Aug 15, 2017

Why Watershed Management

By Ted Tietjen

In the Republican River Basin, all water comes from precipitation including stream flow and filling the aquifer.
So the question is, "How do we best manage the water in a comprehensive way to maximize the benefits"?
It started with ditch irrigation and then dams were built to reduce flooding and to increase ditch irrigation. After that came groundwater irrigation using the aquifer as a reservoir.

A research paper "Damming the Prairie: Human alteration of the Great Plains River regimes", by Costigan & Daniels.

K.H. Costigan, M.D. Daniels / Journal of Hydrology 444–445 (2012) 90–99

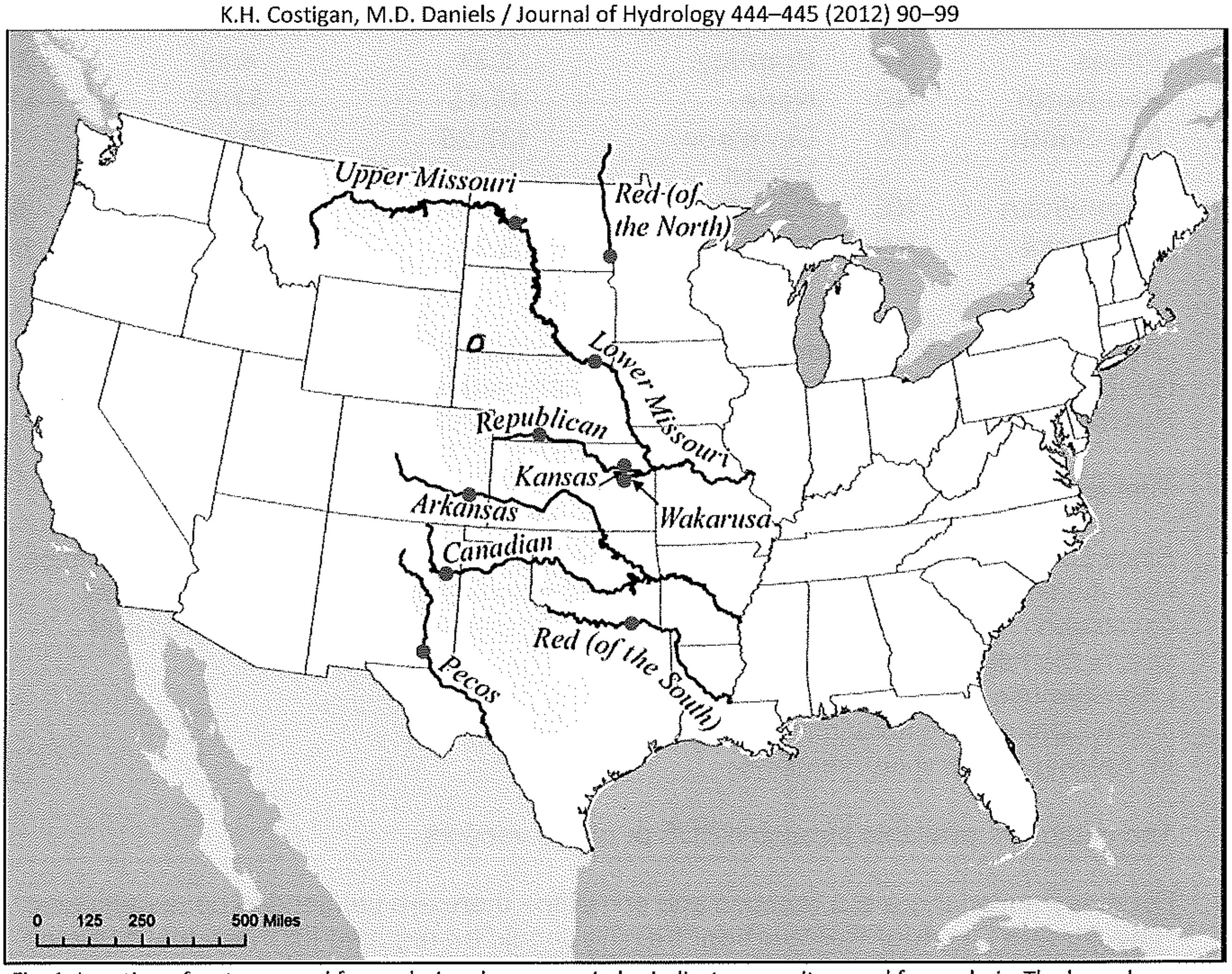


Fig. 1. Location of systems used for analysis, where gray circles indicate gage sites used for analysis. The boundary of the Great Plains USA is delineated in light gray.

The document; shows that stream flow in the Republican River was reduced by 65% after dams were built. Small livestock ponds, terraces and residue management are also negatively affecting stream flow. Later changes in tillage practices further changed the local hydrology.

Table 1
Characteristics of systems used in the analysis, is discharge in Cubic Meters Per Second

River	State	Dam Name	Mean Annual Pre Dam impact	Mean Annual after Dam impact	% Change
Arkansas	**CO**	**John Martin**	**8.27**	**3.4**	**-59**
Canadian	**NM**	**Ute**	**9.66**	**1.19**	**-88**
Kansas	**KS**	**Tuttle-Milford**	**104.87**	**147.42**	**41**
Lower Missouri	**NE**	**Gavin's Point**	**727.18**	**735.11**	**1**
Upper Missouri	**MT**	**Garrison**	**624.1**	**624.39**	**0**
Pecos	**NM**	**Brantley**	**3.31**	**4.39**	**33**
Red-North	**ND**	**None**	**15.15**	**33.73**	**123**
Red-South	**TX**	**Dennison**	**137.25**	**138.13**	**1**
Republican	**NE**	**Harlan County**	**25.06**	**8.81**	**-65**
Wakarusa	**KS**	**Clinton Lake**	**5.32**	**7.62**	**44**

These changes had a major impact on what the streams look like today. Unfortunately the riparian areas were taken over by undesirable vegetation such as: fragmentizes. Russian olive, Salt Cedar and Red Cedar trees are adding to the problem.

That leads to the next question?

Since 2007 two weed districts have been working to remove the undesirable vegetation from the flood plain and to restore the stream back to health. In addition NRCS has developed**: "The Stream Corridor Restoration"** manual to help in this effort and covers the following:
I. Background
II. Developing a Restoration Plan
III. Appling Restoration Principals

The manual is available through NRCS or online vendors.

For every action there is a reaction and sometime there are unintended consequences. "**The Stream Corridor Restoration**" training should be required for those that serve on NRD and Irrigation District boards to better understand how streams function.

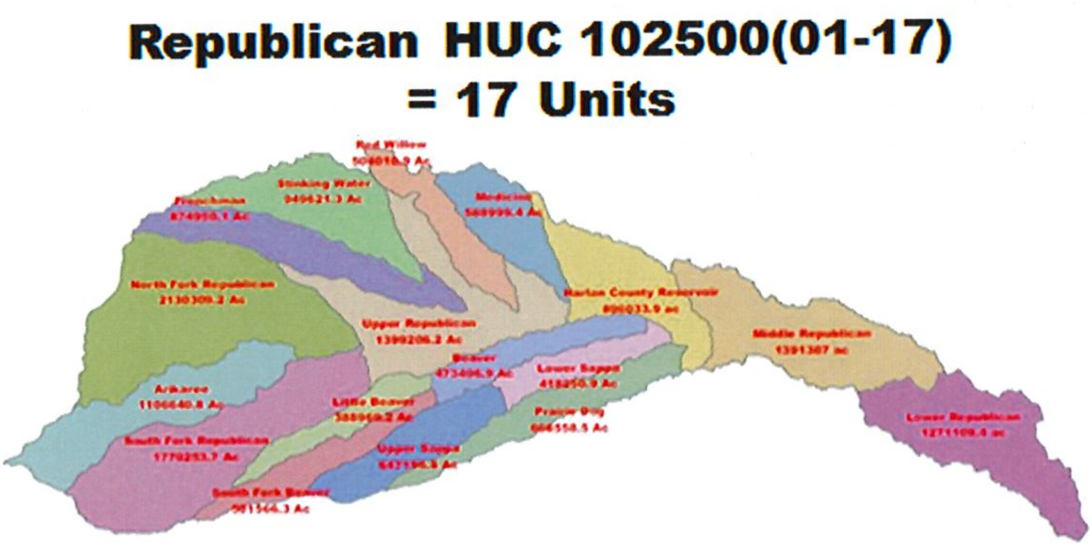
We have now laid the ground work for watershed management. Attached is an article by Frank Kwapnioski that explains how the water balance works in a watershed.

USGS has identified all watersheds in the US using Hydrologic Units that range in size from 1 through 12.

Example:

Missouri River is a HUC 10

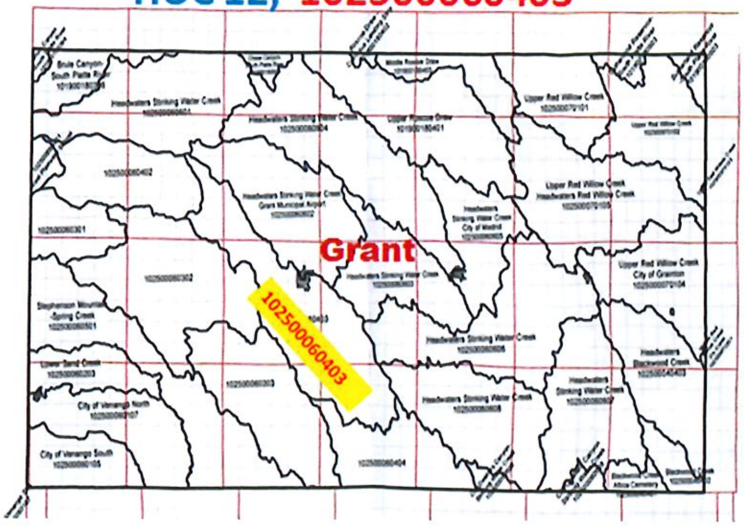
The Republican River is a HUC 1025 and has identified 17 HUC watersheds.



A HUC 12 (102500060403) is south of Grant and happens to cover an enclosed watershed where no runoff comes in or out. It covers about a township in size.

Perkins County

HUC 12, 102500060403



Starting with a HUC 12 watershed the research can be quantified to show how much precipitation comes in and what happens to the water.

Some of the uses occur as:

Evaporation	Transpiration (from vegetation)
Aquifer recharge.	Municipal use.
Livestock and human consumption	Aquatic life
Wildlife	Recreation

Since agriculture is among the biggest suppliers as well as consumers of water it is only logical that we concentrate on those uses.

Examples:

Perkins County consumptive water use estimates for 2007

12-Aug-17		Perkins County , NE						
Average Rainfall	**35.48**	**Inches**	**2007**					
Adams Lumber data								
		Inches	Inches		Growing Season			
CROP	ACRES	CONSUMPTION	DEPLETION	Acre/Inches	Growing Season	Precipitation		
Irrigated Corn (180 bu/ac)	118300	22.0	8.9	1,058,442	April - Sept.	30.1		
Irrigated Corn (200 bu/ac)	0	25.0	6.9	0	April - Sept.	30.1		
Irrigated Corn (220 bu/ac)	0	27.0	4.9	0	April - Sept.	30.1		
Irrigated Corn (240 bu/ac)	0	28.0	3.9	0	April - Sept.	30.1		
Ir. Sugar Beets ("x" ton/ac)	1100	32.7	-0.8	-845	April - Sept.	30.1		
Ir. Soybeans (50 bu/ac)	5100	23.0	8.9	45,553	May - Sept.	24.9		
Ir. Soybeans (60 bu/ac)	0	24.0	7.9	0	May - Sept.	24.9		
Ir. Soybeans (70 bu/ac)	0	25.8	6.1	0	May - Sept.	24.9		
Ir. Sorghum ("x" bu/ac)	0	23.0	8.9	0	May - Sept.	24.9		
Ir. Dry Edible Beans ("x" lbs/ac)	3300	22.0	9.9	32,778				
Ir. Potatoes ("x" tons/ac)	0	29.0	2.9	0				
Irrigated Alfalfa ("x" tons/ac)	1300	40.6	-8.7	-11,265				
Sunflowers ("x" lbs/ac)	2500	23.5	8.4	21,083				
Irrigated Wheat ("x" bu/ac)	16200	26.6	5.3	86,378	August - June	25.1		
Ir. Small Grains (other)	0	26.6	5.3	0				
Dryland Corn (100 bu/ac)	62600	17.8	14.1	883,735	April - Sept.	21.6		
Dryland Soybeans (45 bu/ac)	600	16.7	15.2	9,133	May - Sept.	20.8	Representative Equivalent	
Dryland Sorghum	200	17.6	14.3	2,866	April - Sept.	20.8	**7,821,568**	**A/inches**
Wheat/Corn/Soybean/Wheat	0	17.5	14.4	0			**651,797**	**A/feet**
Dryland Edible Beans	0	16.7	15.2	0	May - Sept.	20.8		
Dryland Alfalfa	500	19.2	12.7	6,366	March - Nov.	0.8		
Dryland Wheat	111200	15.1	16.9	1,877,854	August - June	25.1		
Summer Fallow Wheat	56155	9.4	22.5	1,241,988	August - June	25.1		
Summer Fallow Wheat/Corn	0	11.0	21.0	0		35.5		
Dryland Small Grains (Oats/Mille	0	19.0	12.9	0				
Conservation Reserve(CRP)	42379	21.1	10.8	459,049				
Other AG. Lands	993	16.6	15.3	15,225				
Range, Pasture, Grasses	92775	19.1	12.8	1,190,489	March - Oct.	32.0		
Riparian Forest & Woodlands	1669	19.1	12.8	21,417	March - Oct.	32.0		
Wetlands	136	57.0	-25.1	-3,409	Feb. - Oct.	32.0		
Open Water	0	48.0	-16.1	0	N/A			
Waste Land	1042	19.0	12.9	13,475				
Buildings & Building Sites	2470	16.6	15.3	37,870	N/A			
Urban Land & towns	0	19.7	12.2	0	N/A			
Rural Roads (Unsurfaced)	9150	19.0	12.9	118,328	N/A			
Totals	**561,002**			**7,821,568**				

Perkins County consumptive water use estimates for 2008

12-Aug-17		Perkins County NE					
Average Rainfall	18.77	Inches	2008				
Adams Lumber data							
CROP	ACRES	Inches CONSUMPTION	Inches DEPLETION	Acre/Inches	Growing Season	Growing Season Precipitation	
Irrigated Corn (180 bu/ac)	0	23.0	-6.1	0	April - Sept.	12.6	
Irrigated Corn (200 bu/ac)	104500	25.0	-8.1	-847,182	April - Sept.	12.6	
Irrigated Corn (220 bu/ac)(Silage)	500	27.0	-10.1	-5,054	April - Sept.	12.6	
Irrigated Corn (240 bu/ac)	0	28.0	-11.1	0	April - Sept.	12.6	
Irr. Sugar Beets ("x" ton/ac)	1900	32.7	-15.8	-30,033	April - Sept.	12.6	
Irr. Soybeans (50 bu/ac)	0	23.0	-6.1	0	May - Sept.	11.8	
Irr. Soybeans (60 bu/ac)	15600	24.0	-7.1	-110,889	May - Sept.	11.8	
Irr. Soybeans (70 bu/ac)	0	25.8	-8.9	0	May - Sept.	11.8	
Irr. Sorghum ("x" bu/ac)	200	23.0	-6.1	-1,221	May - Sept.	11.8	
Irr. Dry Edible Beans ("x" lbs/ac)	6900	22.0	-5.1	-35,238			
Irr. Potatoes ("x" tons/ac)	0	29.0	-12.1	0			
Irrigated Alfalfa ("x" tons/ac)	2500	40.6	-23.7	-59,265			
Sunflowers ("x" lbs/ac)	2900	23.5	-6.6	-19,160			
Irrigated Wheat ("x" bu/ac)	10800	28.6	-9.7	-104,836	August - June	14.4	
Irr. Small Grains (other)	0	28.6	-9.7	0			
Dryland Corn (100 bu/ac)	49700	17.8	-0.9	-45,078	April - Sept.	12.6	
Dryland Soybeans (45 bu/ac)	800	16.7	0.2	154	May - Sept.	24.9	Representative Equivalent Ne
Dryland Sorghum	0	17.6	-0.7	0	April - Sept.	24.9	-1,129,851 A/inches
Wheat/Corn/Soybean/Wheat	0	17.5	-0.6	0			-94,154 A/feet
Dryland Edible Beans	0	9.4	7.5	0	May - Sept.	11.8	
Dryland Alfalfa	500	19.2	-2.3	-1,154	March - Nov.	25.5	
Dryland Wheat	94400	19.2	-2.3	-217,781	August - June	14.4	
Summer Fallow	107582	9.8	7.1	762,937	August - June	14.4	
Summer Fallow Wheat/Corn	0	12.3	4.6	0			
Dryland Small Grains (Oats/Millet	0	18.0	-1.1	0			
Conservation Reserve(CRP)	41574	21.1	-4.2	-174,602			
Other AG. Lands (hay)	11200	16.6	0.3	3,282			
Range, Pasture, Grasses	87584	19.1	-2.2	-193,254	March - Oct.	22.0	
Riparian Forest & Woodlands	0	19.1	-2.2	0	March - Oct.	22.0	
Wetlands	186	57.0	-40.1	-7,460	Feb. - Oct.	22.6	
Open Water	0	45.0	-28.1	0	N/A		
Waste Land	4741	19.0	-2.1	-9,989			
Buildings & Building Sites	2453	16.6	0.3	728	N/A		
Urban Land & towns	5402	19.7	-2.8	-15,163	N/A		
Rural Roads (Unsurfaced)	9165	19.0	-2.1	-19,311	N/A		
Totals	561,077			(1,129,851)			

Precipitation varies so much from one year to the next that makes comprehensive water management a challenge.

Satellite imagery can also help to identify consumption in real time and then use the data to help to better manage our resources to maximize the benefits.

Understanding and encouraging residue management as a tool to reduce evaporation and increase soil recharge is a win-win opportunity.

Changing cropping systems to reduce consumptive water use including shorter season corn may reduce usage.

Summary

If we are going to solve the challenges before us, steps need to be taken to balance the water availability with the demand. Today our demand exceeds what is available, so we have to find the most beneficial uses of our water without destroying our economic and environmental base.

Water Balance as a Watershed Management Tool

Just as the better you understand a subject, the better you are likely able to explain it, the better you understand a situation, the better you are likely able to manage it. Water balance is a tool that helps us better understand the water situation. It can help us understand, within a specific area such as a watershed, where all the water comes from and how much there is as well as where it all goes. This type of inventory is critical when it comes to deciding what we can and want to do with the water and where its best value may lie.

Water budget, as an engineering tool, has been taught for years as a specific set of steps to systematically assess a reservoir site or other water supply project and determine firm yield. The only difference, and the thing that is unusual with this approach from a conventional water budget application, is generally the balance application and the fact that water budget has seldom been used for this purpose.

Since the water supply is not uniform and static another important feature of a water budget, as a tool, is that it can be adapted to assess any scale and time frame appropriate to the management needs. Not only can it assess the full extent of the record but also the duration, magnitude and frequency of any recurring cycles which helps quantify the extent of risk and opportunity available in a given situation.

When this information is known it can help determine the need for and extent of storage possible and necessary to meet the expected demands. Only after you fully understand and quantify the water supply and expected and agreed to demand can you then start to identify where; how much and what type of storage is necessary and appropriate to address supply variability and meet the water needs and firm yield requirements.

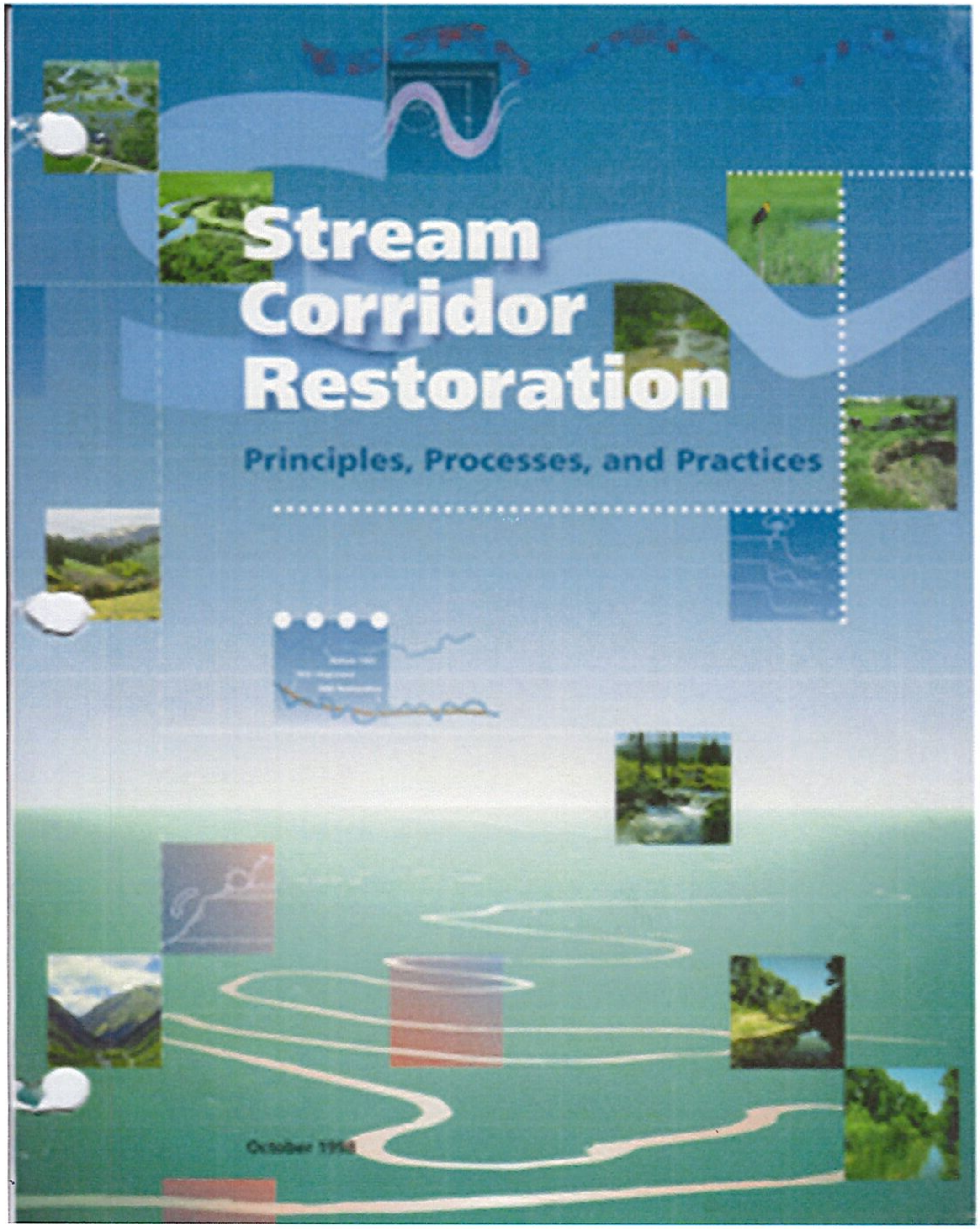
Although we have already developed some surface water storage, because of various reasons it is not likely to be expanded much more. Therefore, identification and development of the best and most effective ground water utilization will be critical with ground water storage management the most possible and adequate in scale.

There really is no other tool that has systematically, on a watershed basis, address these expectations. Water balance is a tool, not a silver bullet, that when applied with appropriate knowledge and judgment can be extremely efficient at optimizing water management at scale. The opportunity for water budget application has recently been significantly improved with the availability of both remote and direct ET estimating and measurement.

In the past, without these resources and the ability for consistent implementation of this type of tool in a comprehensive manner, most water management amounted to simply attempting to react to what nature provided without systematic quantification. This understanding, essentially a "Tragedy of the Commons" outcome, can help explain why, after almost 150 years of water management effort, Nebraska still has periods of water supply excess, water demand shortage and water conflicts.

All systems operate within specific physical limits that are generally a given and must be observed. Other possible constraints to addressing water management issues are financial and social or political but with the abundance of necessary data and effective tools we now have available, financial concerns should not be a real constraint to watershed management.

The extent of water development can be financially constrained but the assessment itself should not be. With a water budget tool, we have all the resources necessary to manage water in Nebraska to the degree we need to be extremely effective. This generally leaves only political and possibly statutory conditions as limits and if these remain as obstacles, then the problem is self-imposed.



The manual is available at NRCS offices or it can be ordered on line from a number of vendors