

PRAIRIE VIEW

A&M UNIVERSITY

COLLEGE OF AGRICULTURE

AND HUMAN SCIENCES



Abstract

Increase demand for water resources across the Brazos watershed requires an evaluation of the potential impact of some of the majo grown on this watershed. This study evaluated the potential effect major row crops (corn, sorghum, cotton and wheat) on the effective the portion of gross rainfall that infiltrates into the crop rootzone, wate and groundwater recharge. Five locations in five different counties acr Brazos watershed (upper, middle and lower parts) were selected. H daily weather data [rainfall and potential evapotranspiration (ET_o)], soil properties, and crop water parameters were used as input for the I Management System (IManSys) model to calculate daily water components. From the upper to the lower parts of the watershed, increased by as much as 175% while ET_o decreased by 30%. The variatio magnitude of effective rainfall for wheat at different location comparatively higher than that of the other crops. The water requirem sorghum was comparatively lower than other crops. Groundwater rech terms of percentage of gross rainfall, was the highest for wheat at all lo except at Lubbock. Cotton, Corn, and Sorghum had similar recharge rat locations. Water yield increased with increase in rainfall across the wa irrespective of the crop. Further analyses are needed for more cor conclusions and recommendations.

Introduction

Increase demand for water resources across the Brazos watershed (Fig. 1), Texas requires an evaluation of the impact of some of the major crops grown on this watershed. The major crops grown in this watershed are cotton, winter wheat, corn, sorghum etc (Fig. 2). The changes in acreage covered by these crops are shown in Fig. 3. Cotton has the highest acreage while winter wheat has the lowest acreage in 2011 during last six years (2008 – 2013).



Fig. 3: Acreage of major croplands (2008 – 2013)

Objectives

The main objective of this study is to evaluate the potential effect of four major row crops on the effective rainfall, groundwater recharge rates, and runoff/water yield across the Brazos watershed using a IManSys and site specific historical data.

Methodology

Data:

Climate data (rainfall and potential evapotranspiration) at five stations of Texas ET Network and soil data derived from Soil Survey Geographic Database (SSURGO) were used in this study. Planting date, harvesting date and growing season of each crop were selected based on the geographic location of the area as detailed in Borrelli et al. (1998).

Effective Rainfall, Water Yield, and Groundwater Recharge Under Different Crops Across the Brazos Watershed, TX

Ali Fares, Ripendra Awal*, Alton B. Johnson and Ram L. Ray, College of Agriculture and Human Sciences, Prairie View A&M University





Developed/Open Space

---- Winter Wheat \rightarrow Sorghum



Tab	le 1 : Grow	ving season	of selected	d crops (Ba	sed on Bo	rrelli et al., 2	L998)	Net irrigation requirement:
Crops	Lu Planting	bbock Harvesting	Growing season	Crops	Planting	(nox Harvesting	Growing season	The water requirement for sorghum was comparatively lower than other crops. Water requirement for cotton
Corn Sorghum Cotton	15-Apr 29-May 20-May	18-Sep 25-Oct 21-Oct	(days) 157 150 155	Corn Sorghum Cotton	22-Apr 02-Jun 01-Jun	09-Sep 30-Oct 07-Nov	(days) 141 151 160	was higher than other three crops at Williamson, Brazos and Fort Bend whereas water requirement for wheat was higher than other three crops at
Wheat	27-Sep	25-Jun	272	Wheat	02-Oct	19-Jun	261	Lubbock and Knox.
	Will Planting	lamson Harvesting	Growing		B Planting	razos Harvesting	Growing	Water yield:
Crops	date 25-Mar	date 09-Aug	season (days) 138	Crops	date 07-Apr	date 07-Aug	season (days) 123	Water yield increased with increase in rainfall across the river basin irrespective of the crop.
Sorghum Cotton Wheat	04-Apr 24-Apr 20-Oct	09-Aug 21-Sep 14-Jun	128 151 238	Sorghum Cotton Wheat	09-Apr 20-Apr 22-Oct	24-Jul 17-Sep 22-Jun	107 151 244	
Innigot	ion Man	ogomont	System (1)		modelı			Groundwater recharge:
(IRRs) interce evapote parame	and othe ption, and ranspiration ters, soil p Input da Type, Irriga ation System ce, SCS Cur LAI)	er water l effective ra on), and site oroperties, i ata tion Period, n, Irrigation rve Number,	budget co ainfall) usi and crop rrigation s	proponents omponents ng daily his specific in ystem).	(runoff, storical cli formation (Rain, F	gation requi drainage, imate data (n (e.g., plan ⁻) Data files ETo, Crop data	a, Soil)	 Index and a similar recharge rates at all locations. Cotton, Corn and Sorghum had similar recharge rates at all locations. Crop evapotranspiration: Crop evapotranspiration of Sorghum was lower than other crops irrespective of the location.
Wate for and week	r budget co nual, monthly ly and daily	omponents y, bi-weekly, time period	(Irrigation Sys	Managemen stem)	t (Mean Minim	RR Statistics , Median, Maxi um, IRR of diff	mum, erent	Future
	Drainag	e) Fig. 4: Sche	ematic rep	resentatior	n of IManS	Sys	and 20	Further study will incorporate all other available stations within the basin. Furt Water Requirement Estimation Decision model which is currently under develop Texas.
Five log middle ET _o), so the IMa	Rec cations in and lower oil physical anSys mod	esults five different parts) were properties, del.	ent counties eselected and crop	Disc es across t Historical water para	the Brazos daily clima meters we	ONS s river basir ate data (rai ere used as	(upper, nfall and input for	WEDSS_IX-ArcMap-ArtEditor File Edit View Bookmarks Intert Selection Geoprocessing Cutomite Windows Help Intert Table Contry Editors Inter Selection Geoprocessing Cutomite Windows Help Intert Table Contry Editors Inter Selection Geoprocessing Cutomite Windows Help Intert Table Contry Intert Selection Intert Selection Geoprocessing Cutomite Windows Help Intert Table Contry Intert Selection Geoprocessing Cutomite Windows Help Intert Table Contry Intert Selection Intert Selection Geoprocessing Cutomite Windows Help Intert Table Contry Intert Selection
Rainfa From t	II and po the upper	to the lowe	apotrans or parts of	piration:	Annual r	rainfall 🗖 Annual	ЕТо	Conclu
the wa much 30% (f Fig. 5 at diff Texas	atershed r as 175% v Fig. 5). Annual to ferent site ET Netwo	ainfall incre vhile ET _o deo otal rainfall s based on o orks (2009 –	ase by as crease by and ET _o data of 2013)	90 75 60 45 30 11.9 15 Lubbo	4.5 14.5 Dck Seymour Aquifer Dck Knox	73.5 55 21.9 Georgetown II Williamson Brazo	5.5 59.1 32.7 Golf Rosenberg se Fort Bend	IManSys proves to be a very useful tool components of water budget and agricu. The result shows water requirement fo other crops mainly due to its lower of recharge, in terms of percentage of gross locations except at Lubbock.
Effecti Theye	ve rainfa	magnitudo	of		Cotte			Acknowle
effecti gross the cro	ve rainfall rainfall tha op rootzor	, the portion at infiltrates he across th	n of into e	 → →		Sorghum		This work is supported by the USDA National Evans-Allen project 2014-33100-08916.
growin was sr	ng season, naller at L	ubbock whe	ere	й 4 – 2 – 0 –	1			

Tab	le 1 : Grow	ing season	of selected	crops (Ba	sed on Bo	rrelli et al., 2	1998)	Net irrigation requirement:	
	Lu Planting	bock Harvesting	Growing		Planting	(nox Harvesting	Growing	The water requirement for sorghu was comparatively lower than oth	
Crops	date	date	season (days)	Crops	date	date	season (days)	was higher than other three crops	
Corn	15-Apr	18-Sep	157	Corn	22-Apr	09-Sep	141	Williamson, Brazos and Fort Bend	
Sorghum	29-May	25-Oct	150	Sorghum	02-Jun	30-Oct	151	whereas water requirement for wh	
Cotton Wheat	20-May 27-Sep	21-Oct 25-Jun	155 272	Wheat	01-Jun 02-Oct	07-Nov 19-Jun	261	Lubbock and Knox.	
	Will	lamson	Growing		B	razos	Growing	Water yield:	
Crops	Planting date	Harvesting date	season	Crops	Planting date	Harvesting date	season	Water vield increased with	
Corn	25-Mar	09-Aug	(days) 138	Corn	07-Apr	07-Aug	(days) 123	increase in rainfall across the river	
Sorghum	04-Apr	09-Aug	128	Sorghum	09-Apr	24-Jul	107	basin irrespective of the crop.	
Cotton	24-Apr	21-Sep	151	Cotton	20-Apr	17-Sep	151		
wneat	20-Oct	14-Jun	238	wneat	22-UCT	22-Jun	244	Groupdwater recharge:	
Irrigat	ion Mana	agement S	System (II	VlanSys) ı	model:	. •		Groundwater recharge, in terms of percentage of gross rainfall,	
IManSy (IRRs)	vs model (and othe	Fares and F er water	ares, 2012 budget co) calculates omponents	s daily irri s (runoff,	gation requi drainage,	irements canopy	was the highest for wheat at all locations except at Lubbock.	
interce evapot	ption, and ranspiratio	effective raise	ainfall) usi e and crop	ng daily his specific ir	storical cli	imate data (n (e.g., plan	rain and	Cotton, Corn and Sorghum had similar recharge rates at all	
parame	eters, soil p	properties, i	irrigation s	ystem).	normation			locations.	
	Input da	ta							
(Crop Irriga	ation System	, Irrigation			(Rain, E	Data files ETo, Crop data	a, Soil)	Crop evapotranspiration:	
Practi	LAI)	ve Number,						Crop evapotranspiration of Sorghum was lower than other	
		ſ						crops irrespective of the	
			IMa (Irrigation)	nSys Managemen	t 🚽 —			locations.	
			Sys	stem)					
Wate for and	r budget co nual, monthly	mponents y, bi-weekly,			(Mean,	RR Statistics	imum,	Futu	
(IRF	R, Runoff, Int Drainag	erception, e)			return p	eriod (2, 5, 10 vears)	and 20	Further study will incorporate all o	
		,				,		available stations within the basin.	
		Fig. 4: Sche	ematic rep	resentatior	n of IManS	Sys		Water Requirement Estimation Dec	
								Texas.	
								IWREDSS TX - ArcMan - ArcEditor	
	Re	sults	and	Disc	ussi	ons		WREDS_IX - ArcEditor File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help E a b b a b a b a b a b a b a b a b a b	
								Image: Second	
Five lo	cations in	five differe	ent countie	es across t	he Brazos	s river basir	n (upper,	Image: Solution of the solutio	
middle	and lower	r parts) wer	e selected	Historical	daily clima	ate data (rai	nfall and	Soil Hydrologic groups: HARRIS - B D Proportion: .175 .808 SCS Curve Number 78, 78 (Use Comma to Separate)	
ET _o), sc the IM:	oil physical	properties,	, and crop	water para	meters we	ere used as	input for	All Data Station: HOUSTON, HO	
Kainta	ill and po	tential ev	apotrans	piration:					
the wa	atershed r	ainfall incre	ase by as	(i) o 90 ¬	Annual r 82.7	rainfall Annual	ETo	Con	
much	as 175% v	vhile ET _o de	crease by	60 - 60 - 60 - 60 - 60 - 60 - 60 - 60 -	4.5	73.5	5.5 59.1		
30% (Fig. 5).			45 - 30 - 15 - 11.9	14.5	21.9	32.7	components of water budget and a	
Fig. 5	: Annual to	otal rainfall s based on (and ET _o data of	Annua Cristiana	ock Seymour	Georgetown TAMU	Golf Rosenberg	The result shows water requireme	
Texas	ET Netwo	rks (2009 –	2013)	Lubbo	Aquifer ock Knox	II Cours Williamson Brazo	se Fort Bend	other crops mainly due to its low	
								locations except at Lubbock.	
		11:							
Effect	Ve dinia							Acknow	
<mark>Effect</mark> The va	ariation in	magnitude	of	→	-CottonCo	rn 📥 Sorghum			
Effect The va effect	ariation in ive rainfall	magnitude , the portio	of n of	16 (u) 14 12	-CottonCo	orn 📥 Sorghum	→ Wheat	This work is supported by the USD	
Effect The va effect gross the cr	ariation in ive rainfall rainfall tha	magnitude , the portio it infiltrates ne across th	of n of into e	• 16 14 - 12 10 - 10 8 - 10	-Cotton -Co	orn Sorghum	Wheat	This work is supported by the USD Evans-Allen project 2014-33100-089	
Effect The va effect gross the cr growi	ariation in ive rainfall rainfall tha op rootzor ng season,	magnitude , the portio it infiltrates ne across th for differer	of n of into e nt crops	Effective rainfall (in) - 14 - - 10 - - 10 - - 91	-Cotton -Co	orn Sorghum	Wheat	This work is supported by the USD Evans-Allen project 2014-33100-089	



total annual rainfall was lowest among five locations. The variation was higher at Brazos and Fort Bend where total annual rainfalls were comparatively higher.



Fig. 6: Effective rainfall

• Borrelli, J., Fedler, C.B., and Gregory, J.M. (1998): Mean Crop Consumptive Use and Free-Water Evaporation for Texas. Dept. of Civ. Eng, Texas Tech Univ., 271 pp. • Fares, A. and Fares, S. (2012): Irrigation Management System, IManSys, a User-Friendly Computer Based Water Management Software Package. In: Proceedings of the Irrigation Show and Education Conference, Orlando FL, Nov. 2 – 6, 2012.



Jnited States Department of Agriculture National Institute of Food and Agriculture



are Work



GIR □ 0.000 □ 22.905 □ 23.379 □ 23.556 □ 23.582 ④ station_ET ⊕ UserL ⊕ ✓ TaxID ⊕ SolLS ⊕ County ⊕ et ⊕ station ⊕ station 229863.75 3317960.95 Meter

clusions

tool to study relationship between different agricultural crops under different conditions. nt for sorghum is comparatively lower than wer crop evapotranspiration. Groundwater gross rainfall, is the highest for wheat at all

ledgements

A National Institute of Food and Agriculture

Keterences