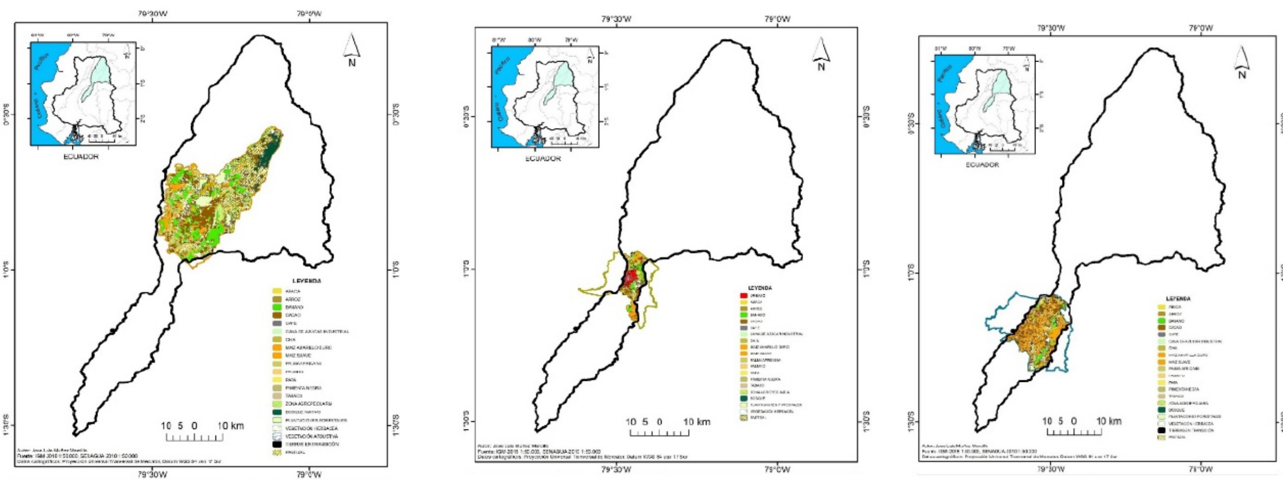


Figure 6a, 6b and 6c. Current land use of the Vinces river basin in its upper, middle and lower part.

The demand and pressure of water for irrigation of agricultural crops in the Vinces river basin is important considering that it is precisely in the dry months where to maintain high production rates permanent irrigation is necessary. In figures 7a, 7b and 7c you can see according to the cantons of the upper, middle and lower part the presence of the main monocultures existing in the sub-basin of the Vinces River.

CULTIVO	ÁREA (HA)	%
ABACA	6,86	0,01
ARROZ	1.643,62	3,19
BANANO	15.559,71	30,16
CACAO	19.306,07	37,42
CHIA	58,13	0,11
MAIZ AMARILLO DURO	6.635,28	12,86
PALMA ACEITERA	7.423,08	14,39
TABACO	960,72	1,86
TOTAL	51.593,48	100

CULTIVO	ÁREA (HA)	%
ARROZ	368,38	4,56
BANANO	1.419,52	17,56
CACAO	2.846,89	35,22
MAIZ	1.427,63	17,66
PALMA ACEITERA	2.021,67	25,01
TOTAL	8.084,09	100,00

CULTIVO	ÁREA (HA)	%
ARROZ	490,94	1,84
BANANO	1.810,71	6,80
CACAO	8.874,28	33,34
MAIZ AMARILLO DURO	12.490,79	46,93
PALMA ACEITERA	2.881,81	10,83
TABACO	69.5	0,26
TOTAL	26.618,03	100,00

Figure 7a, 7b, and 7c. Distribution of monocultures in the Basin of the Vinces River in its upper, middle and lower part.

DISCUSSION

The temporal-spatial analysis of the agricultural coverage of the Vinces river basin in the last three decades has made it possible to visualize the sustained growth of agricultural production through the development of intensive export monocultures whose expansion has spread to high altitude areas and important gradient of the land and with an impact on the demand for surface water for irrigation in the summer months. In this regard, Flórez-Yepes et al., 2017 state that the application of multitemporal analysis allows determining the most significant environmental changes and impacts over time, allowing to know the interrelationships between the elements that compose it and anthropic activities.

The intensive monoculture of banana has been expanded mainly by economic groups with power whose plots exceed 100 hectares, generating a very high pressure from the water resource of the basin for irrigation. Frequently it can be observed that they do not respect the flows granted by the environmental authority and in many cases, they have been financially sanctioned but pay their fines and continue to clandestinely use the water for irrigation of the Vinces River. This reality lived in the basin is not very different from what happens in the rural area of Bogotá, where the expansion of the agricultural frontier has led to the almost total disappearance of the buffer areas of the páramo, this is related to the forms of economic use of the land, due to several large estates that have been leased to third parties, precipitating the ecosystem and water deterioration of the basin (Hernández, Rojas, Sánchez, 2013).

The presence of exotic monocultures in the Vinces River basin has significantly changed the landscape of one of the richest areas in natural resources of Ecuador, to date there are very few remnants of forest patches in the middle and lower part of the basin resulting in unsuccessful controls exercised by the competent environmental authority, In this problem agree (Lambin et al. 2001) those who point out that human intervention is what has caused the greatesttransformations on the earth's surface despite the fact that environmental modificationscan occur naturallyor can be of the anthropogenic type being thegeneral results changes in coverage plant and land use that bring with them effects thatemmes the biological and cultural potential.

The results of the temporary-spatial studyof the agricultural cover of theVinces river basinduring the period 1990 -2014 has made it possible to identify trends in land occupation patterns. (Morales et al., 2016) indicates that the spatial-quantitative analysis of changes in vegetation cover and land use between1979 - 2013 in the Banderas Bay region, Mexicogenerated valuable information for the monitoring of natural resources with implications for the hy drological cycle,biodiversity, soil erosionand localclimate, among other relevant aspects.

In practice, banana producers in Ecuador do not know the volumes of water they use through sprinkler irrigation since it is assumed that it is always irrigated until the soil is saturated (Erika Zarate & Derk Kuiper, 2013) although the ideal would be 27,500 m3 of water for irrigation per ha / year. Ecuadorian producers also point out that in the basins where bananas are produced there is competition for water resources, noting the decrease in the availability of water in dry season especially, this has caused changes in the hydrology of rivers due to factors such as deforestation and inappropriate land use. According to Erika Zarate & Derk Kuiper (2013) the situation in Peru is no less different since an annual ha of bananas in production requires 28,500 m3 of water for irrigation and before the minimum rainfall there is a forecast of increase in water stress in the coming years since at present the minimum environmental flows are not respected, with serious repercussions for the ecosystems.

CONCLUSIONS

Of the main agricultural monocultures existing in the Vinces River basin such as bananas, cocoa and oil palm, banana cultivation stands out as the one that exerts the most pressure on the water resource given the high volume of irrigation it requires to maintain its productivity levels.

The application of irrigation water is an imperative need to obtain high and stable yields in the cultivation of bananas in the Vinces river basin, the main source of water being surface water courses. It is important to note that the field trips show many clandestine connections to the main water axis of the basin as well as to that of its tributaries, this as a cause of the lack of economic and human resources to control the wide area of the basin.

The regulation of the expansion of the planting of banana cultivation in the Vinces river basin has a single economic objective and that is to stop the overproduction of the fruit to maintain its price, there is no context of environmental protection, so the outlook for the Vinces River in the medium term in the summer season is almost total drought.

BIBLIOGRAPHY

Caicedo C., Cadena D., Alcívar T., Veloz A., Montecé F. (2016). Analysis of the behavior of rainfall in Quevedo - Ecuador, for crop planning. European Scientific Journal (ESJ). 12 (33).212-220 pp. DOI: http://dx.doi.org/10.19044/esj.2016.v12n33p212

Chacón, V. (2012). They denounce contradictions in figures on land dedicated to pineapple. Ucr University Weekly, October 24, 2012. Retrieved from http://www.semanariouniversidad.ucr.cr/component/content/article/1887-Pa%C3%ADs/7745-denuncian-contradicciones-en-cifras-sobre-tierras-dedicadas-a-la-pina.html

Changjiang Institute Of Survey, Planning, Design And Research (CISPDR), 2016. PLAN HIDRÁULICO REGIONAL DE LA DEMARCACIÓN HIDROGRÁFICA GUAYAS

CISPDR, 2015. Plan Hidraúlico Regional de la Demarcación Hirográfica Guayas. Memoria y Anexos. Changjiang Institute of Survey Planning Design and Research.

CISPDR, 2014. Planificación Hídrica Nacional del Ecuador (2014-2035). Phase II Report. Changjiang Institute of Survey Planning Design and Research.

Erika Zarate & Derk Kuiper. 2013. Evaluation of water footprint of bananas for small producers in Peru and Ecuador. GOOD STUFF INTERNATIONAL – Switzerland. TECHNICAL ASSISTANCE FOR SUSTAINABLE TRADE & ENVIRONMENT (TASTE Foundation), pp.70.

Flórez-Yepes, Gloria Yaneth, Rincon-Santamaría, Alejandro, Cardona, Pablo Santiago, & Alzate-Alvarez, Angela María. (2017). Multitemporal analysis of plant covers in the area of influence of gold mines located in the upper part of the Maltería sector in Manizales, Colombia. DYNA, 84(201), 95-101. https://dx.doi.org/10.15446/dyna.v84n201.55759

Frappart, F., Bourrel, L., Brodu, N., Salazar, X.R., Baup, F., Darrozes, J., Pombosa, R., 2017. Monitoring of the spatio-temporal dynamics of the floods in the Guayas Watershed (Ecuadorian Pacific Coast) using global monitoring ENVISAT ASAR images and rainfall data. Water 9, 1.

Granada J. 2001. Oil palm irrigation. In update in the production of oil palm. Maturín (Venezuela). May, 2-4. 2001. Selected readings. Maturin. p.219-224

Galárraga-Sánchez. NATIONAL REPORT ON WATER MANAGEMENT IN ECUADOR, 2000. Economic Commission for Latin America, ECLAC, 120 pp. Retrieved in: https://www.cepal.org/DRNI/proyectos/samtac/InEc00100.pdf

Gudynas, E. (2013). Extractions, extractivisms and extra-hections: a conceptual framework on the appropriation of natural resources. Development Observatory, CLAES, 18, pp. 1-18.

Hernández-Gómez, Rojas-Robles, Sánchez-Calderón. (2013). Changes in land use associated with urban expansion and planning in the corregimiento of Pasquilla, rural area of Bogotá (Colombia). Geography Notebooks, 22(2), 257-271

INOCAR. 2010. Technical Report of the commission carried out in the area of the Guayas River south. November 29 to December 8, 2009. OceanogGraphic Instituteof the Navy. Guayaquil. 183 p.

Labrecque, S., Fournier, R., Luther, J., & Piercey D. (2006). A comparison of four methods to map biomass from Landsat-TMand inventory data in western Newfoundland.Forest Ecology and Management, 226, 129 – 144.

Lacerda, L., Kremer, H., Kjerfve, B., Salomons, W., Marshall, J., & Crossland, C. (2002). South American Basins: LOICZ Global Change Assessment and Synthesis of River Watershed – Coastal Sea Interaction and Human Dimensions. LOICZ Reports & Studies No. 21, Volume 1: ii+95 pp, Volume 2: ii+127 pp.

Lambin, E.F. & B. Turner. 2001. The causes of land-use- cover change, Global Enviromental Change. USA, p.184.

MAGAP. (2012). Ecuador chairs the Economic Committee of the International Cocoa Organization. Retrieved from Ministry of Agriculture, Livestock, Aquaculture and Fisheries. http://www.agricultura.gob.ec/ecuador-preside-comite-economico-de-laorganizacion-internacional-del-cacao/

MAGAP, 2015. Land Use and Lan Cover Map. Years 2014-2015. 1:25,000 Scale. Ministry of Agriculture, Livestock, Aquaculture and Fisheries.

Minar Naomi Damanik-Ambarita, Pieter Boets, Hanh Tien Nguyen Thi, Marie Anne Eurie Forio, Gert Everaert, Koen Lock, Peace Liz Sasha Musonge, Natalija Suhareva, Elina Bennetsen, Sacha Gobeyn, Tuan Long Ho, Luis Dominguez-Granda, Peter L.M. Goethals, Impact assessment of local land use on ecological water quality of the Guayas river basin (Ecuador), Ecological Informatics, Volume 48, 2018, Pages 226-237, ISSN 1574-9541, https://doi.org/10.1016/j.ecoinf.2018.08.009

Ministry of Agriculture, Livestock, Aquaculture and Fisheries, MAGAP. 2019. Map of Land Cover and Use in Continental Ecuador - Category: Cultivation, scale 1:100,000, year 2013 - 2014

Ministerio de Agricultura, Ganadería, Acuacultura y Pesca: Plan Nacional de Riego y Drenaje 2012 - 2027, [online] Ed. MAGAP, pp. 186, ISBN-09 8441 0399, Ecuador, 2013. Available in: http://es.scribd.com/doc/127451977/Libro-Plan-Nacional-de-Riego-y-Drenaje

Morales J., Carrillo F., Farfán L., Cornejo L. (2016). Change of vegetation cover in the Banderas Bay region, Mexico. Caldasia 38(1):17-29.DOI:http://dx.doi.org/10.15446/caldasia.v38n1.57831

Nouy, B; Baudouin, L; Djegui, N; Omore, A. 1999. The palm tree has oil in limitingwater conditions. Plantations, research,development. pp31-45

Walls, Mendis. 2004 Program for the development of the Amazon, Proamazonia. "Manual of Cocoa Cultivation". Ministry of Agriculture. Peru.

Raymond, K.L., Vondracek, B., 2011. Relationships among rotational and conventional grazing systems, stream channels, and macroinvertebrates. Hydrobiologia 669 (1), 105–117. https://doi.org/10.1007/s10750-011-0653-0.

Reinoso V. 2008. Influence of irrigation on the behavior of three hybrids of oil palm (Elaeis guineensis Jacq) of different origins (4th year of execution). La Concordia, Emeralds. Thesis Agricultural Engineer. Quito, Ecuador. Central University of Ecuador. Faculty of Agricultural Sciences.

Rodríguez C. Feasibility Study for the production and commercialization of bananas (Musa sp.), great dwarf variety Cavendish, in Quevedo, province of Los Ríos, 2009. Degree project presented as a requirement for obtaining a degree in Agribusiness Engineering. Universidad San Francisco de Quito, 63 pp.

SENAGUA. 2011. Management report 2008-2010. A different management of water resources. SENAGUA. Ecuador.

Secretariat of Water, SENAGUA. 2018

National Water Secretariat, SENAGUA, 2009. Hydrographic Units (GIS). Retrieved from: https://aplicaciones.senagua.gob.ec/servicios/descargas/archivos/delimitacion-codificacion-Ecuador.pdf

Seoane, J. (2013). "Extractive model and accumulation by dispossession". In: Seoane, J.; Taddei, E. and Algranati, C. (Eds.) Extractivism, dispossession and climate crisis (pp. 21-41). Buenos Aires: Editorial El Colectivo. SEPSA (Executive Secretariat ofAgricultural Sectoral Planning) (2001). Agricultural Livestock Statistical Bulletin No. 12, Retrieved from http://www.mag.go.cr/biblioteca_virtual/bibliotecavirtual/a00029.PDF

SEPSA (Executive Secretariat of Agricultural Sector Planning) (2013). Agricultural Statistical Bulletin No. 23. Time Series 2009-2012. Retrieved from http://www.mag.go.cr/biblioteca_virtual/bibliotecavirtual/a00322.pdf

Silvetti, F.; Soto, G.; Cáceres, D. and Cabrol, D. (2013). Why doesn't the legislation protect Argentina's native forests? Socio-environmental conflicts and public policies in the province of Córdoba. Agrarian World, 13 (26), Retrieved from http://www.mundoagrario.unlp.edu.ar/

Svampa,M. (2009). Change of era. Social movements and political power. Buenos Aires: Siglo XXI editores and CLACSO co-editors.

World Bank, 2018. Population, Total - Ecuador. Worl Bank Development Data Group. https://data.worldbank.org/indicator/SP.POP.TOTL?end=2016&locations=EC& start=1960&view=chart, Accessed date: 8 May 2018.

Zeolla, N. H. (2013). Costs and profitability of soybean cultivation in Argentina. Special Economic Report II CELSO (July). Retrieved from http://www.ceso.com.ar/sites/default/files/ceso_sector_agropecuario_3.pdf