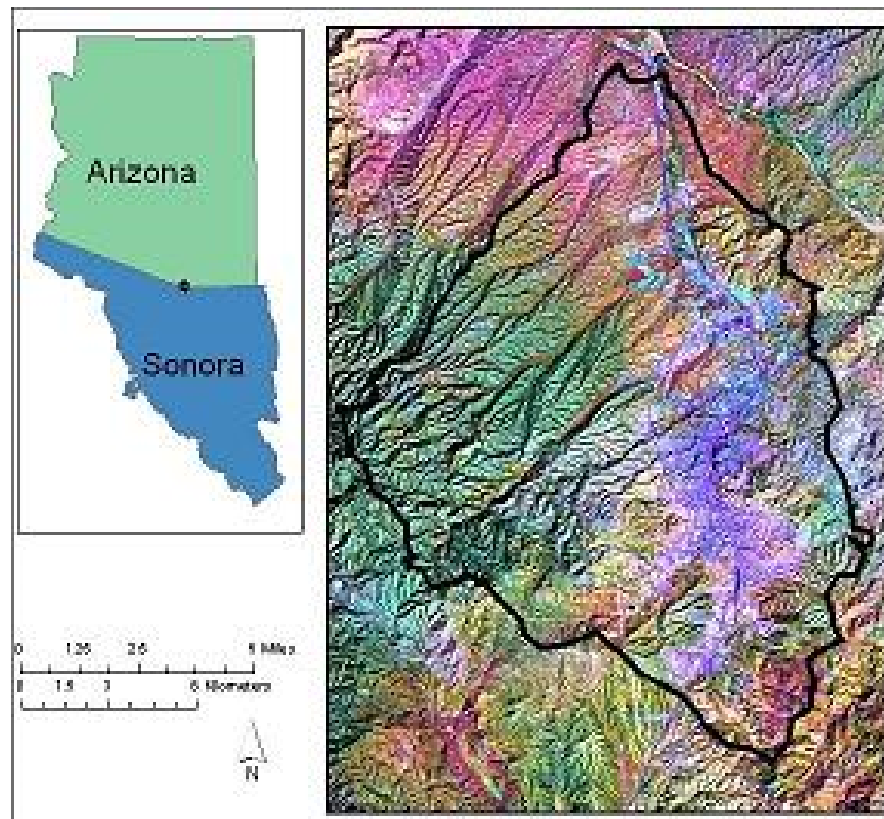


Modeling Storm Water at Ambos Nogales



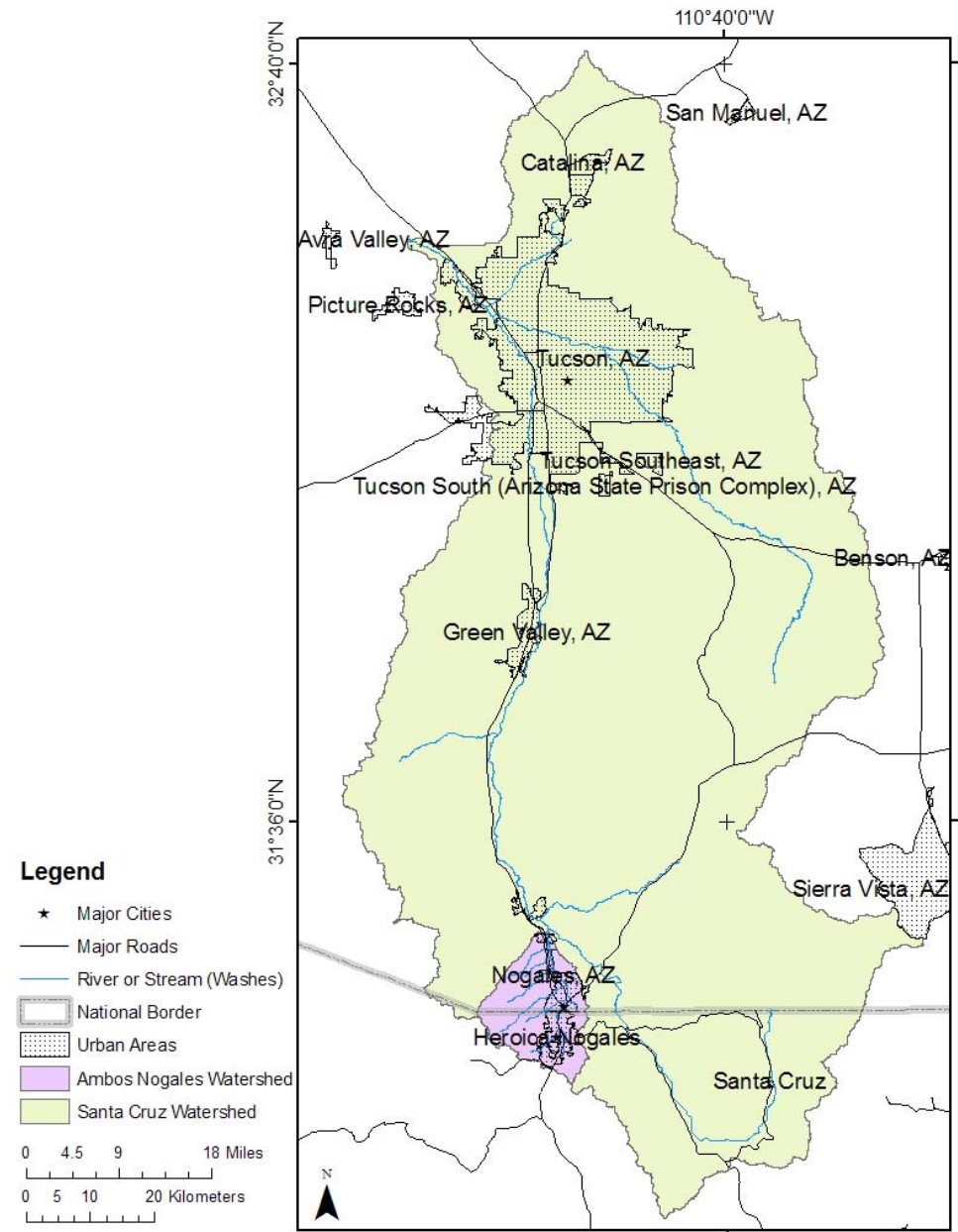
Laura M. Norman, PhD
Western Geographic Science Center
520 N. Park Avenue, Suite #102K
Tucson, AZ 85719-5035
Phone: (520) 670-5510;
lnorman@usgs.gov



Presented at the U.S. Stakeholder Meeting in Nogales to Discuss Storm Water Infrastructure
April 28, 2016

Ambos Nogales

- The Ambos Nogales watershed covers 235 square kilometers with just under half its area in Mexico.
- The Nogales Wash is a nested tributary within the Santa Cruz Watershed drainage basin.
- The watershed as a whole is considered a potential source of contamination to the Nogales Wash and Santa Cruz River.



Issues

Lack of appropriate
(i.) urban planning,
(ii.) communication, &
(iii.) stormwater control
threatens quality of life,
livelihoods, and lives!



Photos of Ambos Nogales, 2008 (top), and 1908 (bottom) illustrating urban development (Alberto Suarez Barnett private collection, <http://www.municipiodenogales.org/>)

Issues

Normal rainfall has the potential of realizing *abnormal* runoff that augments:

- I. loss of life and property through flooding
- II. soil loss and watershed-capacity for revegetation
- III. nonpoint-source pollution of shared drainages, (sediment, solid waste)
- IV. inflow and infiltration (I&I) into shared sewers
 - a. scour of sewer lines, shortening design life and return on investment
 - b. lost sewer-conveyance capacity
 - c. sanitary sewer *overflows* (SSOs) containing microbial/industrial contaminants
 - d. operational challenges for wastewater treatment plants
- V. wear and tear on upstream infrastructure:
 - a. roads and sewer lines flooded, clogged, destroyed, washed downstream
- VI. wear-and-tear on downstream infrastructure:
 - a. concrete debris threatens sewer lines crossing the wash
 - b. erosion of concrete lining and natural banks of the Nogales Wash
 - c. ... and by association, the International Outfall Interceptor (IOI)

This puts public health and the environment at risk.

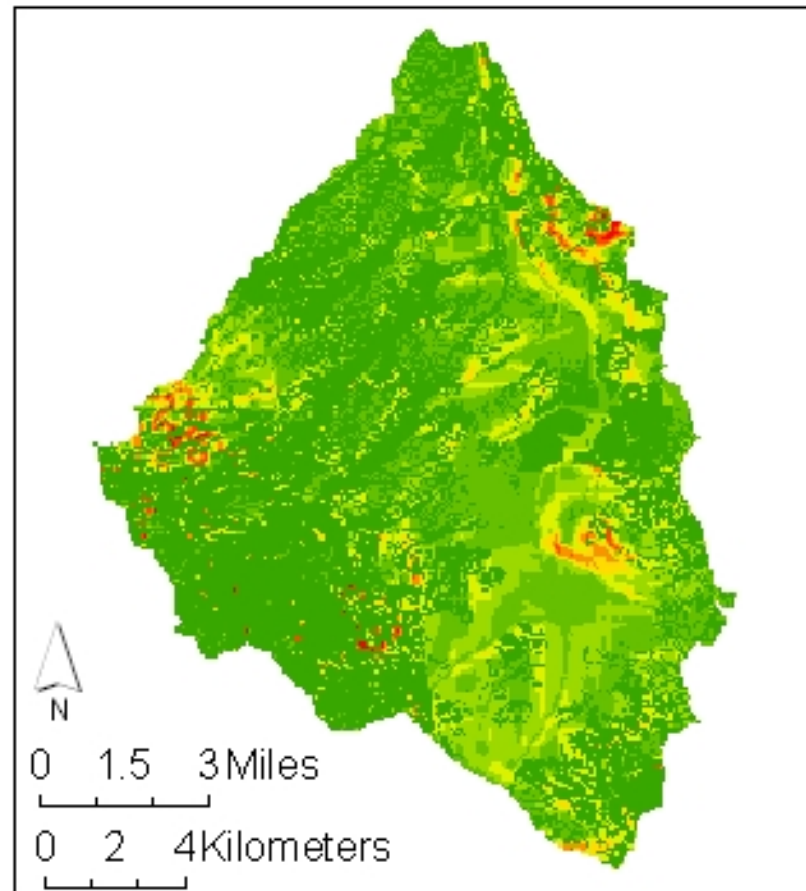
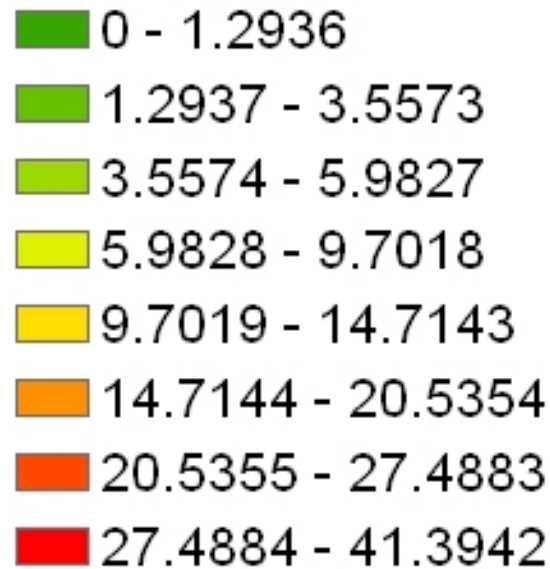
Sources of Sediment

Annual Soil Loss Map for the *Ambos Nogales* watershed (t/a/y).

The estimated potential soil loss due to erosion is 64,149 tons per year

Legend

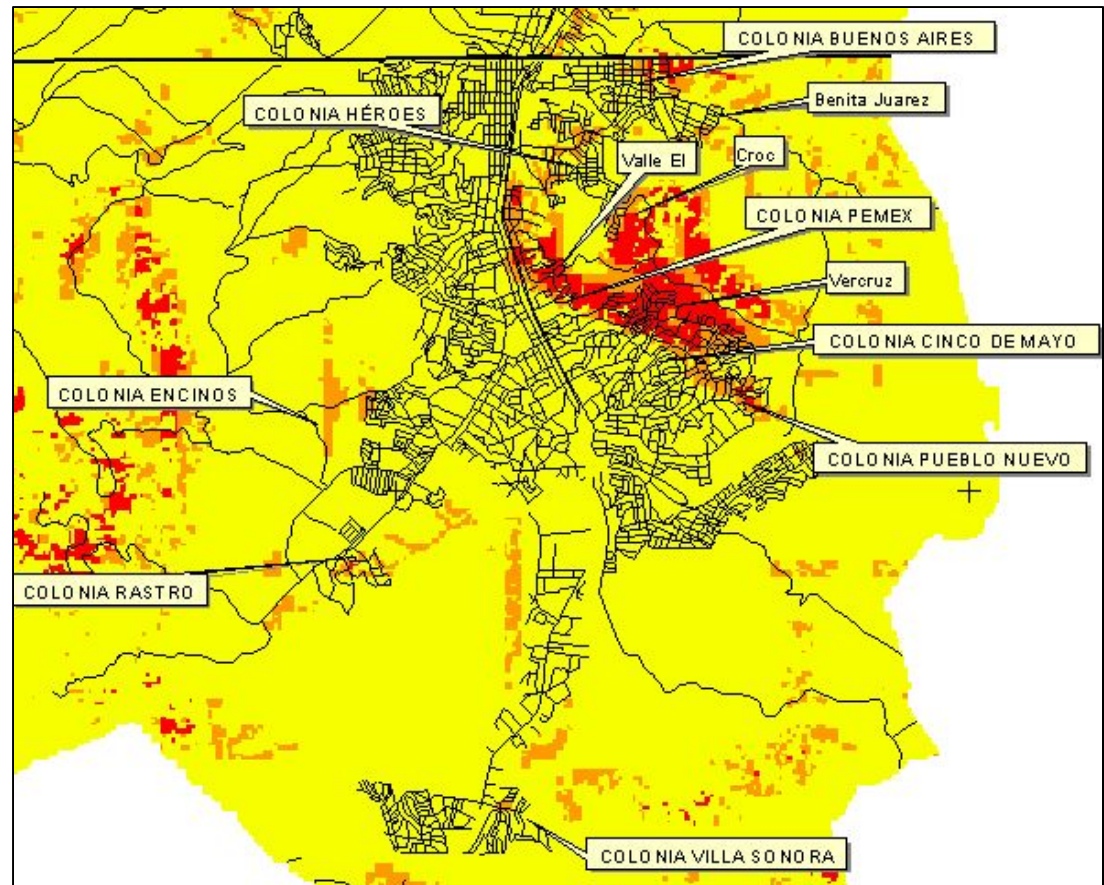
Annual Soil Loss



Norman, L. M. (2007). **United States-Mexican border watershed assessment: Modeling nonpoint source pollution in Ambos Nogales.** *Journal of Borderlands Studies*, 22(1), 79–97. <http://doi.org/10.1080/08865655.2007.9695670>

Sources of Sediment

- High-risk or “Hot-Spot” Areas
- The soil losses from east-central Nogales, Sonora, are more critical than other areas

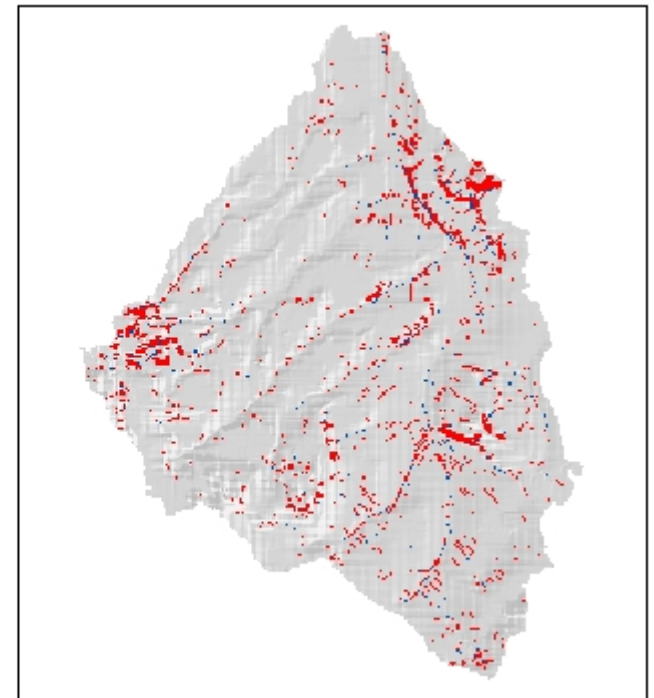
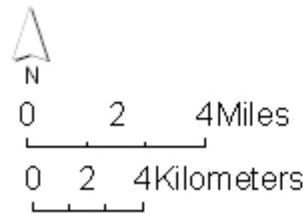


Sinks of Sediment

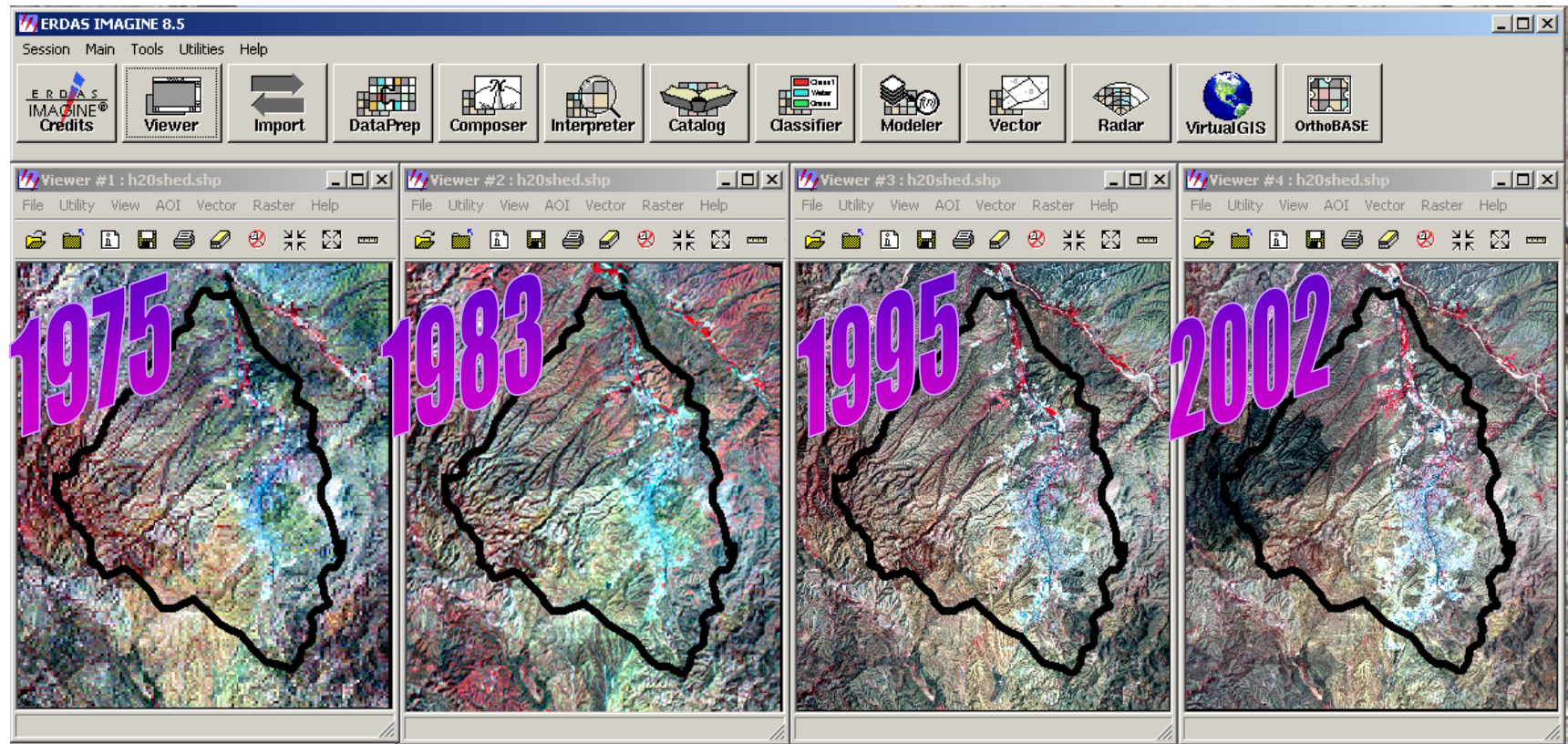
- SEDMOD calculates an SDR to be used in determining the amount of eroded material that would be available for transport and deposition along hillslopes and streams (Fraser 1999).
- This is multiplied by the results of the USLE to derive:
 - Annual sediment delivery to streams was estimated at 2,955 tons.
 - The annual proportion of pollutants expected to actually reach the watershed outlet is estimated at 609 tons.

Legend

- High Source Areas
- High Sink Areas



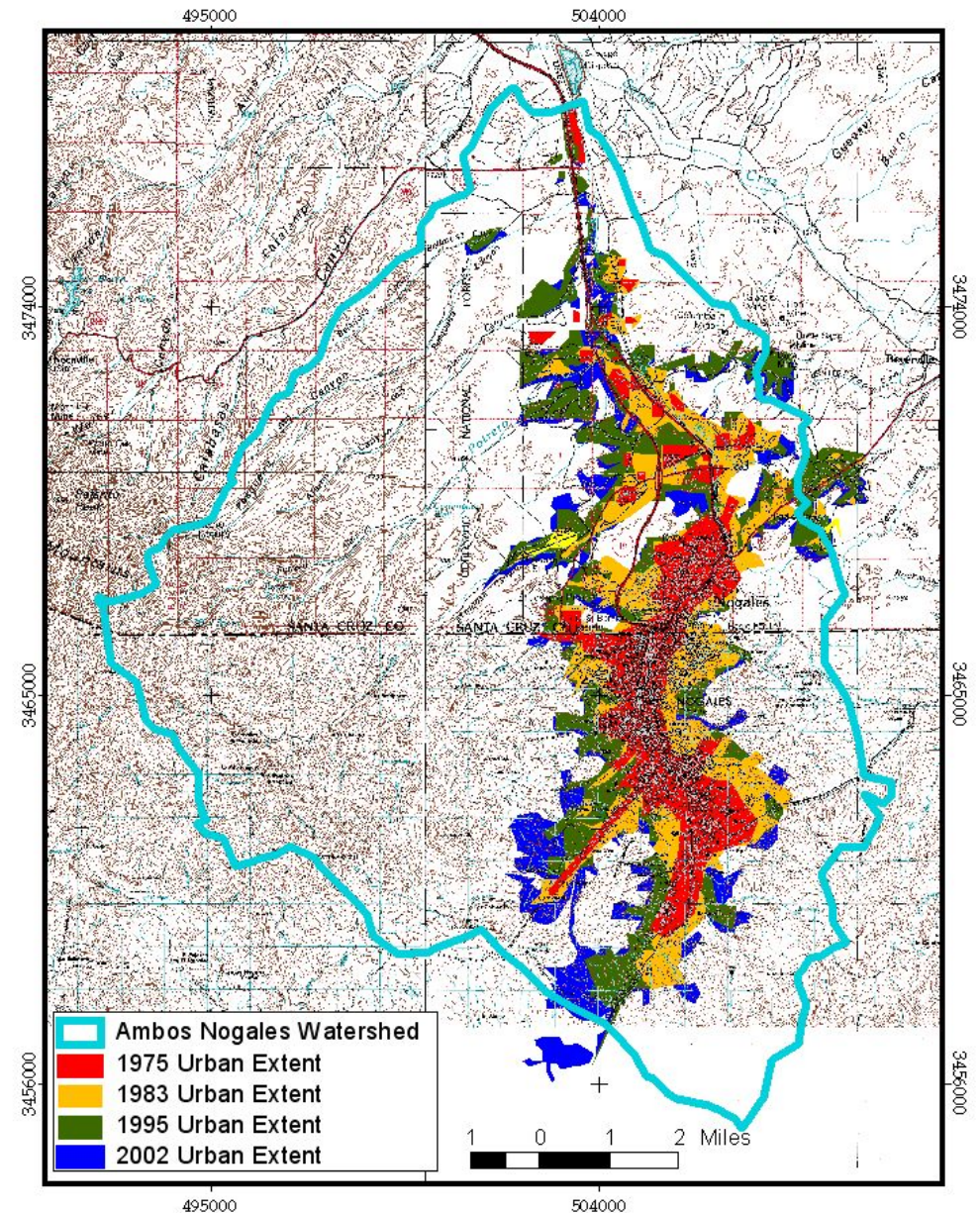
Urban Growth



Norman, L. M., Feller, M., & Phillip Guertin, D. (2009). **Forecasting urban growth across the United States–Mexico border.** *Computers, Environment and Urban Systems*, 33(2), 150–159. <http://doi.org/10.1016/j.compenvurbsys.2008.10.003>

Urban Growth

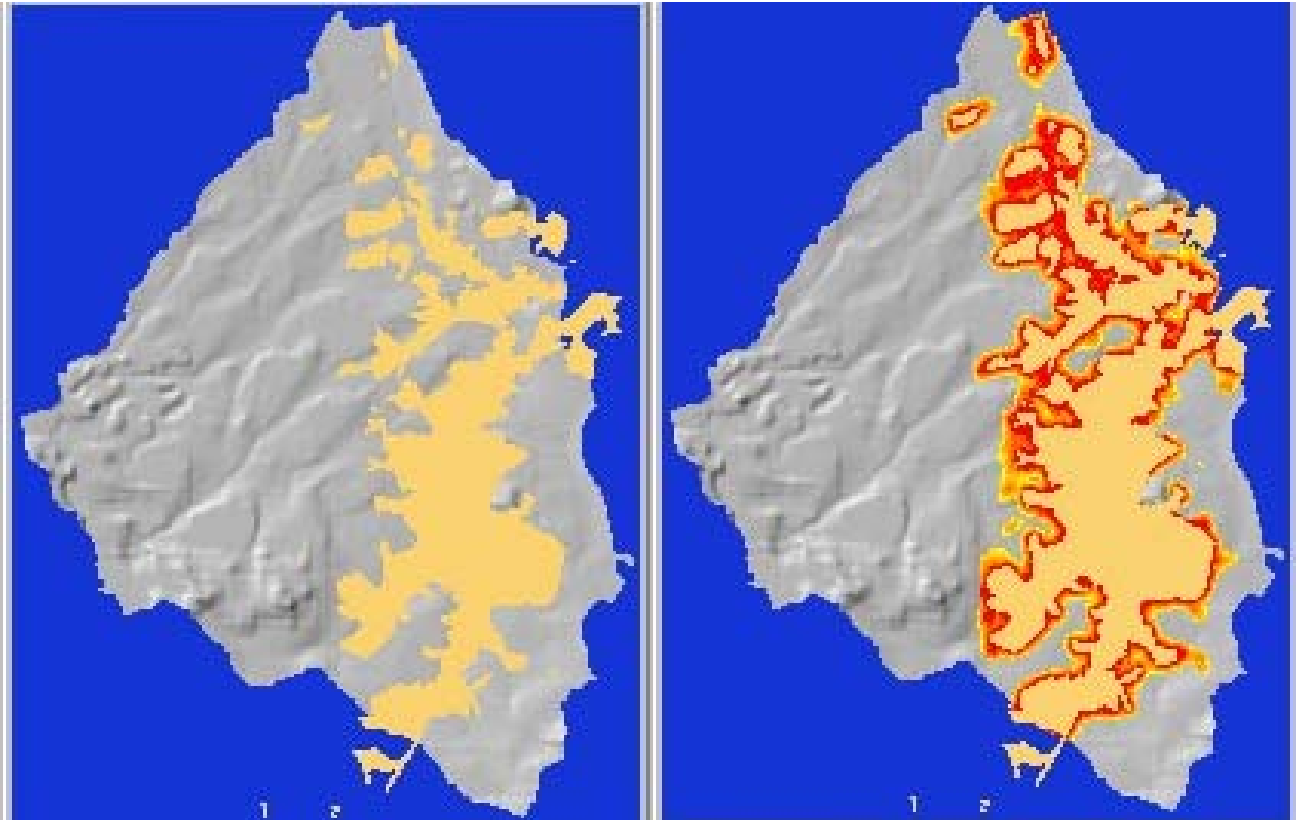
- A cellular automaton model
- Urban growth can be predicted on the basis of a variety of growth rules, the pattern of urban cells, and the interaction of urban cells and their surroundings (Clarke and Gaydos, 1998; USGS, 2003)
- Urban area classifications for this watershed were used as input to the SLEUTH (Slope, Landuse, Excluded, Urban, Transportation, Hillshade) urban growth model to predict land use changes to the year 2030.



SLEUTH Urban Growth Model

Predicted 27-Years Growth to 2030

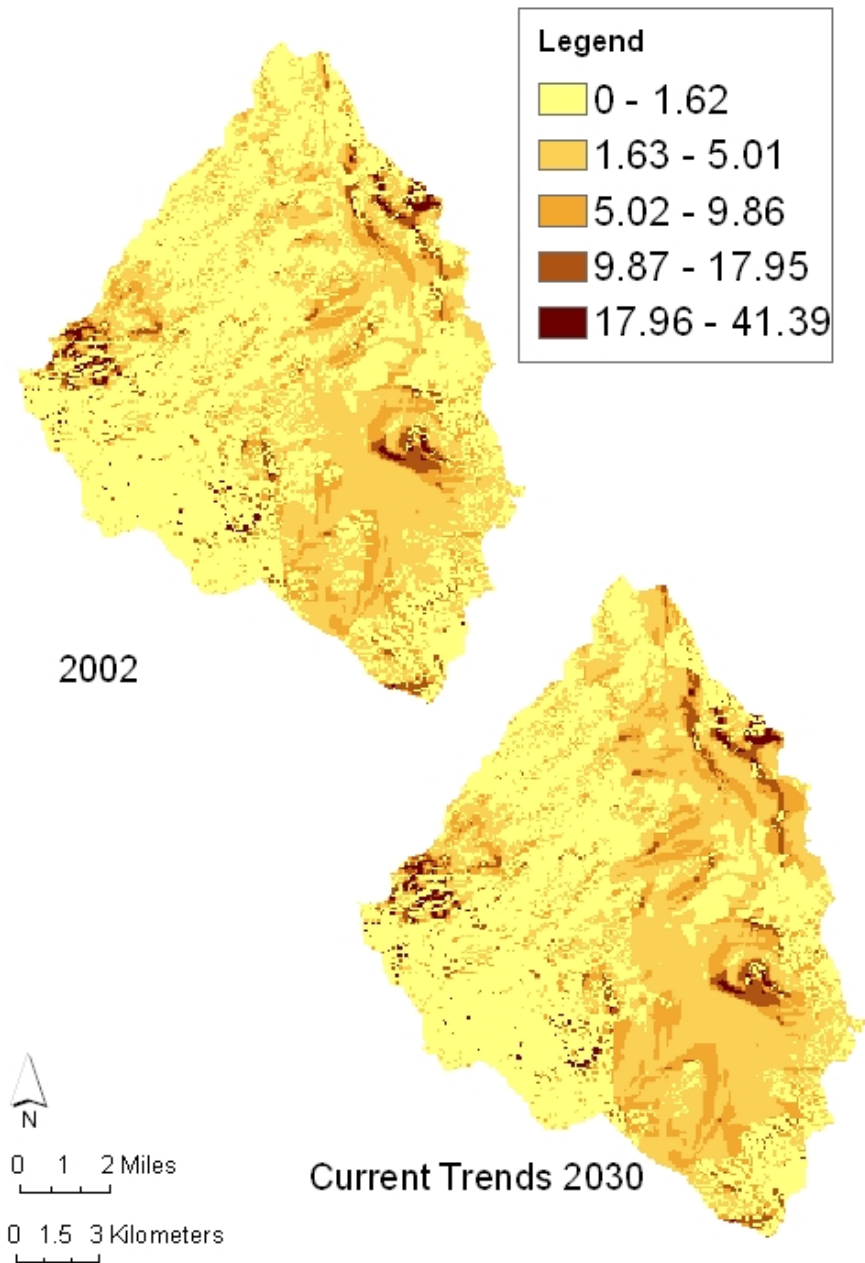
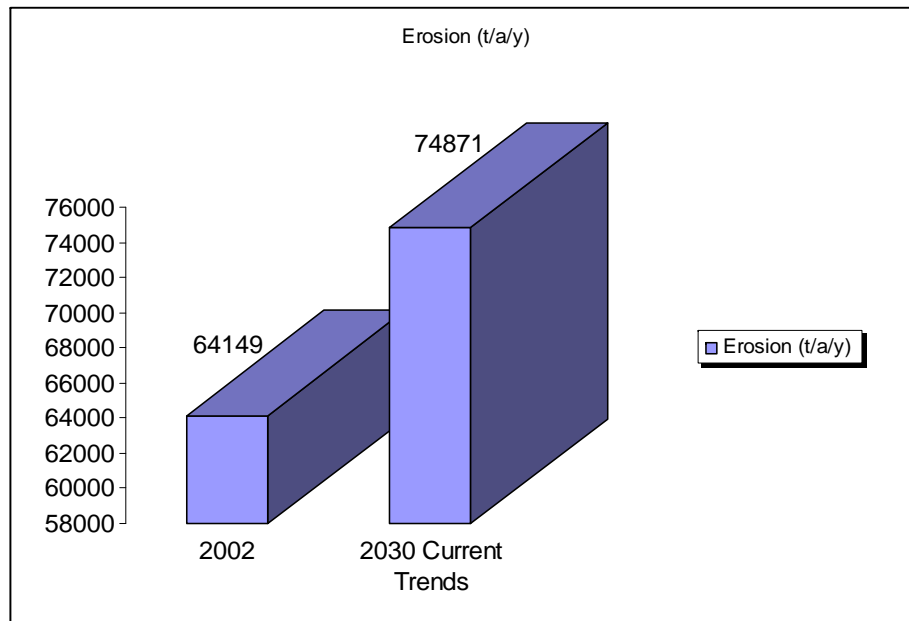
Probability Range	Color
0- 50%	Black
50- 60%	Yellow
60- 70%	Light Yellow
70- 80%	Orange
80- 90%	Dark Orange
90- 95%	Red-Orange
95- 100%	Red



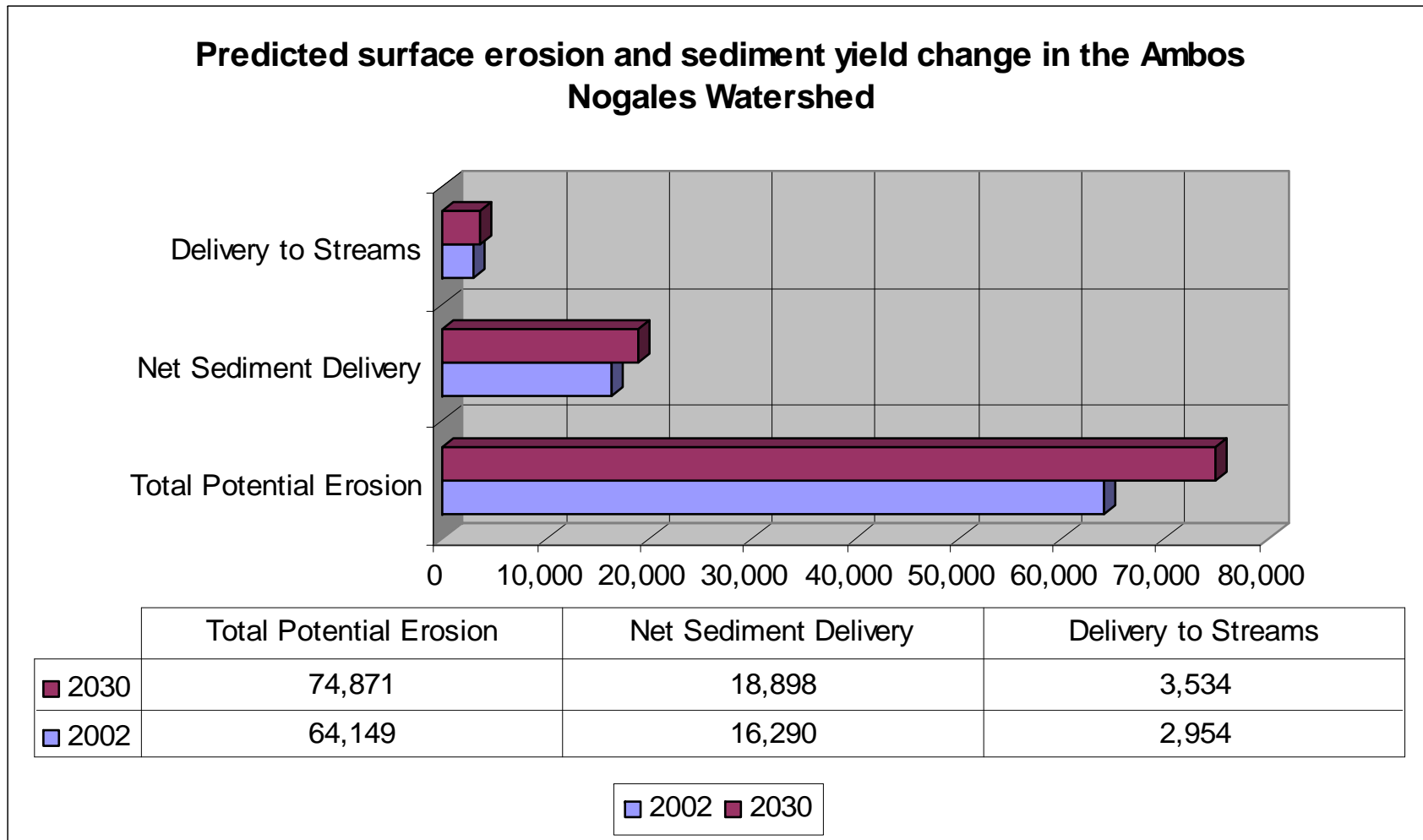
Norman, L. M., Feller, M., & Phillip Guertin, D. (2009). **Forecasting urban growth across the United States–Mexico border.** *Computers, Environment and Urban Systems*, 33(2), 150–159. <http://doi.org/10.1016/j.compenurbsys.2008.10.003>

Erosion Model + Urban Growth

- Predicted urban development will *increase* erosion potential.



Urban Growth + Erosion = More Sediment Yield



Norman, L., Guertin, D., & Feller, M. (2008). **A Coupled Model Approach to Reduce Nonpoint-Source Pollution Resulting from Predicted Urban Growth: A Case Study in the *Ambos Nogales* Watershed.** *Urban Geography*, 29(5), 496–516. <http://doi.org/10.2747/0272-3638.29.5.496>

Alternative Futures...

- Despite the negative environmental impacts due to urban growth predictions, the population in this watershed is expected to continue to grow.
- Sustainable development is an option we can consider to accommodate the influx of humans while preserving natural resources and quality of life.
- Scenarios were developed to embrace this and identify areas of land suitable for development as well as simulate erosion-control measures...

Sustainable Development

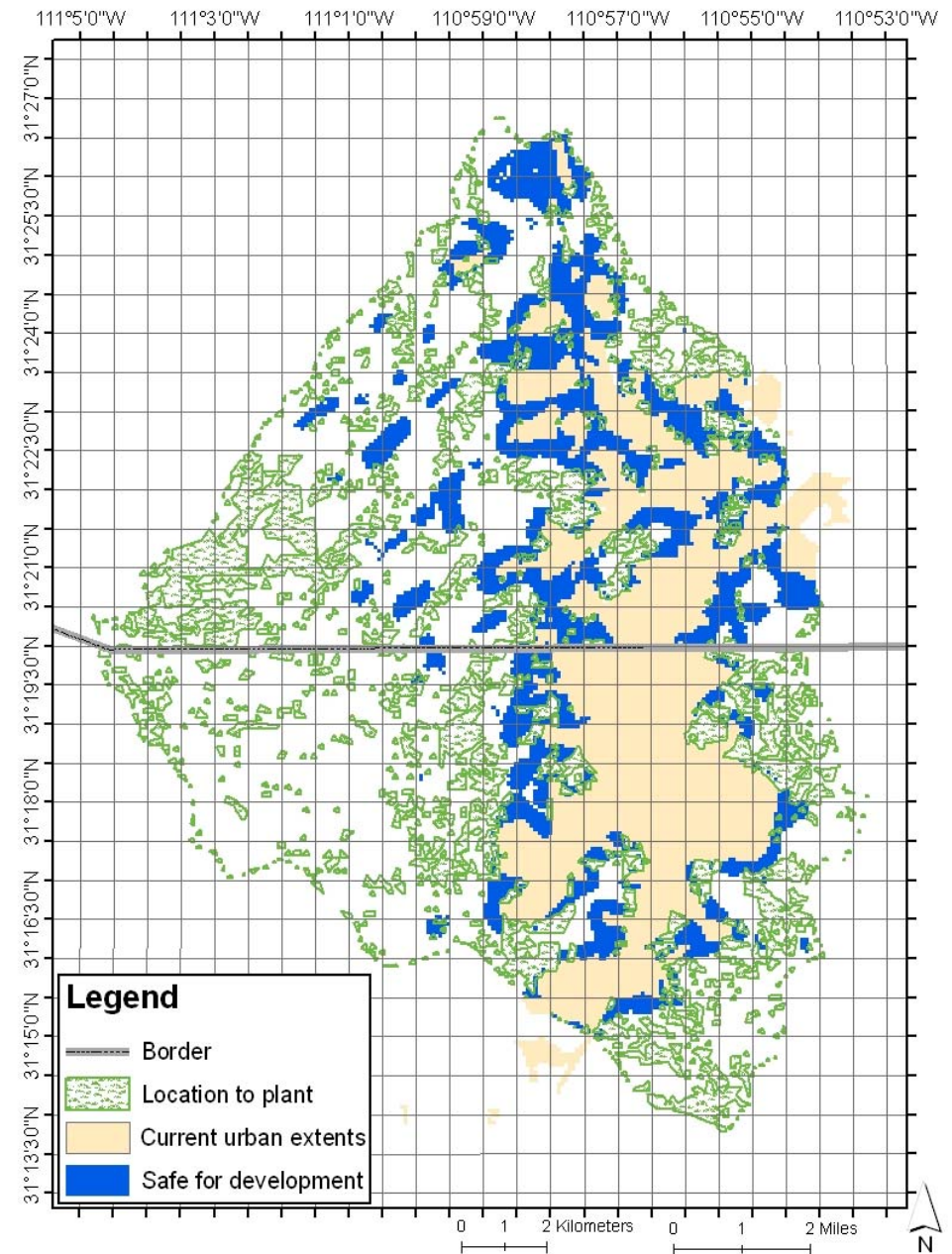
If Urban development occurs in sustainable development zone areas.

→ **And** “Hot-spot” areas get excluded from growth and are planted with native grasses to reach at least an 80% cover of the surface

→ **Then**, the erosion will *decrease* in 2030 11,123 t/y from 2002!!



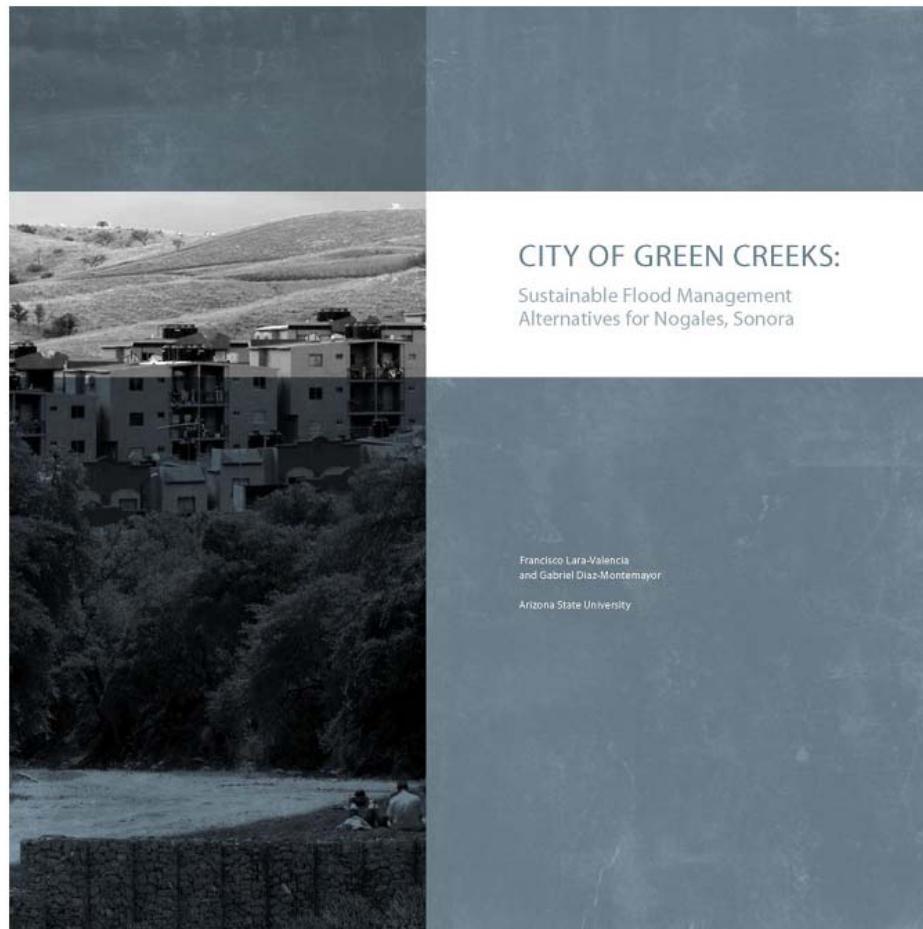
- Using models USLE, SEDMOD, and SLEUTH developed approach for sustainable urban development increases air & water quality in the future:
 - plant native grasses in areas identified as high-risk “hot spots”
 - promote development in low-risk zones



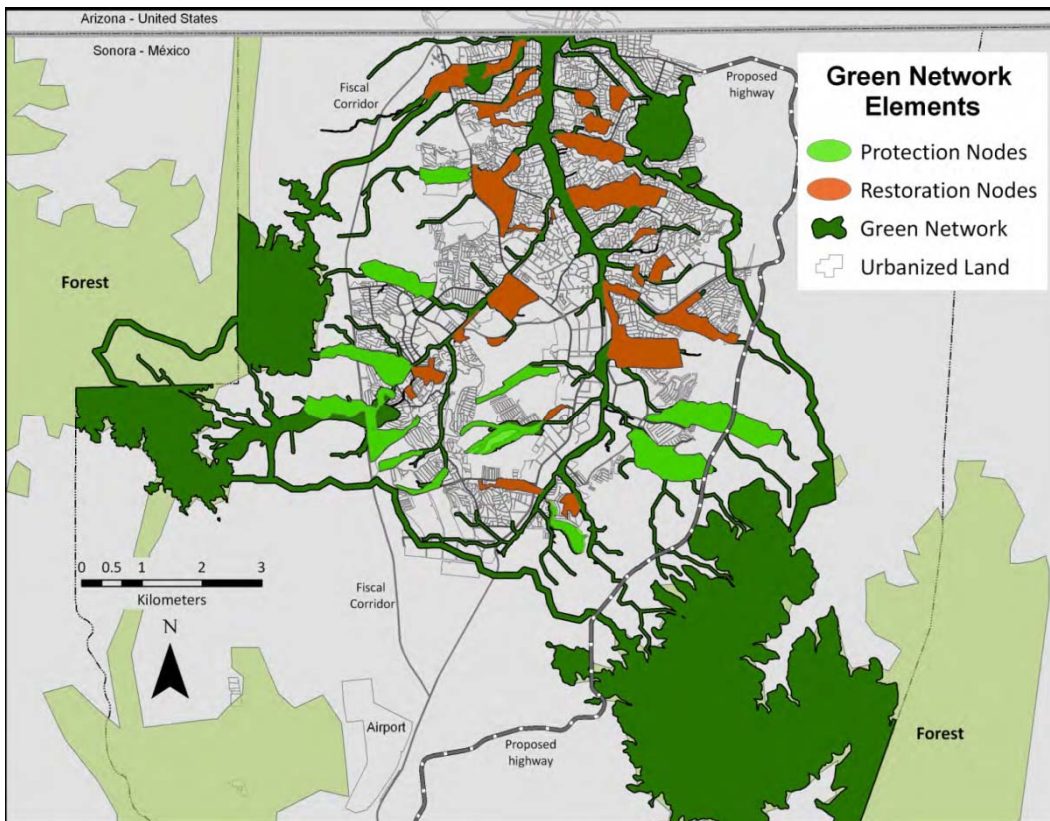
Norman, L. M. (2005). *Modeling land use change and associate water quality impacts in the Ambos Nogales watershed, United States-Mexico border*. THE UNIVERSITY OF ARIZONA. Retrieved from <http://phdtree.org/pdf/25545994-modeling-land-use-change-and-associate-water-quality-impacts-in-the-ambos-nogales-watershed-united-states-mexico-border/>

City of Green Creeks

USGS contracted by Arizona State University (Dr. Francisco Lara-Valencia) to help with EPA Border 2012 grant to assist City of Nogales, Sonora with first “City Plan” ...



City of Green Creeks



Proposes the creation of a network of 35 potential locations for a city-wide green network.

Green infrastructure strategies provide the city with environmentally responsible planning and design alternatives that can

- i. reduce runoff volume,
- ii. protect water resources,
- iii. preserve riparian habitats, and
- iv. offer the additional community benefit of creating more interesting places to live, work, and play!

Example: Colosio Green Corridor

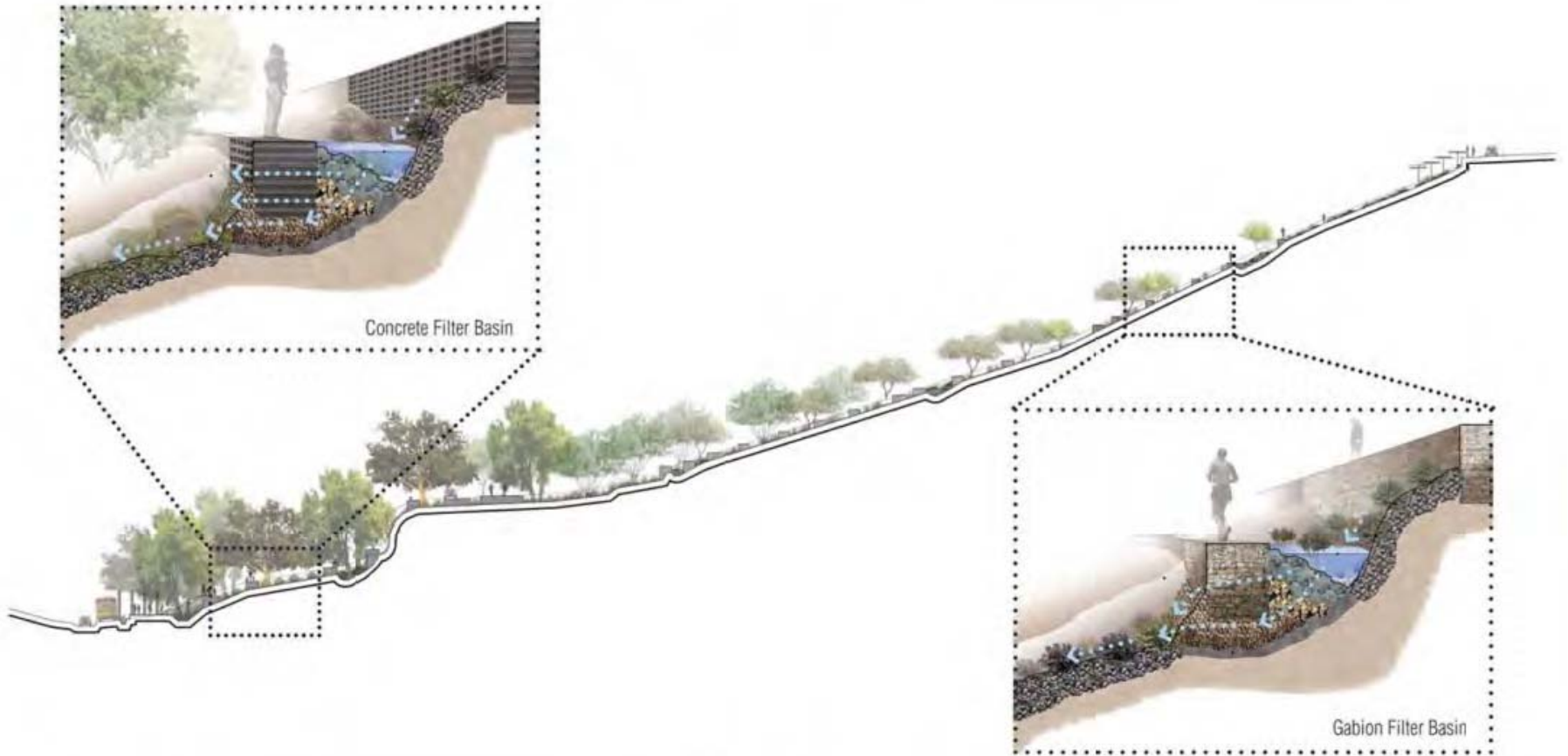
The hillside has been occupied by low-income, self-produced housing lacking the most basic services, like water, sewers, and open space.



Water Dependent Plants

Vegetation Gradient Diagram

Xeric Plants



High Density Small Scale

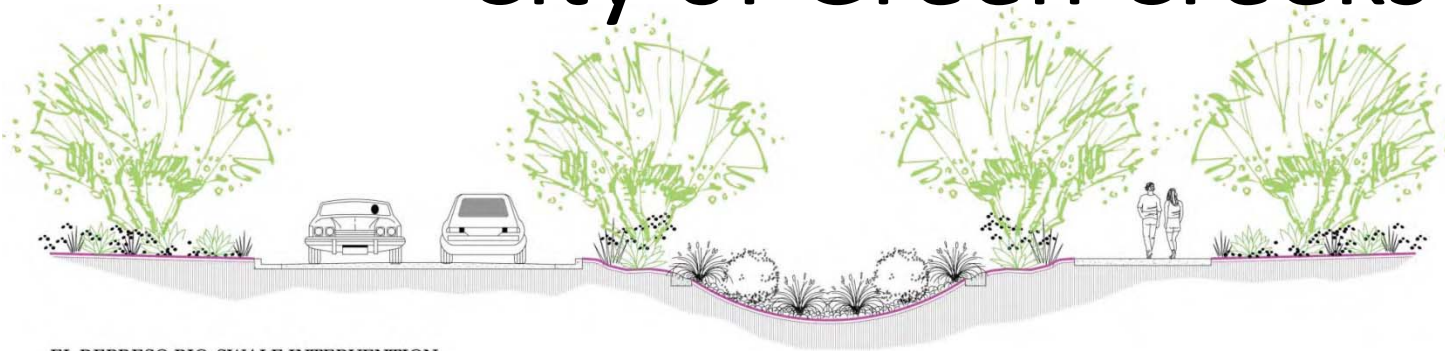
Filtration Gradient Diagram

Low Density Large Scale



Site Section

City of Green Creeks



EL REPRESO BIO-SWALE INTERVENTION

N.T.S.

4A Nogales

EL DIARIO DE SONORA
SÁBADO 4 de Diciembre de 2010

PRESENTAN PROYECTO

Ciudad de Cañadas Verdes

NOGALES

» Un manual elaborado por investigadores sobre cómo mejorar la ciudad fue entregado ayer

FORTUNATO LEAL
fleon@diariodsonora.com.mx

El alcalde José Ángel Hernández Barajas recibió ayer de manos de investigadores de la Universidad del Estado de Arizona el manual denominado Ciudad de Cañadas Verdes: Alternativas para el manejo sustentable de inundaciones en Nogales, Sonora.

El Alcalde agradeció dicho manual y se comprometió a aterrizar el mayor número posible de los proyectos que esto enmarca, incluso señaló que hay noticias de recursos para aplicarse en algunas zonas que incluye este trabajo de investigación.

El manual es la compilación de investigaciones de campo, conjugadas con tecnología aplicada en otras ciudades del mundo y México, y que es factible para Nogales.

El doctor Francisco Lara, de la Universidad Estatal de Arizona, mencionó que el proyecto se realizó gracias al patrocinio de la Semarmat y la Agencia de Protección Ambiental (EPA por sus siglas en inglés).

Dijo que los apoyos bajaron a través de la Comisión de Cooperación Ecológica Fronteriza (COCEF), mediante el programa Frontera 2012.

"Este es un proyecto no sólo para tener una ciudad bonita, sino algo más entero, completo, donde se reconozca la importancia de la ecología y el medio ambiente, donde se promuevan acciones que eleven la calidad de vida de la población y que se resuelvan problemas crónicos como las inundaciones", expresó Francisco Lara.

Agregó que hay nuevas ideas y enfoques en el campo de la planeación urbana, que pueden ser-

vir para atacar simultáneamente diversos problemas y es lo que trataron de hacer con esta idea de una ciudad de cañadas verdes.

"Lo que estamos haciendo es pensar en acciones que puedan iniciarse tanto por el sector público, como el social y que sirvan para resolver problemas de inundación, que se creen espacios públicos abiertos y restablezca las funciones ecológicas básicas", señaló.

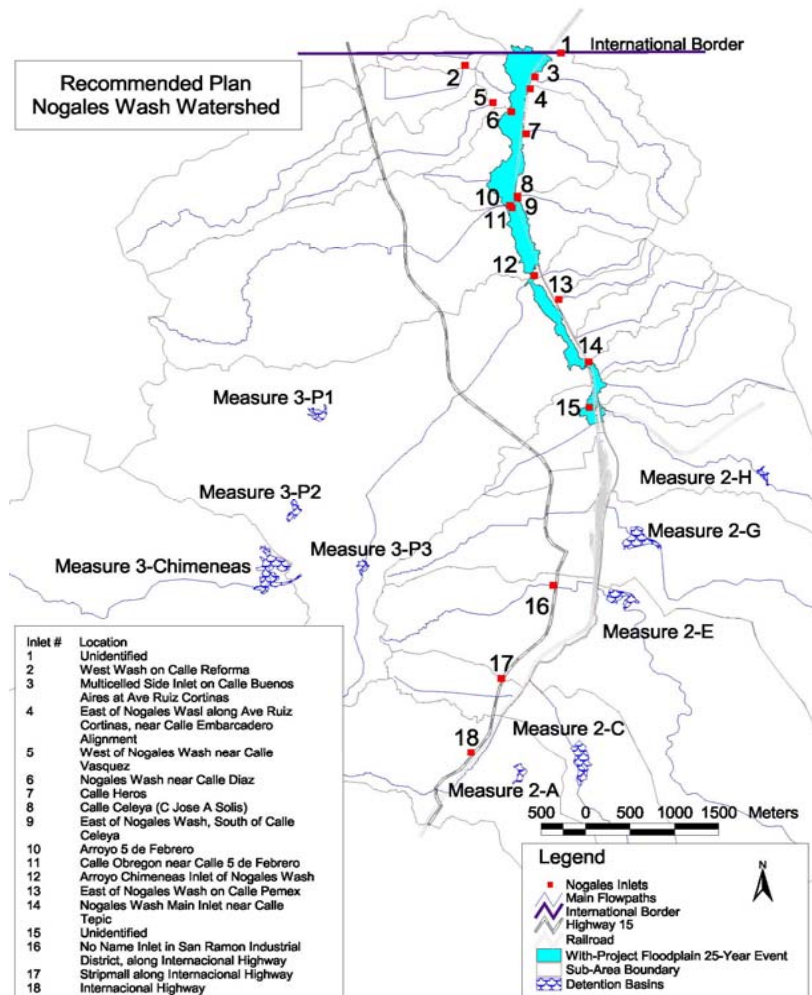
Mencionó el investigador de la Universidad Estatal de Arizona, que en esto participaron estudiantes, así como el Instituto Municipal de Investigación y Planeación (IMIP) que encabeza Claudia Gil Anaya.



El Alcalde recibió de manos de investigadores de la Universidad del Estado de Arizona el manual que propone una serie de obras.

Lara-Valencia, Francisco and Díaz-Montemayor, Gabriel, 2010, City of Green creeks: sustainable flood management alternatives for Nogales, Sonora http://virtual.cocef.org/Final_Reports_B2012/20044/20044_Final_Report_EN.pdf

“Ambos Nogales Special Flood Damage Reduction Study - Nogales, Sonora Mexico” (January, 2005)

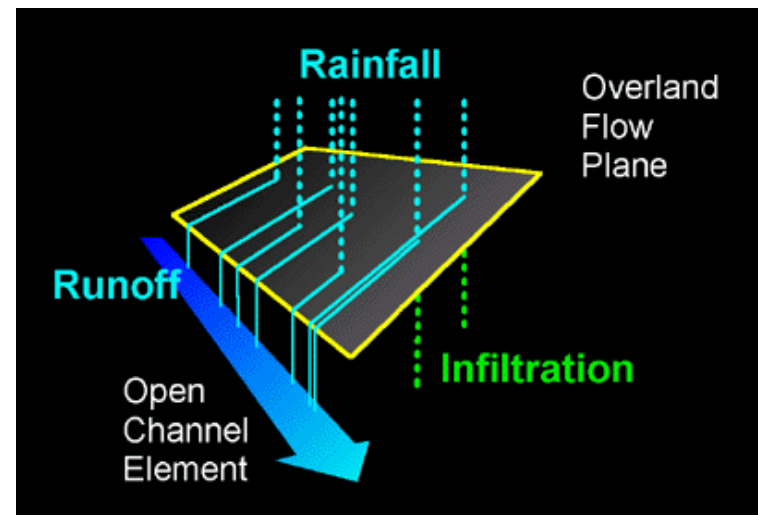


IBWC & ACE hired Tetra Tech to develop *recommendations*:

- Flood proofing structures
- Relocation of structures and infrastructure
- Flood warning
- Floodplain management
- Channel modification/enlargement
- Stormwater inlet improvements
- Stormwater detention

Rainfall-runoff Model

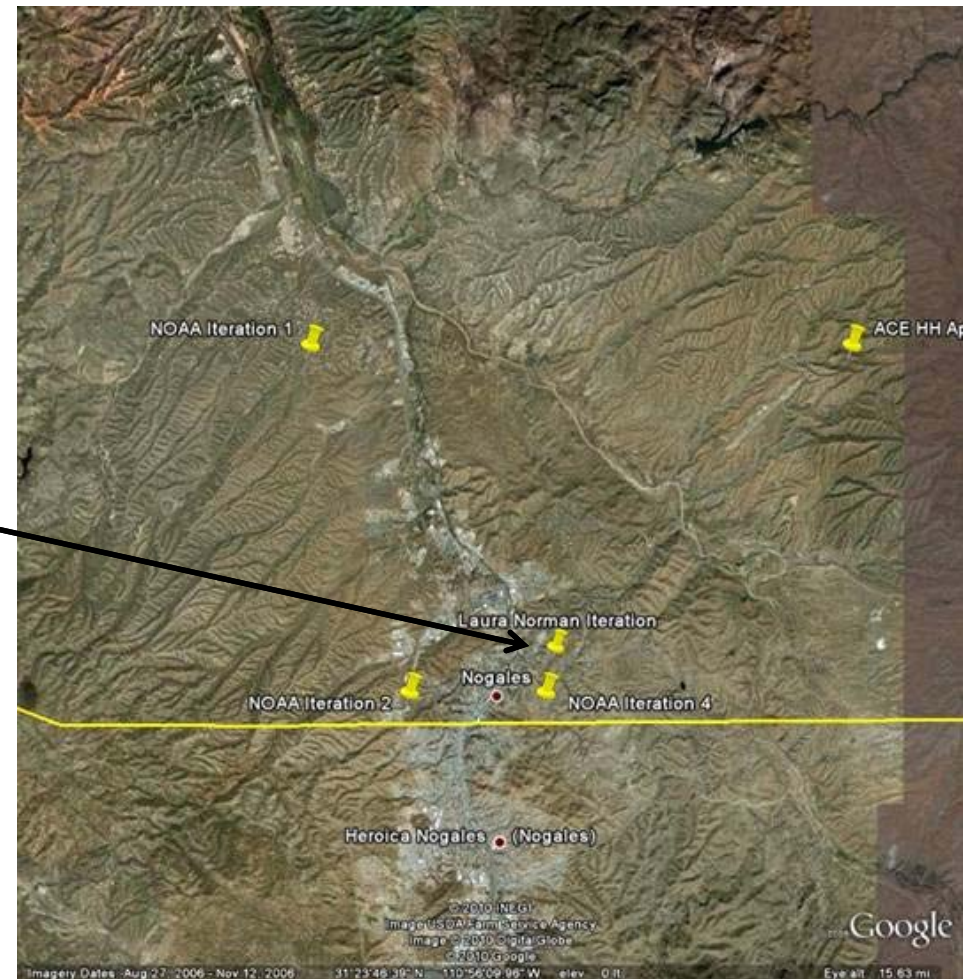
- USGS, USDA-ARS, & UA used the Kinematic Runoff and Erosion Model (KINEROS2) to identify flood-prone areas in 2009.



“AGWA is designed to evaluate relative change and can only provide qualitative estimates of runoff and erosion. It cannot provide reliable quantitative estimates of runoff and erosion without careful calibration. It is also subject to the assumptions and limitations of its component models, and should always be applied with these in mind.”

A “Perfect Storm”

- Variations of homogeneous design storms were dictated by the NOAA Atlas 14 for Arizona.
- Precipitation depth (inches) was extracted at site: Nogales, Arizona (02-5921): Latitude 31.35N and Longitude 110.9167W (3907 ft) and fit into the model.
- Rainfall events include:
 - a 10-year 1-h (1.82 in.)
 - a 25-year 6-h (2.93 in.)
 - a 100-year 6-h (3.76 in.)



Generate scenarios of varying climatic events

- Extreme hydrologic events are described as having an 'X'-year recurrence interval
- In order to simulate potential precipitation events, values from the NOAA 14 Atlas for Nogales, Arizona were modeled.

Recurrence intervals and probabilities of occurrences		
Recurrence interval, in years	Probability of occurrence in any given year	Percent chance of occurrence in any given year
100	1 in 100	1
50	1 in 50	2
25	1 in 25	4
10	1 in 10	10
5	1 in 5	20
2	1 in 2	50

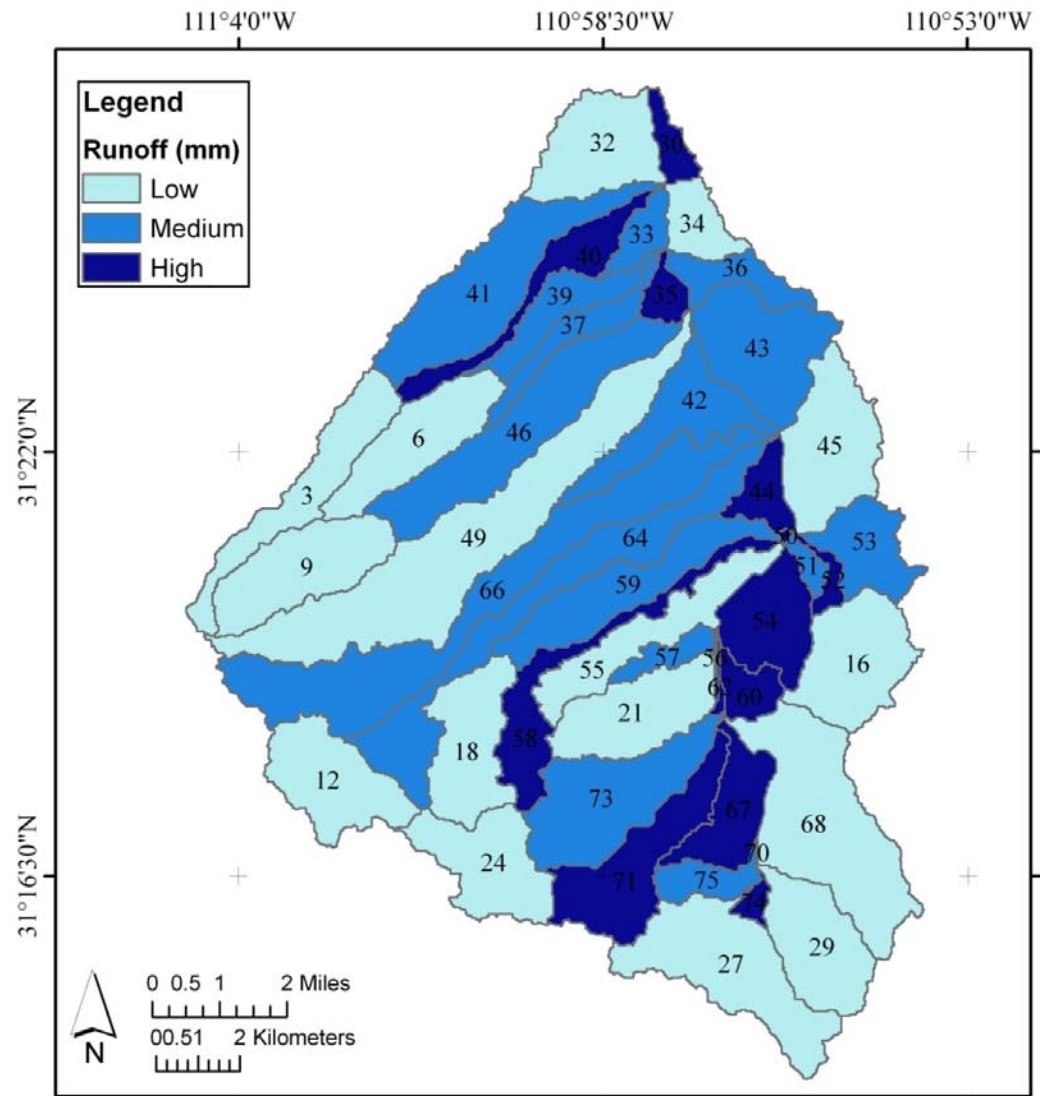
ARI* (years)	<u>5</u> min	<u>10</u> min	<u>15</u> min	<u>30</u> min	<u>60</u> min	<u>120</u> min	<u>3 hr</u>	<u>6 hr</u>	<u>12</u> hr	<u>24</u> hr	<u>48</u> hr	<u>4</u> day	<u>7</u> day	<u>10</u> day	<u>20</u> day	<u>30</u> day	<u>45</u> day	<u>60</u> day
1	0.30	0.45	0.56	0.76	0.94	1.11	1.16	1.32	1.52	1.70	1.92	2.26	2.73	3.19	4.45	5.55	6.85	7.99
2	0.38	0.58	0.72	0.97	1.20	1.41	1.45	1.65	1.91	2.12	2.38	2.82	3.40	3.97	5.56	6.92	8.52	9.94
5	0.49	0.75	0.93	1.26	1.56	1.80	1.84	2.08	2.37	2.63	2.94	3.49	4.23	4.90	6.81	8.41	10.24	11.90
10	0.58	0.88	1.09	1.47	1.82	2.11	2.15	2.43	2.76	3.04	3.40	4.04	4.89	5.64	7.75	9.49	11.47	13.30
25	0.69	1.05	1.31	1.76	2.18	2.53	2.59	2.93	3.30	3.59	4.05	4.83	5.80	6.62	8.96	10.85	12.97	14.98
50	0.78	1.18	1.47	1.97	2.44	2.87	2.94	3.33	3.73	4.01	4.55	5.45	6.51	7.36	9.85	11.82	14.02	16.13
100	0.86	1.31	1.62	2.19	2.71	3.21	3.30	3.76	4.18	4.45	5.08	6.11	7.25	8.12	10.72	12.75	15.00	17.21
200	0.95	1.44	1.79	2.40	2.98	3.55	3.67	4.20	4.65	4.88	5.63	6.79	8.00	8.88	11.57	13.63	15.92	18.20
500	1.06	1.61	2.00	2.69	3.33	4.02	4.18	4.81	5.29	5.47	6.38	7.74	9.02	9.89	12.64	14.73	17.01	19.38
1000	1.14	1.74	2.16	2.90	3.59	4.39	4.59	5.31	5.81	5.93	6.97	8.49	9.83	10.65	13.42	15.49	17.76	20.18

- ⦿ **Caveat:** When rainfall data are collected at a point within a stream basin, it is unlikely that this same amount of rainfall occurred uniformly throughout the entire basin.

Rainfall-runoff Model

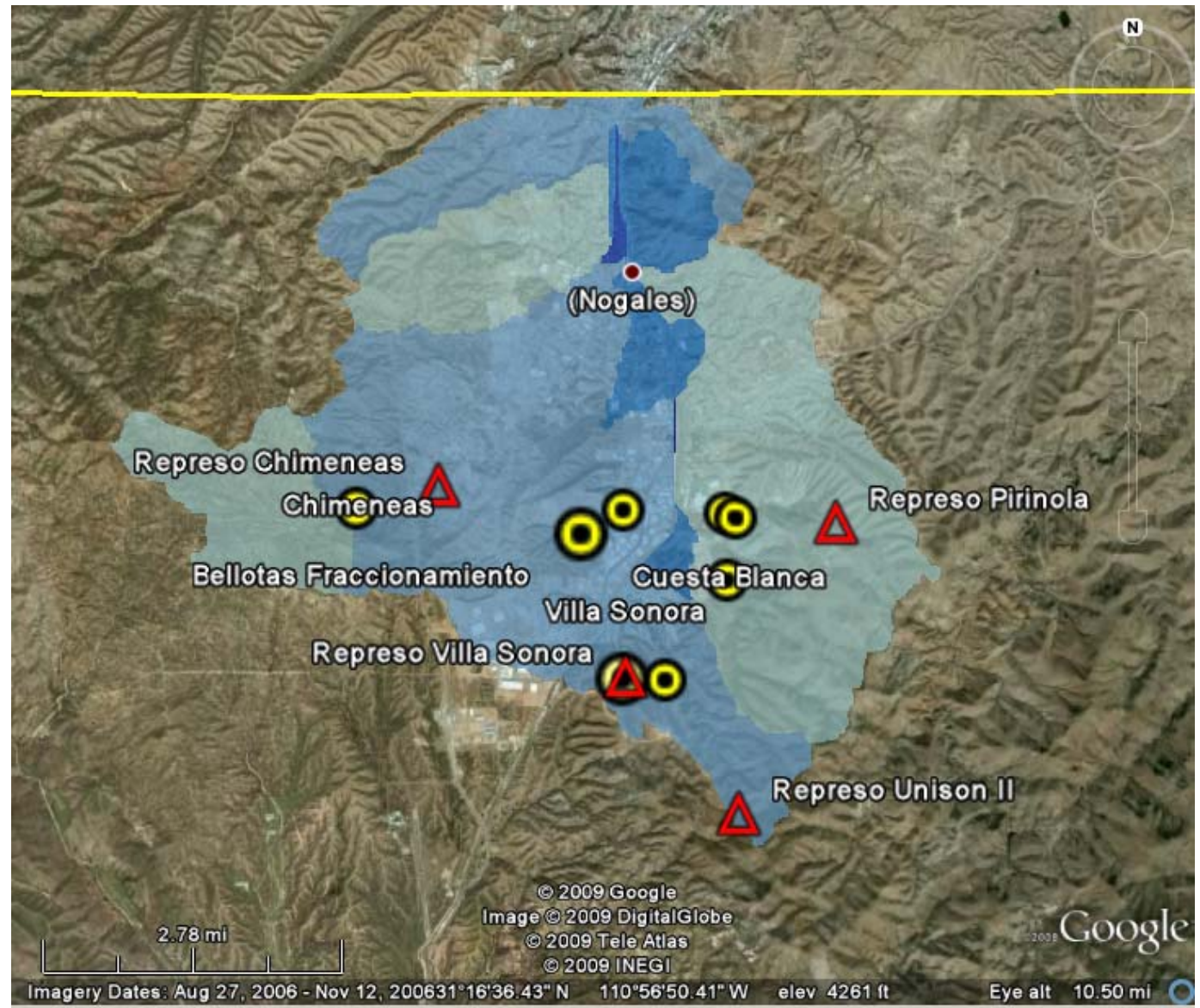
- Locations for potential human intervention can be located by using quantiles to classify runoff into 3 classes of risk.

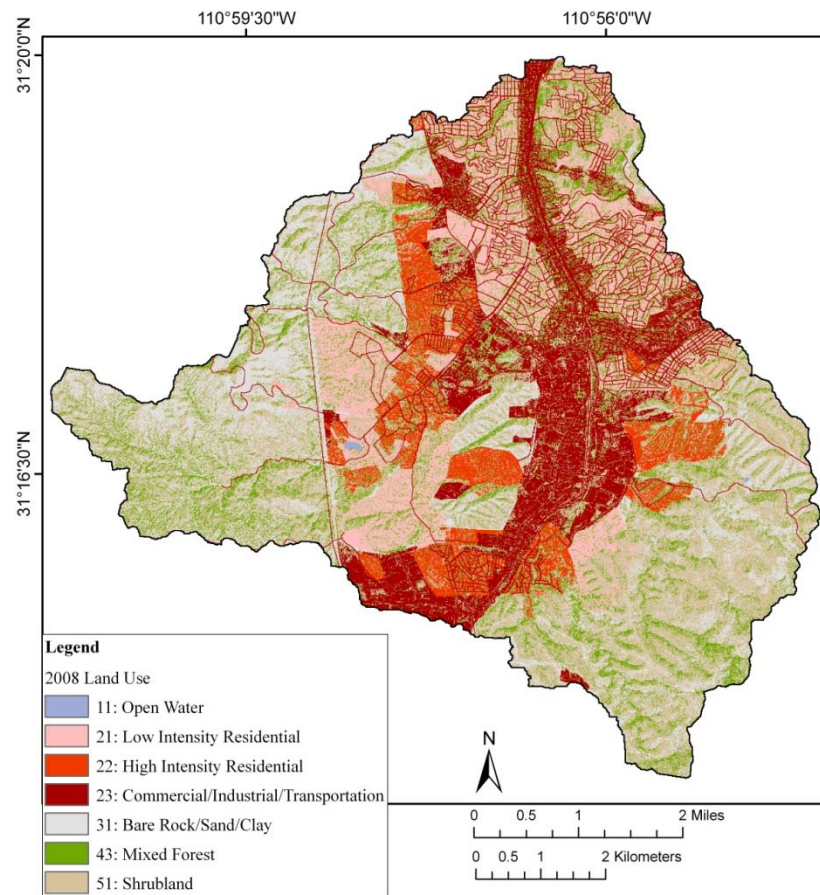
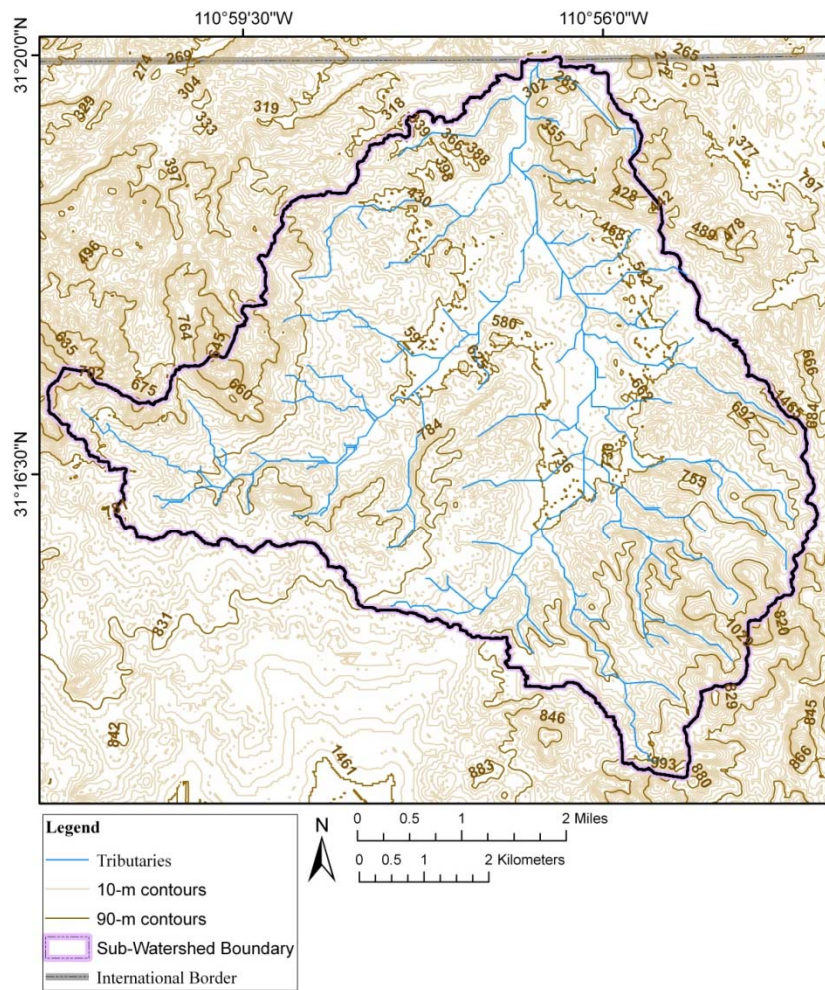
Ambos Nogales watershed runoff (mm) classified into three categories of runoff to identify areas of high, medium, and low risk.



IBWC-funded Research

- Model impacts of Detention Features:
 - including those identified as new construction by the City of Nogales, Sonora (8 shown)
 - and those to be rehabilitated by CONAGUA (4 shown)

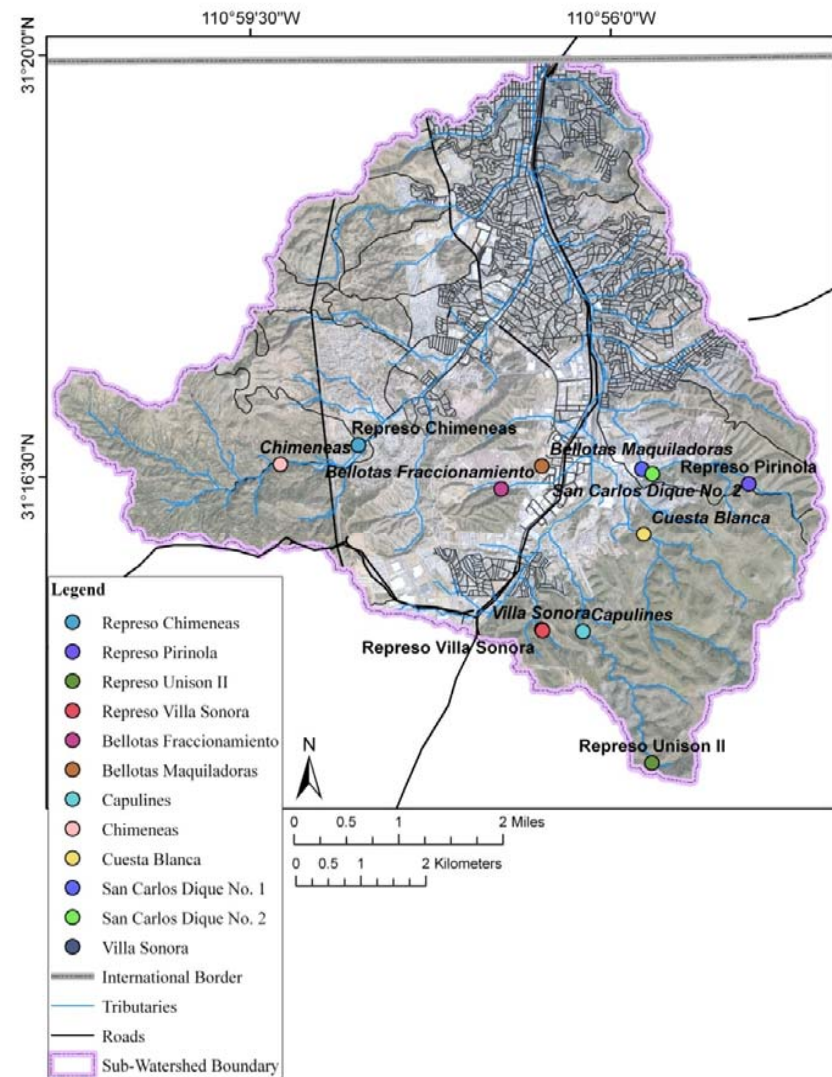


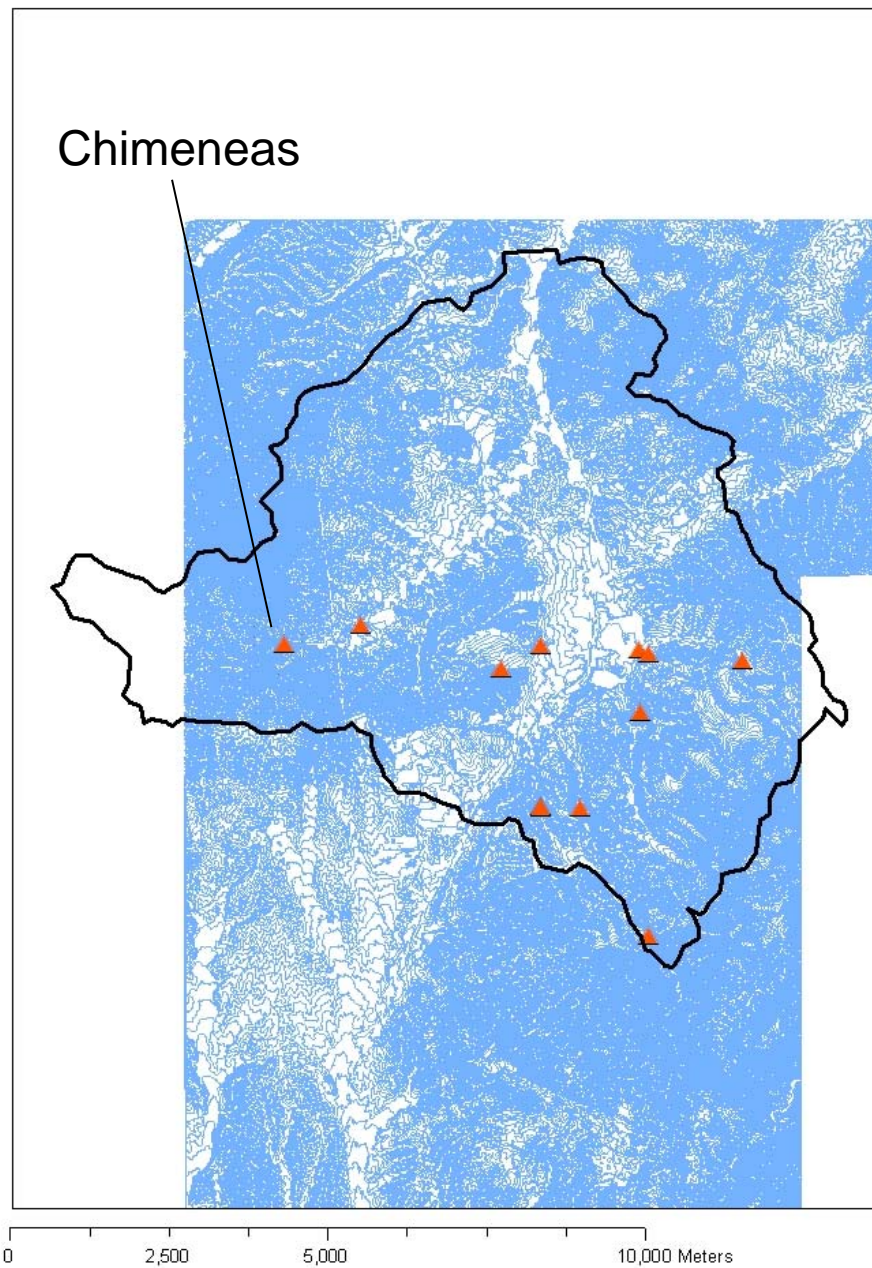


Norman, L.M., Villarreal, M.L., Wallace, C.S.A., Gil Anaya, C.Z., Diaz Arcos, Israel and Gray, Floyd, 2010, **A high-resolution land-use map; Nogales, Sonora, Mexico**: U.S. Geological Survey Open-File Report 2010-1156, 21 p. [<http://pubs.usgs.gov/of/2010/1156/>].

Embankment dams identified for modeling

- Rock Gabion Dams constructed by City:
 - Capulines
 - Cuesta Blanca
 - Bellotas Fraccionamiento
 - Bellotas Maquiladoras
 - Chimeneas
 - Villa Sonora
- Earthen dams rehabilitated by CONAGUA:
 - Represo Chimeneas
 - Represo Villa Sonora
 - Represo Pirinola
 - Represo Unison II
- Earthen dams constructed by the City:
 - San Carlos Dique 1
 - San Carlos Dique 2





Chimeneas

0 2,500 5,000 10,000 Meters

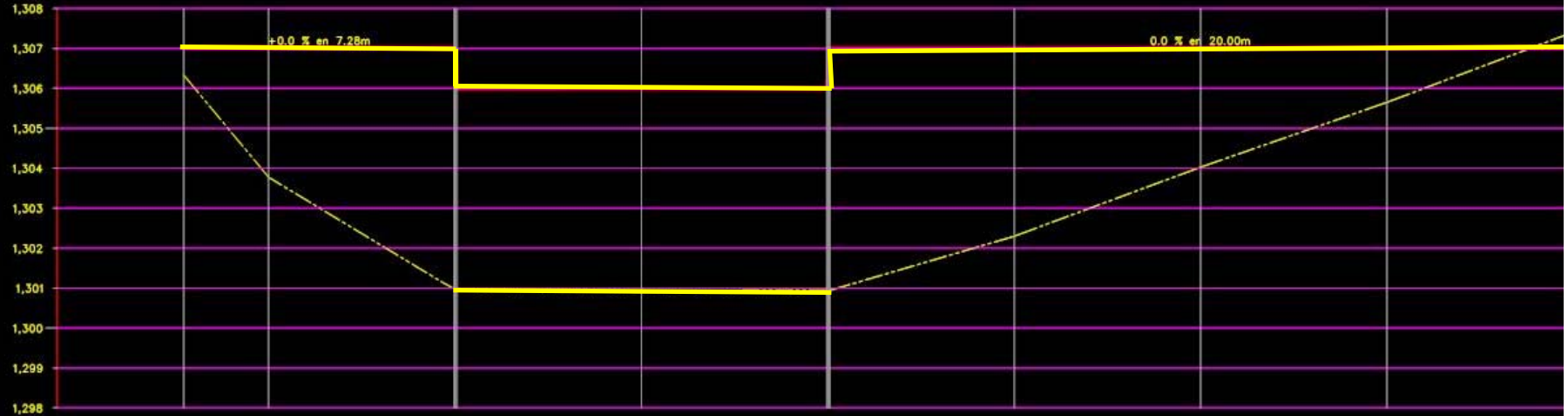
SECCIONES TRANSVERSALES

ESTACION 0+007.722

ESCALA HORIZONTAL 1 : 100
ESCALA VERTICAL 1 : 100

1307

1301



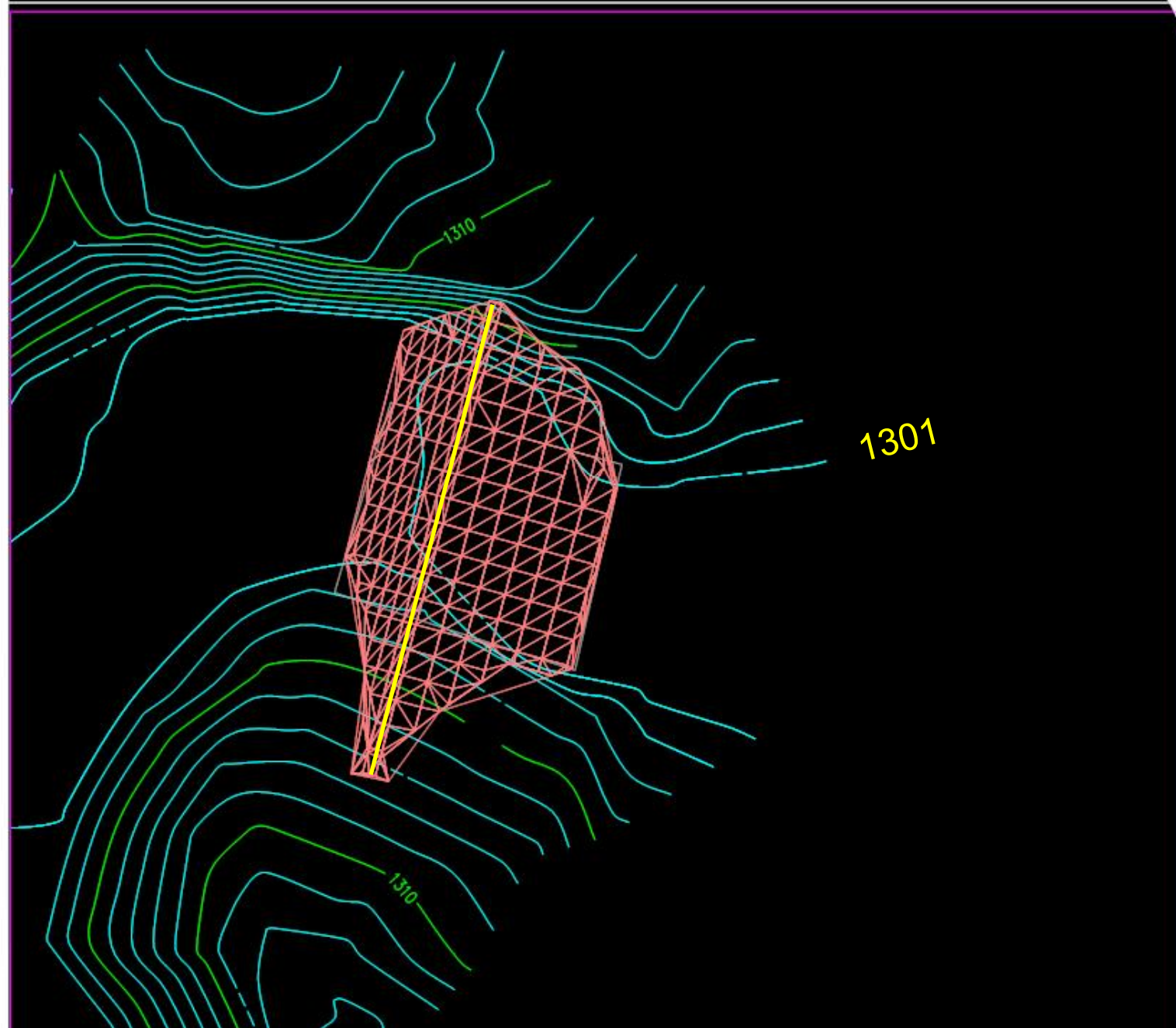
COMPACTACION		ORDENADAS DE LA CURVA MASA		VOLUMEN		ESPESOR		ELEVACION	
				TERRAPLEN	CORTE	TERRAPLEN	CORTE	SUBRASANTE	TERRENO
	0+007.722	1,306.33	1,307.00	0.00	0.00	0.67		1,306.33	1,307.00
	0+010.000	1,303.78	1,307.00	15.77	0.71	3.22		1,303.78	1,307.00
	0+015.833	1,305.97	1,307.00	18.331	0.00	0.63		1,305.97	1,307.00
	0+020.000	1,300.92	1,306.00	251.92	0.20	5.08		1,300.92	1,306.00
	0+025.833	1,305.84	1,307.00	253.34	0.00	0.66		1,305.84	1,307.00
	0+030.000	1,302.30	1,307.00	239.26	0.26	4.70		1,302.30	1,307.00
	0+035.000	1,304.03	1,307.00	141.86	1.60	2.97		1,304.03	1,307.00
	0+040.000	1,305.65	1,307.00	39.36	2.66	1.35		1,305.65	1,307.00

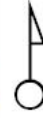
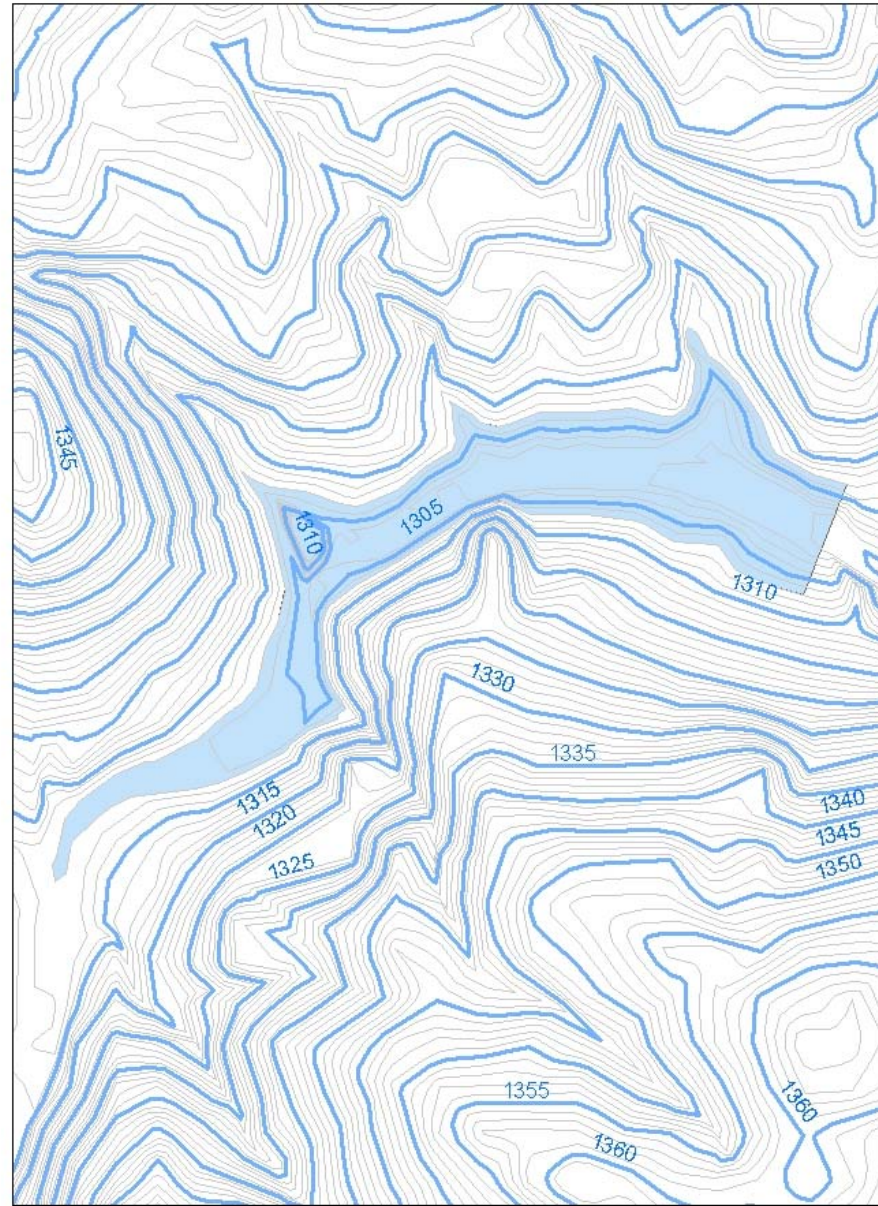
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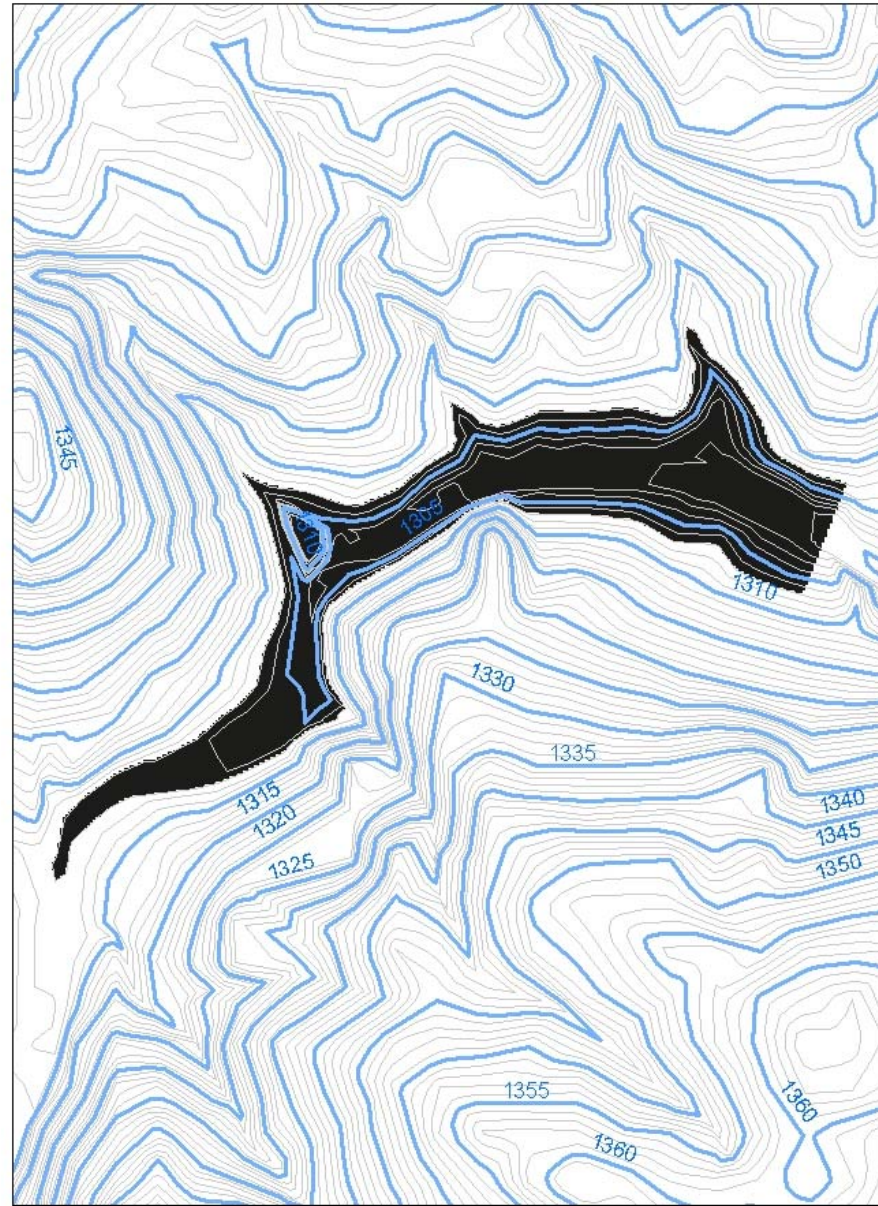
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ESC
E

LOCALIZACION

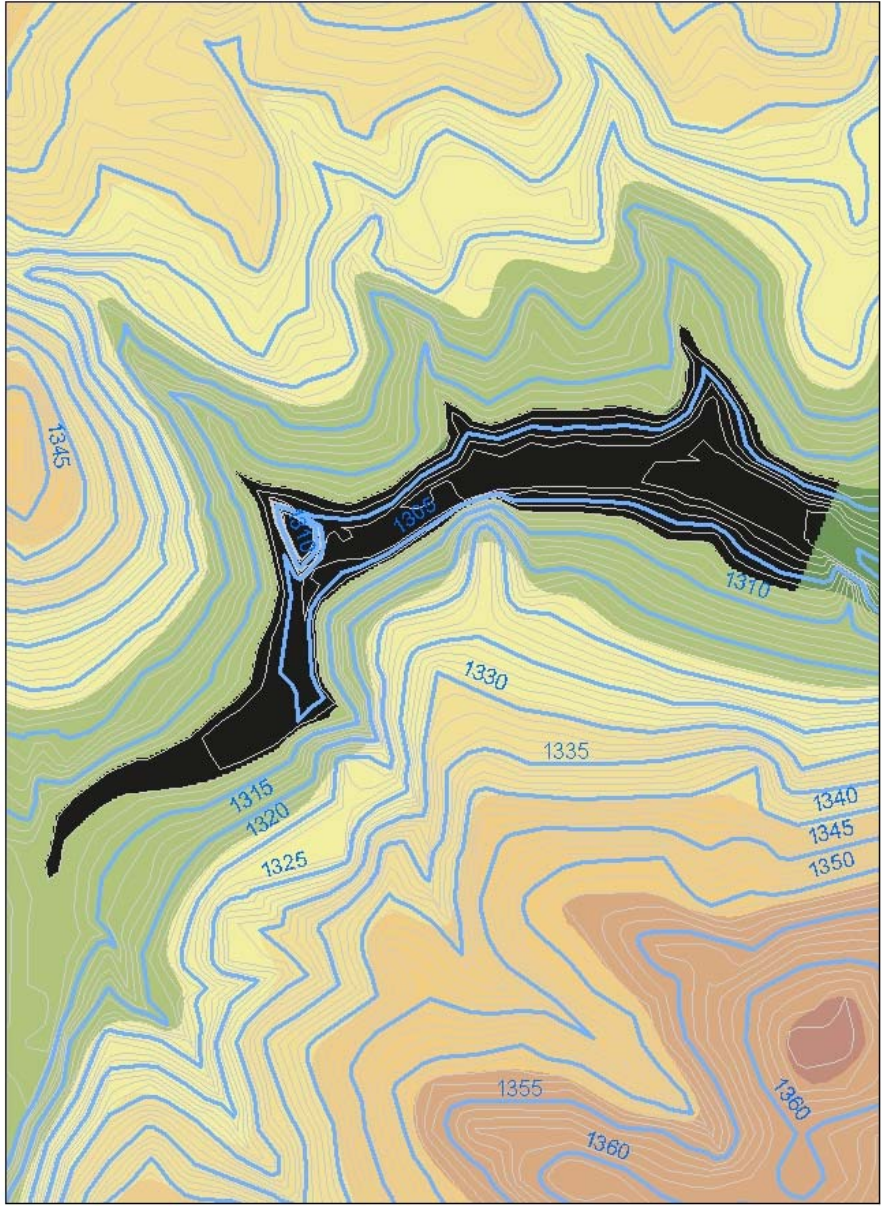




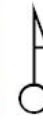
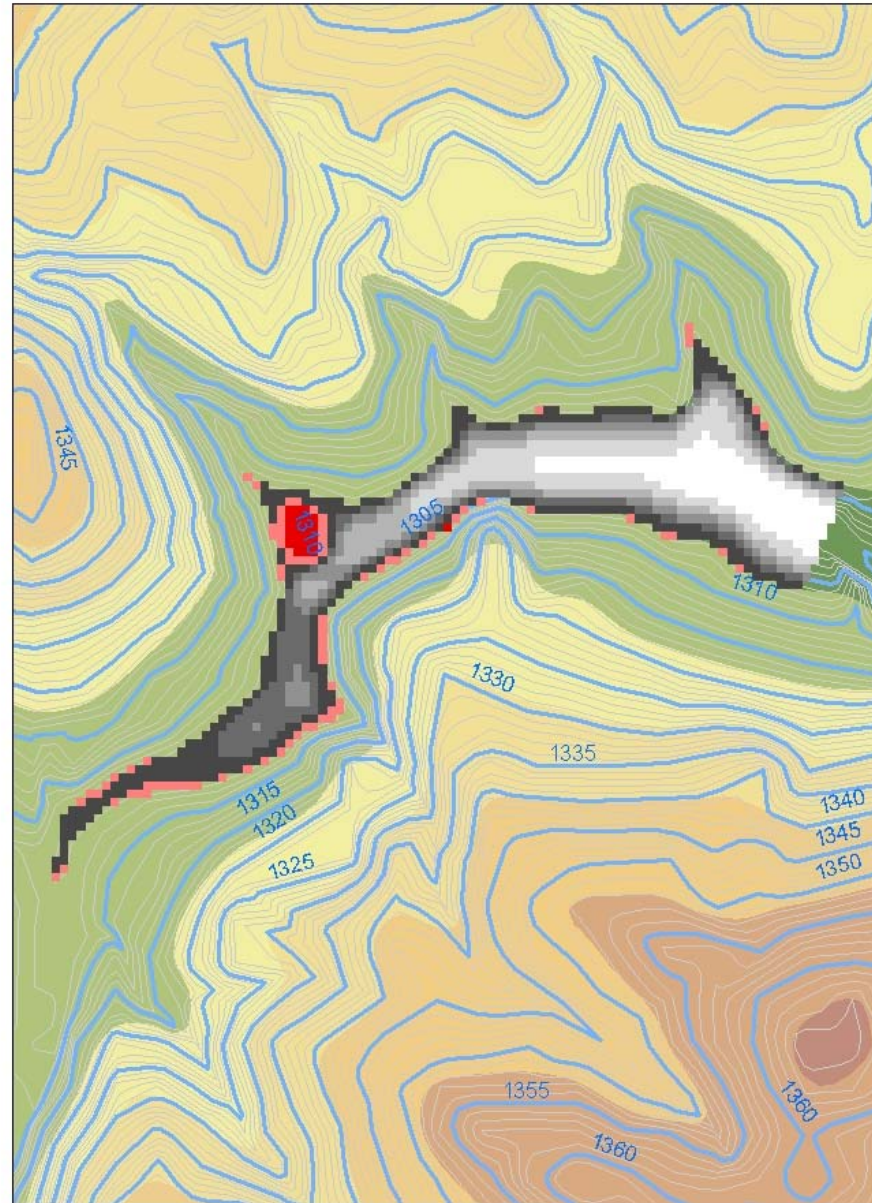
0 50 100 200 Meters



0 50 100 200 Meters



0 50 100 200 Meters

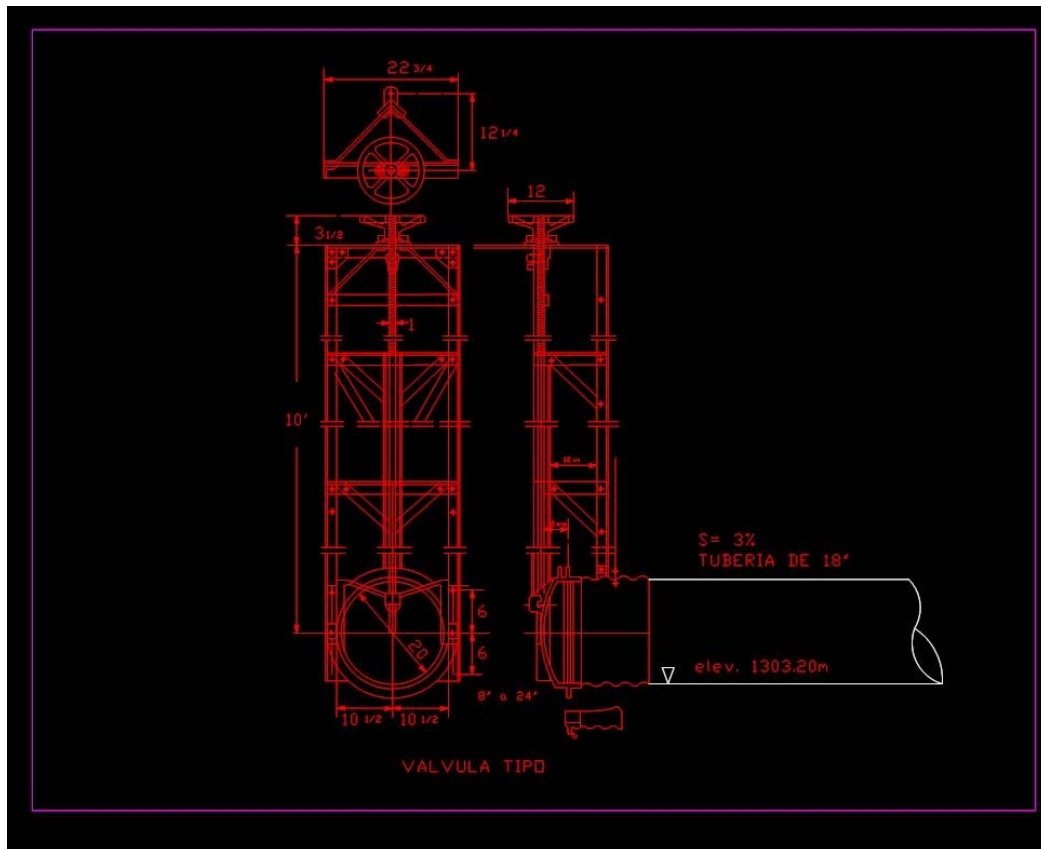
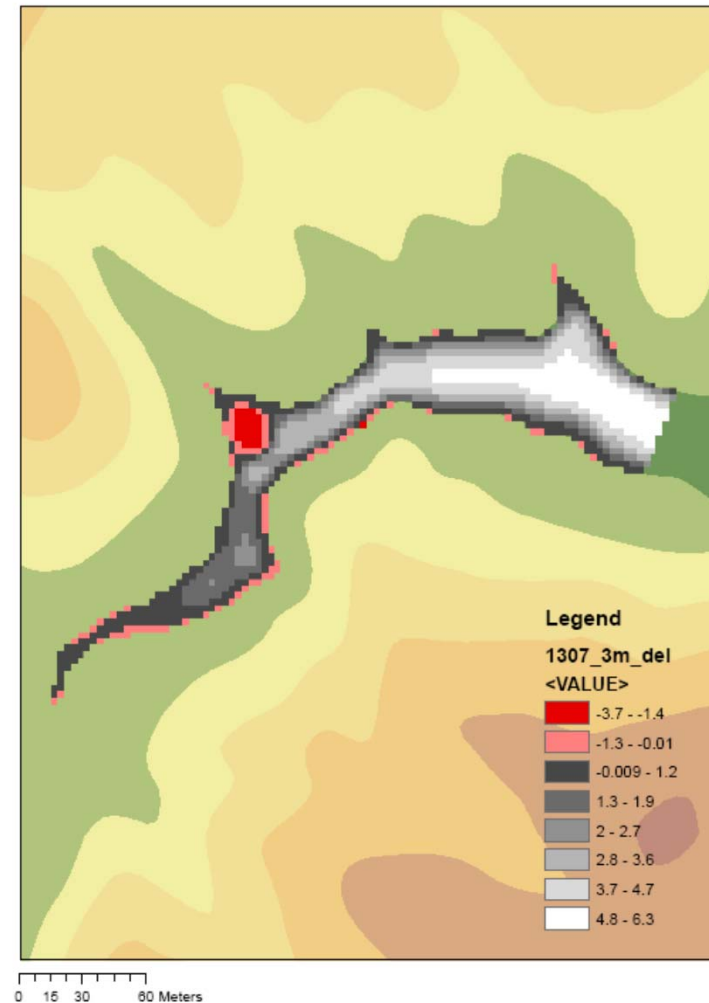


2D Area = 8851 m²
Volume = 24756 m³

0 50 100 200 Meters

Describe basins in 3-D terminology, using total volume, the total basin depth, top and bottom surface areas, and discharge structures

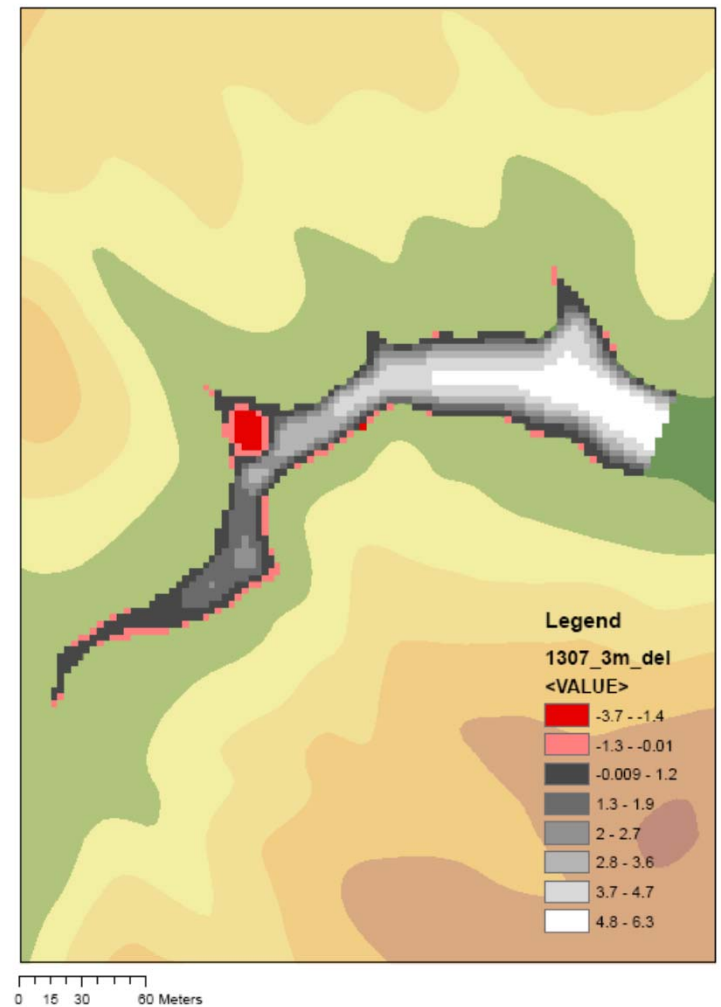
Chimeneas - 3m



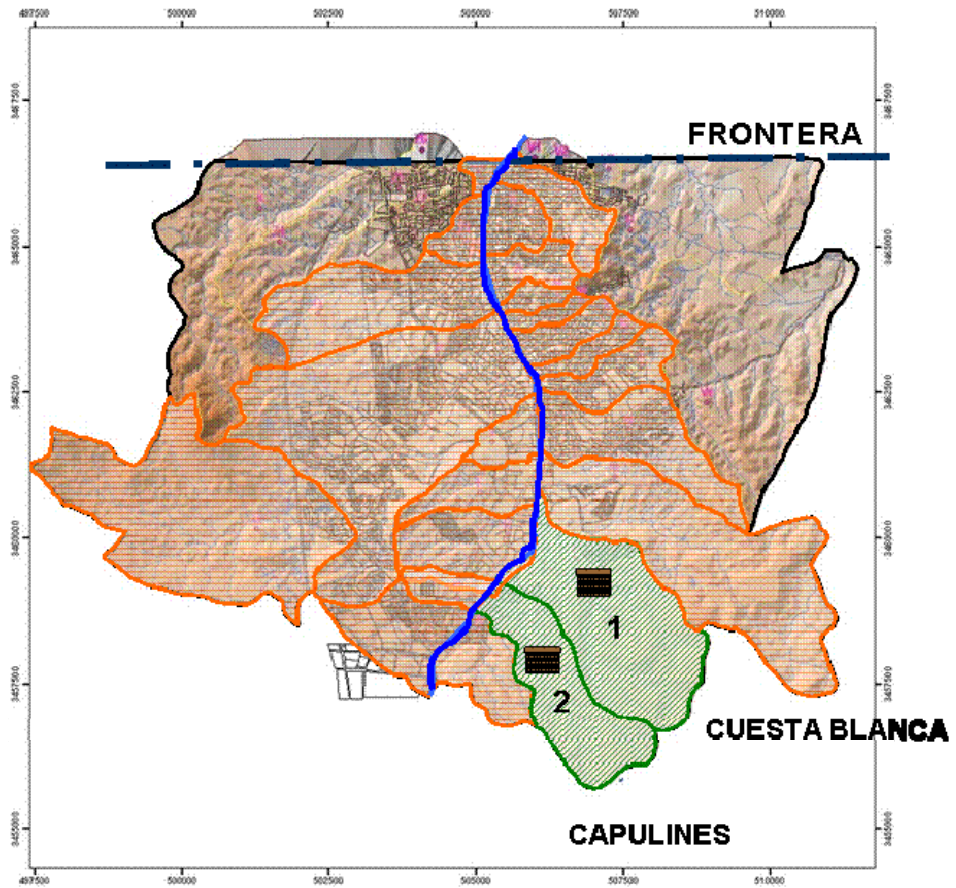


Describe basins in 3-D terminology, using total volume, the total basin depth, top and bottom surface areas, and discharge structures

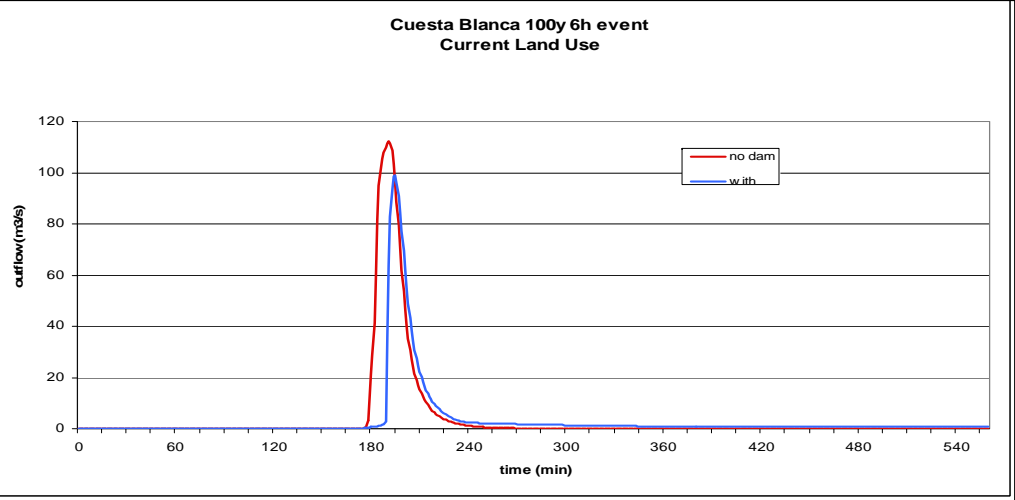
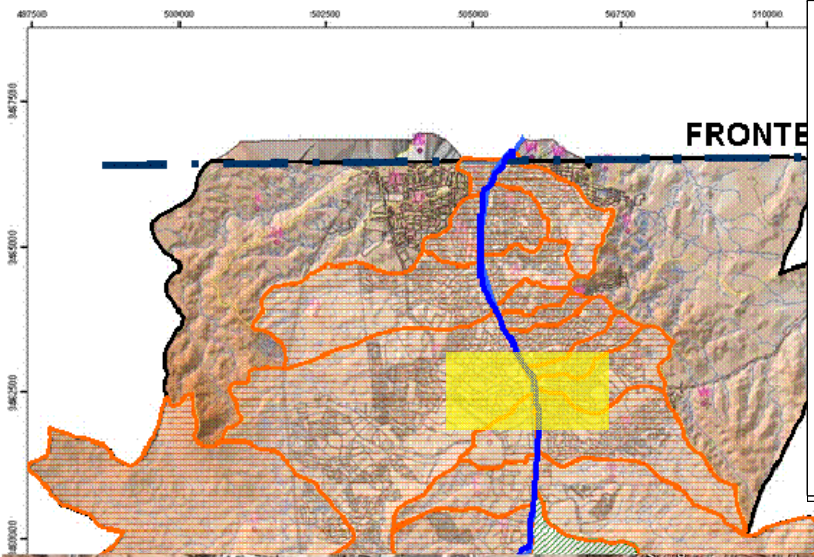
Chimeneas - 3m





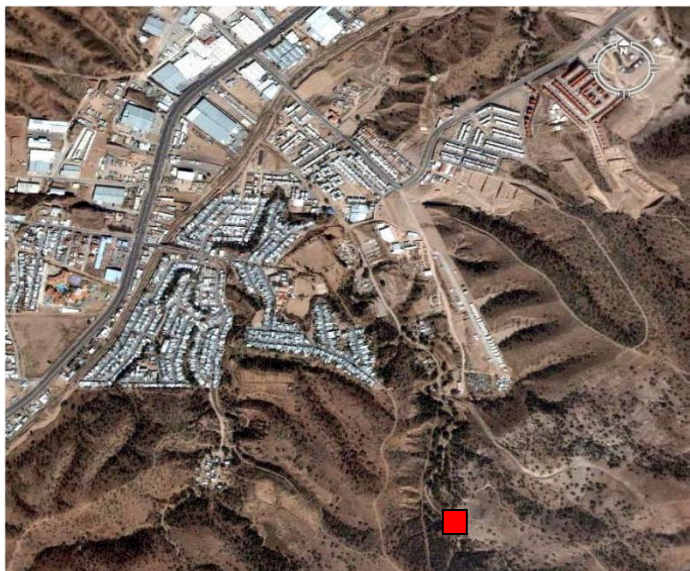
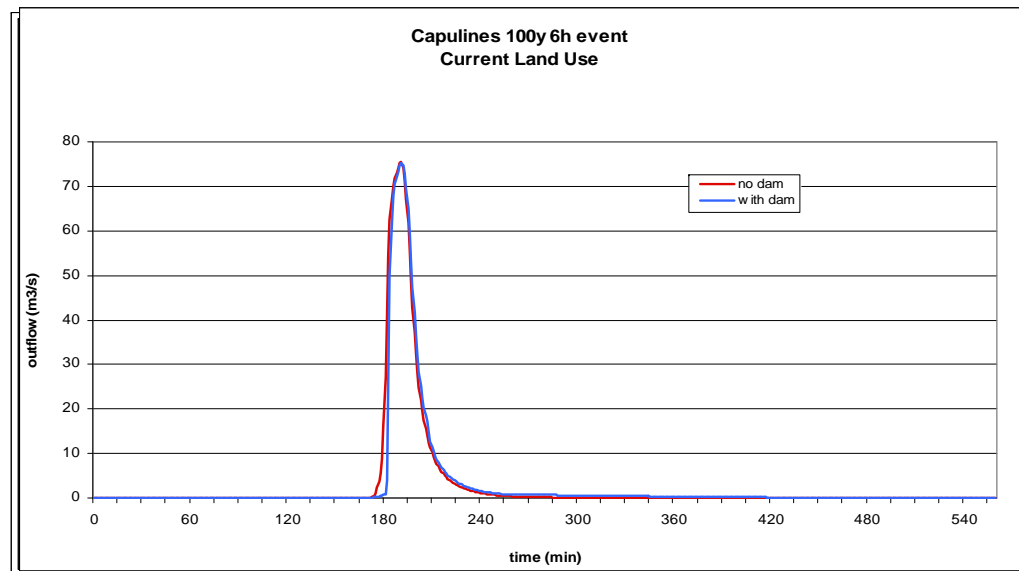
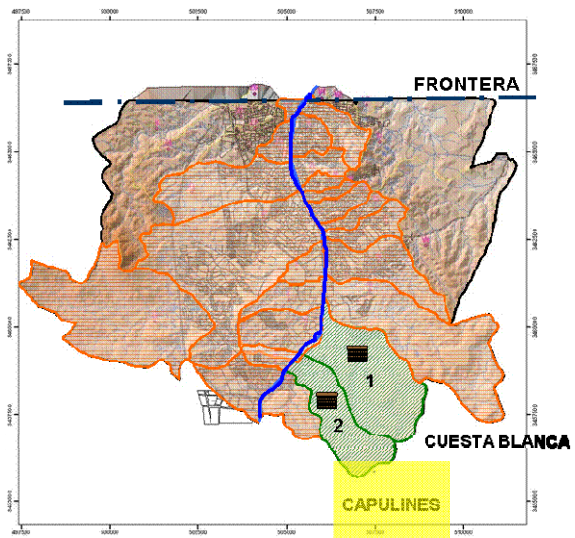


Map courtesy of City of Nogales, Sonora.
Mapa cortesía de la Municipalidad de Nogales, Sonora.



NCA





Sediment yield (kg), 25 year, 6 hour event		
Channel Impacts	Cuesta Blanca	Capulines
w/out feature	8,518,604	9,268,617
w/ feature	2,964,995	3,869,279
Difference	5,553,609	5,399,338

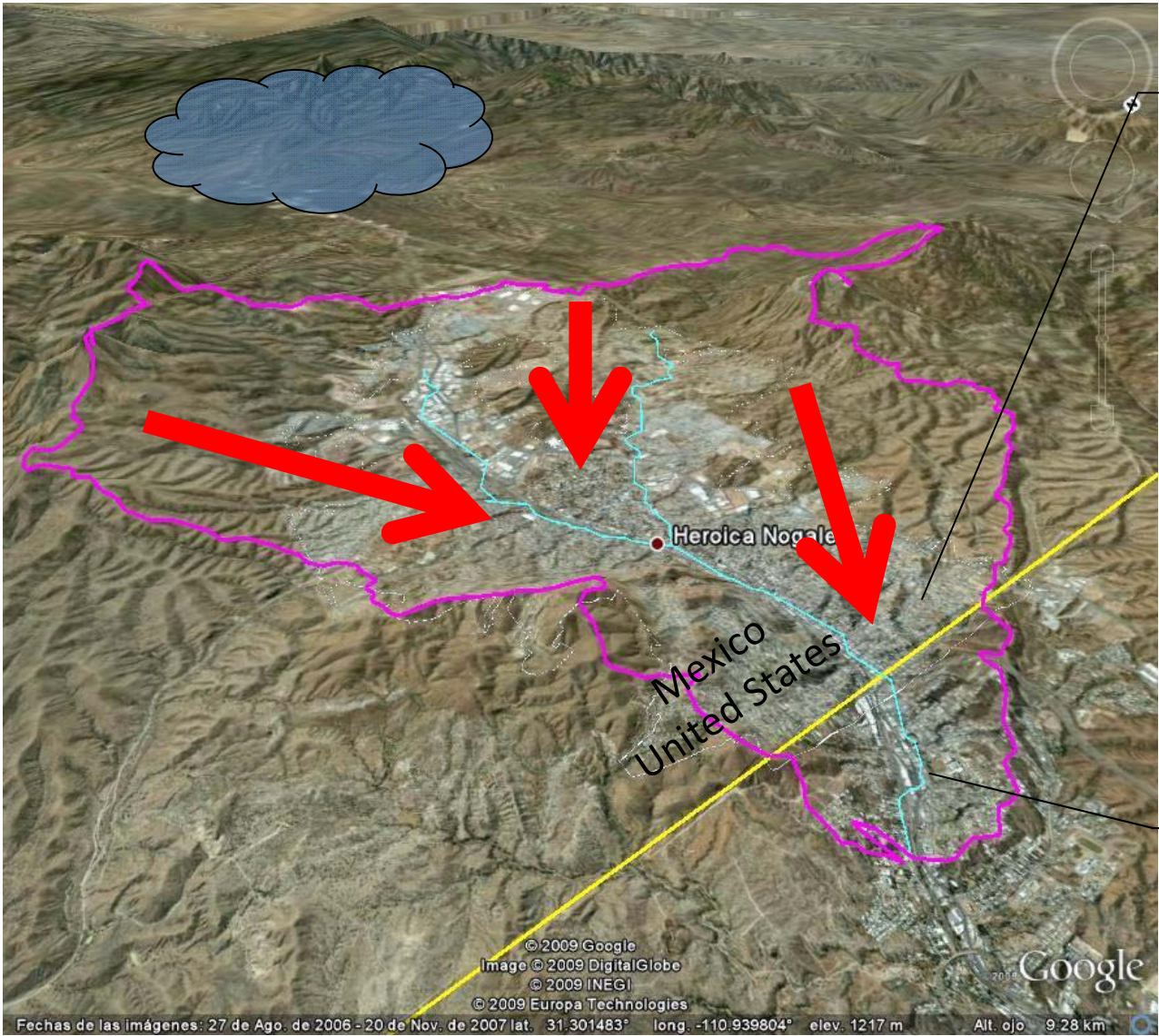




Norman, L.M., Levick, L., Guertin, D.P., Callegary, J., Quintanar Guadarrama, J., Zulema Gil Anaya, C., Prichard, A., Gray, F., Castellanos, E., Tepezano, E., Huth, H., Vandervoet, P., Rodriguez, S., Nunez, J., Atwood, D., Patricio Olivero Granillo, G., and Octavio Gastelum Ceballos, F., 2010, **Nogales flood detention study**: U.S. Geological Survey Open-File Report 2010-1262, 141 p.

Emergency Response

- 2009—working with Chuck McHugh, AZ Dept of Emergency & Military Affairs (**ADEMA**) to help establish trigger points for flood reaction in the Nogales Wash with **USACE**, **ADEQ**, and the **NWS**... to reduce the impact of disaster on person and property.
- Floyd Gray (USGS) funded on **DHS** proposal with **NOAA** and **UofA** to develop an Early Warning Hazard System and needs help to identify best locations for gauges (precip. & water).



Nogales,
Sonora

Nogales,
Arizona





Current Flood Warning System





- The NWS, UA, and USDA had developed and implemented a version of KINEROS2, adapted to flash flood prediction using radar precipitation product (K2/NWS) that displays graphs of both radar-derived rainfall and predicted runoff.
- 20 cooperative rainfall gauges to be purchased and installed in Nogales, Sonora and attached to Internet monitoring network for Arizona (Rainlog.org).
- This could be used to calibrate the K2 model for advanced flood warning
- Could help planning for future scenarios
- And also act as a demonstration to locate most advantageous sites for larger more extensive equipment (radar) that will provide emergency managers with the most reliable alert system...

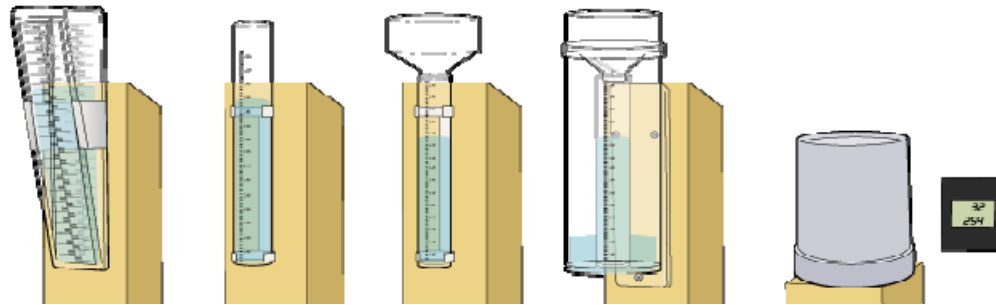


**** *community-based flood warning system* ****

- One effective way to mitigate flood risk is to provide a tool that allows the forecaster to effectively predict the timing and magnitude of peak flows in small watersheds.
- ✓ Incorporate real-time rainfall data input and compute volumes of runoff, peak flow, and watershed discharge rate.
- ✓ A runoff graph will show stage of flows and equivalent discharge rate in streams, and indicates the peak stage (discharge) and time of peak

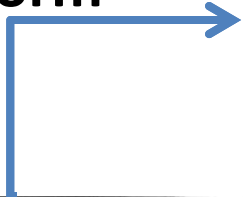
Nogales, Sonora

- 20 cooperative rainfall gauges purchased and installed in Nogales, Sonora and attached to Internet monitoring network for Arizona (Rainlog.org).



- Needed help from colleagues in Nogales, Sonora
 - Input on storm distributions and site selection... Multiple gages are desirable since precipitation is highly variable during the monsoon season, when thunderstorms can produce heavy and localized rainfall.
 - Operations and maintenance:
 - installation, operation and maintenance of the gages
 - Tie to the internet, and possibility of setting thresholds for ER communication

Distribution is Important for Storm Tracking



> 20 for WGS selection

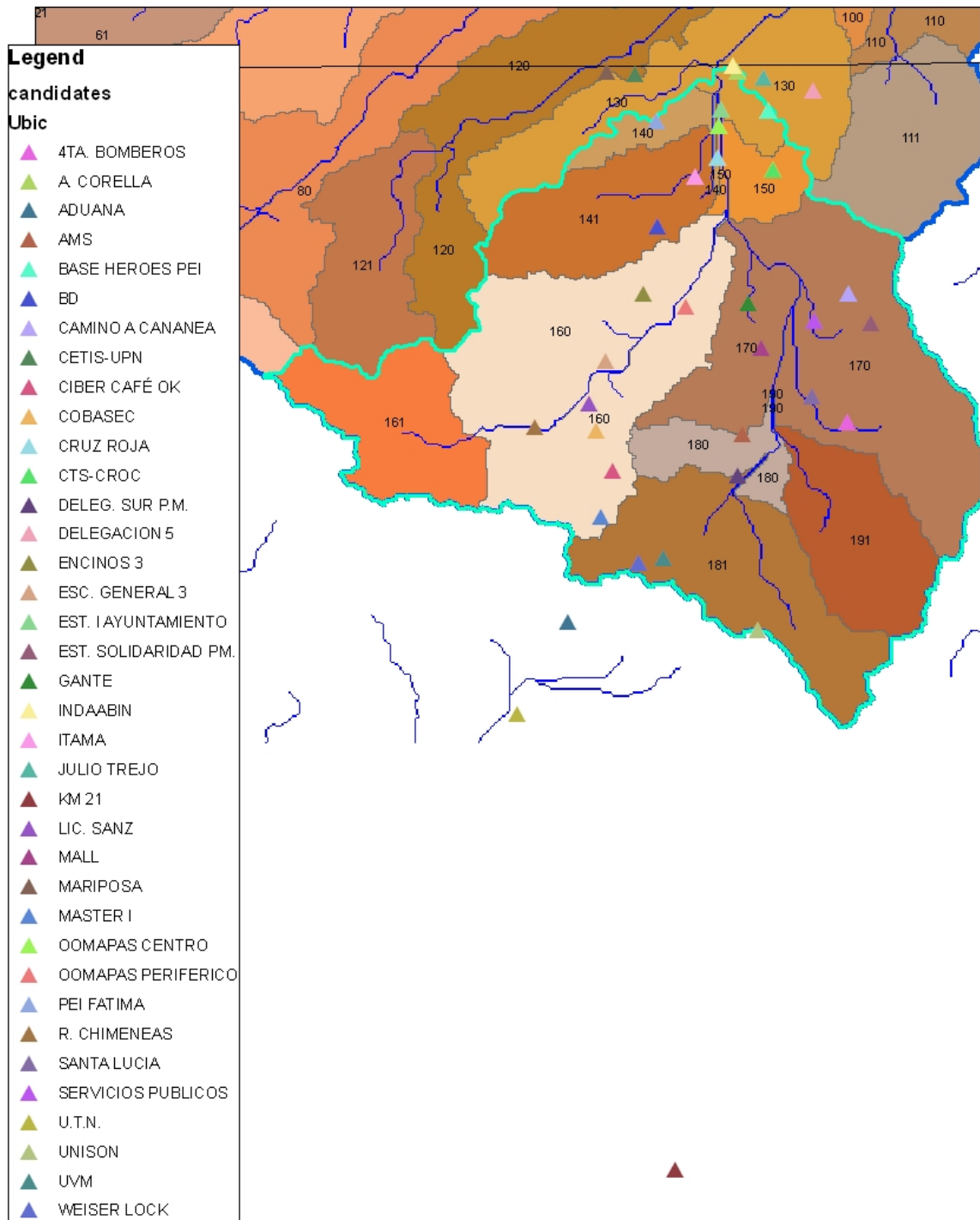
WGS-84 / security

Judicial / govt. / school - good visibility

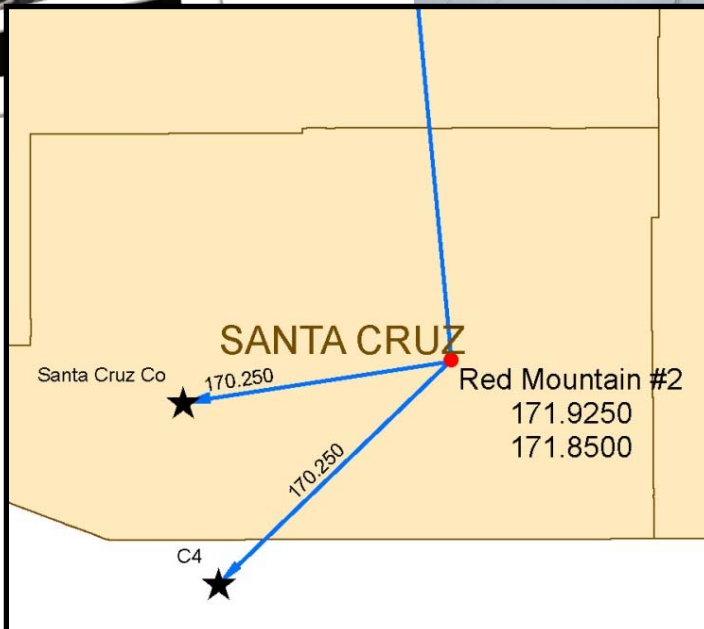
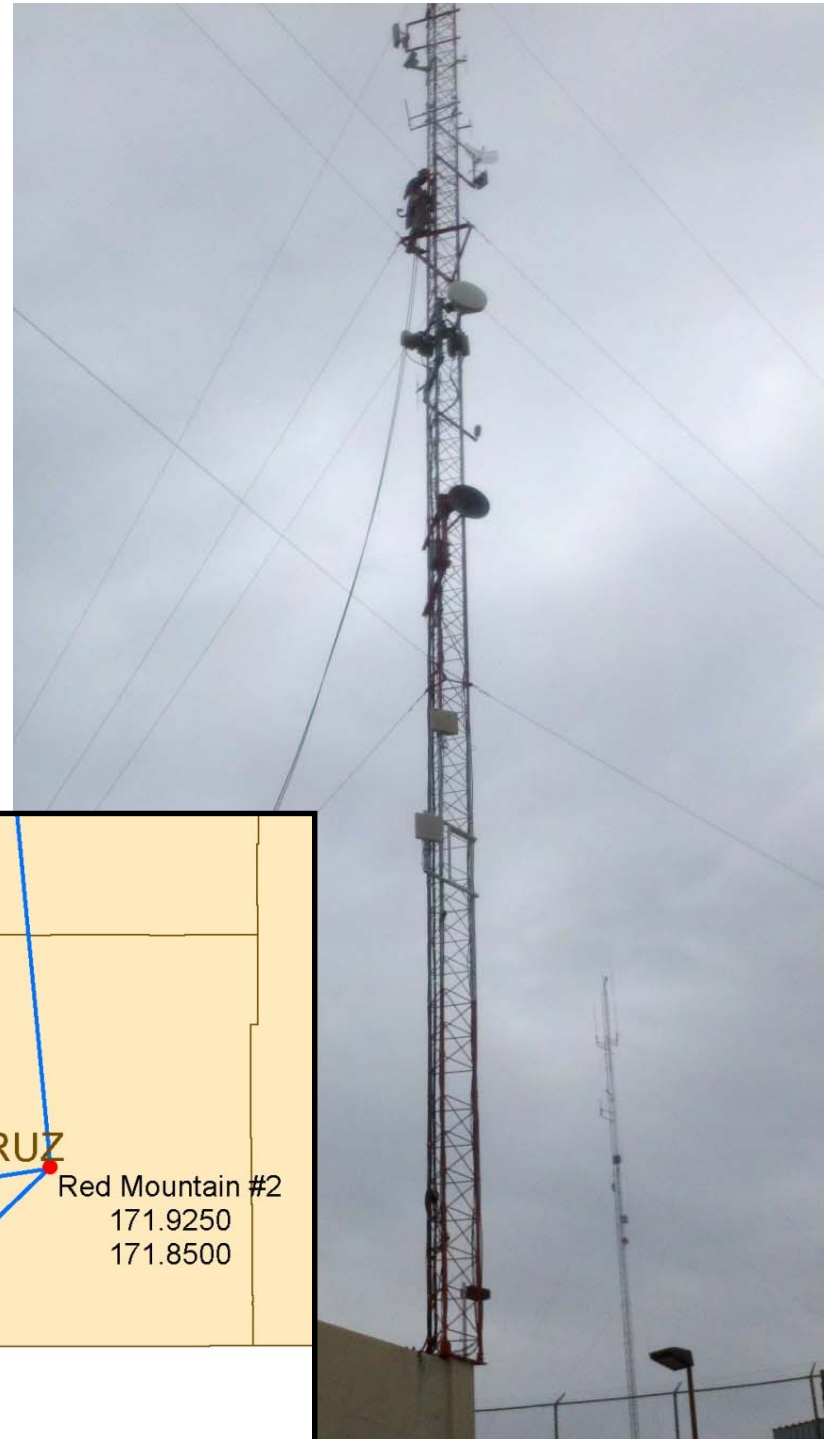
considerable

Julio Tr.	N 31° 19.848'	W 110° 56.283'	E. 1217	B.A.
Delegacion 5	N 31° 19.732'	W 110° 55.751'	Elev. 1243 m	B.A.
Base Heroes	N 31° 19.542'	W 110° 56.234'	E 1238 m	Herco.
A. Corella	N 31° 19.910'	W 110° 56.561'	E. 1189 m	Elias.
Est I / Agente	N 31° 19.559'	W 110° 56.745'	E. 1195 m	Centro
Industria	N 21° 19.964'	W 110° 56.617'	E. 1189 m	Centro
Centro / U.P.M.	N 31° 19.888'	W 110° 57.661'	E. 1258 m	NW
PEI Fatima	N 31° 19.454'	W 110° 57.437'	E. 1250 m	NW
Dampas Centro	N 31° 19.410'	W 110° 56.769'	E. 1198 m	N
Cruz Roja	N 31° 19.111'	W 110° 56.782	1203	
CTS Croc	N 31° 19.001'	W 110° 56.178'	1268	
Santa Lucia	N 31° 16.721'	W 110° 55.764'	1248	
4ta Bomberos	N 31° 16.679'	W 110° 55.891'	1266	
Est. Soli. Ppt	N 31° 17.591'	W 110° 55.130'	1270	
Camino Cananea	N 31° 17.862	W 110° 55.372	1287	
Serv. Publicos	N 31° 17.610	W 110° 55.737	1252	
ITAMA	N 31° 18.941'	W 110° 57.013	1207	
BD	N 31° 18.485	W 110° 57.417'	1246	
Mariposa	N 31° 19.705	W 110° 57.972	1235	
Master I	N 31° 15.813	W 110° 58.015	1343	
Dampas Peri	N 31° 17.744	W 110° 57.117'	1245	
Sancti Spiritus	N 31° 15.382	W 110° 57.627	1320	
UVM	N 31° 15.431	W 110° 57.356	1308	
Km 21	N 31° 09.801	W 110° 57.240	1159	
U.T.N.	N 31° 13.999	W 110° 58.925	1270	
Aduana	N 31° 14.844	W 110° 58.382	1313	

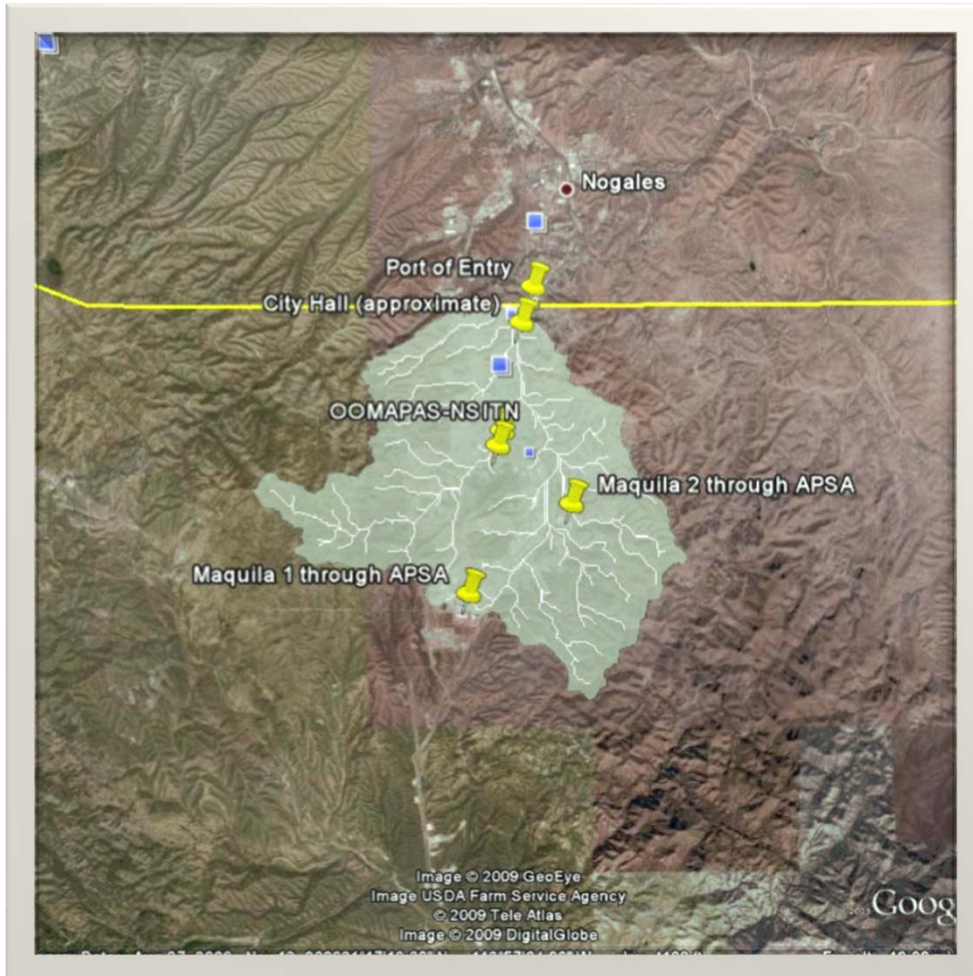
How are rain gauges engineered. = manual for gauges



Rain Gages



Rain Gages

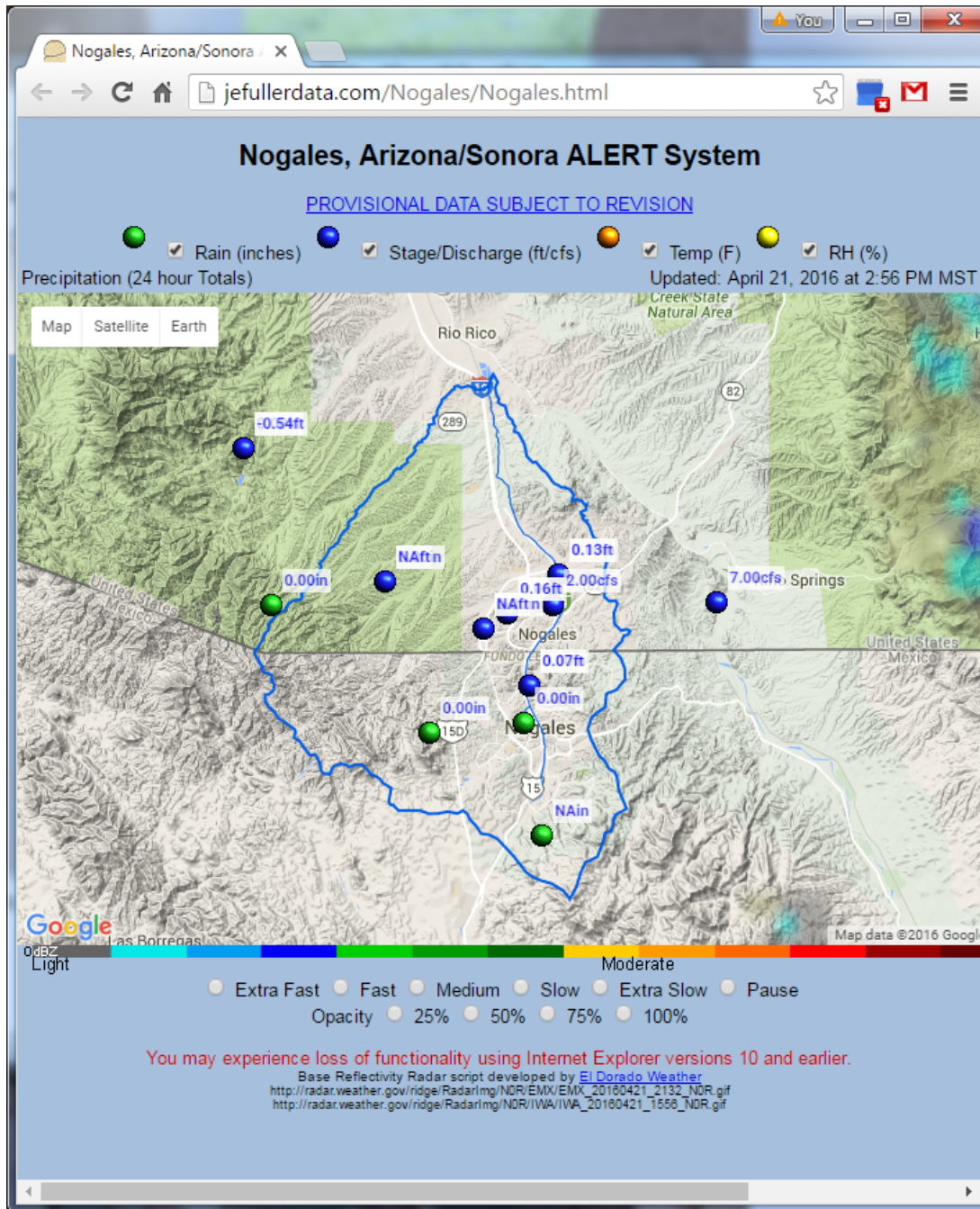


- The system is in place and 100% operational
- Real-time data connections via satellite and via connection to the Arizona Statewide Flood Warning System through one of its existing repeaters located along the border.
- Additionally, the base station, located in Nogales, Sonora, provides local emergency operations personnel with complete off-grid, real-time data access.
- Plans to coordinate installation of high-visibility staff gauges at frequently flooded transportation corridors and crossings ...

Workshops and Trainings

- On October 12, 2012, a training was held at the C4 Center ALERT Training, Nogales, Sonora,.
- On April 17-18, 2013, a software demonstration and training workshop for an Emergency Flood Warning System being created for the city of Nogales, Sonora, Mexico at the Santa Cruz County Flood Control District office in Nogales, AZ.
- April 15, 2016 a training was held in Nogales, Ariz. on three aspects of the Nogales, Sonora ALERT System: (i.) ALERT System Overview, (ii.) Davis Web Data Setup, and (iii.) Equipment Training

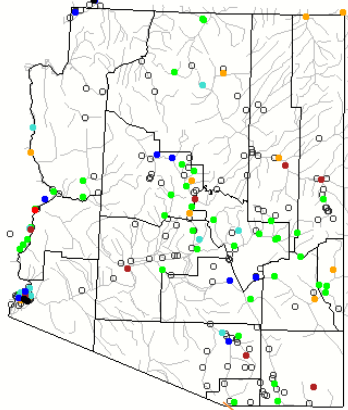




Rain Gages

- Base Station
- 3 Weather Stations
- 1 Precip/Stream Station
- 1 Precipitation Station

Tuesday, October 05, 2010 14:30ET



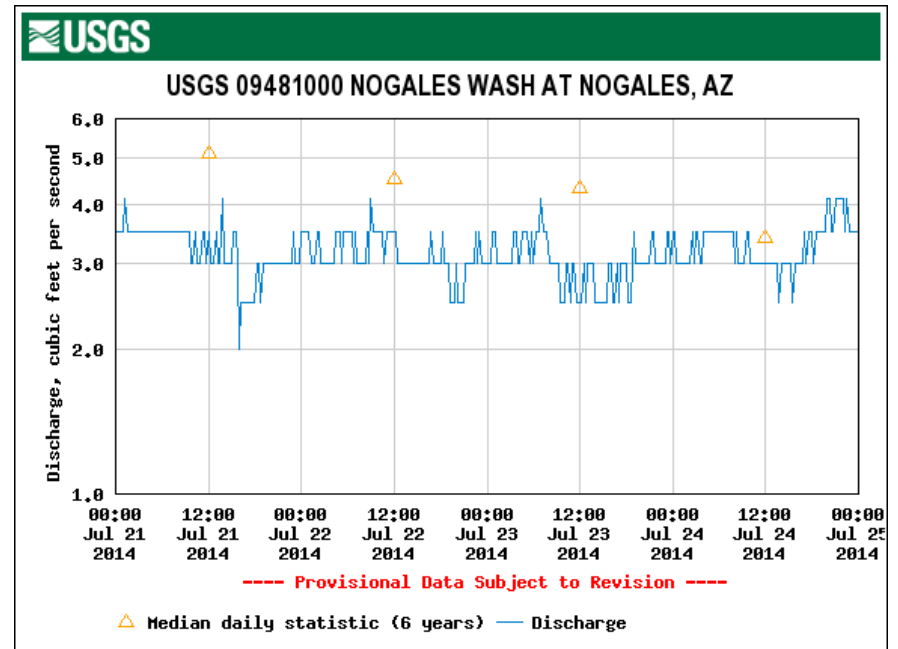
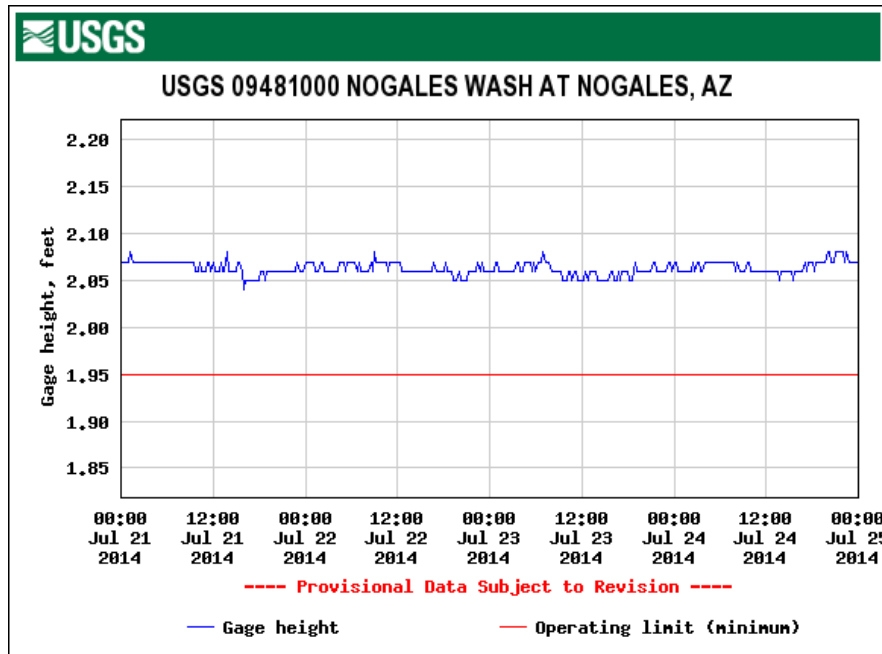
USGS

Nogales Wash Stream gage



Installed by USGS/ADWR
with a grant from Border 2012
Maintained by U.S. IBWC
The system began recording data on
April 23, 2010

Arroyo Nogales



Baseflow = 2.5 – 3.5 cfs
(71 – 99 lps)

A State Emergency

Nogales International
Nogales, Arizona | Wednesday, August 11, 2010

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Nogales braces for another night of

By JB Miller and Manuel Coppola
Published Friday, July 30, 2010 3:09 PM CDT

10 As Nogales braces itself for more rain this weekend, the city be need them today.

"The chances of continued rain are 70 percent tonight and 60 p following the same pattern as last night's rain," said Ofelia McCollough, the

Later today, people can pick up free sandbags at the public works departme the Holbrook Bridge on Morley Avenue, McCollough said.

- Print this story
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- Post a Comment



"We are se sandbags should go 285-5613.

Until about distributed hardest hit Hohokam the Union its tracks h in the Nog

John Hays County, sa deep som

Arizona Daily Star

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Heavy rain runoff causes flooding in Nogales, AZ

Story (0) Comments

By Jamar Younger Arizona Daily Star | Posted: Friday, July 30, 2010 8:12 pm | Commer

Heavy water flow in a Nogales, Ariz., wash destroyed three concrete panels and threatened to force the evacuations of some city residents.

The flooding affected the community of Chula Vista in the northern part of the city by with sandbags in case more damage occurred, said Flavio Gonzalez, utilities director.

The sandbags also will be used during repairs to the panels, which line the sides said.

"During repairs, we will have to divert the flow of water," he said.

The flooding, which destroyed the panels on the west side of the wash, was a result of heavy rains in Sonora, Mexico, he said.

The wash flows from a storm-water tunnel that spans two sides of the international border, bringing storm water from Mexico.

The waters started to recede Friday evening, but officials were concerned about forecasts for more rain late Friday night and Saturday, he said.

GREEN VALLEY NEWS AND SUN

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Wednesday, August 2010

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Nogales to get state help after flooding

By Manuel C. Coppola
Nogales International
Published: Tuesday, August 3, 2010 8:51 PM MST

Gov. Jan Brewer is expected to sign an emergency declaration this week that will give Nogales access to state resources to deal with heavy damage from last week's flooding.

Efforts also are under way between the International Water and Boundary Commission and the U.S. Army Corps of Engineers to hire a private contractor to repair portions of the Nogales Wash damaged in the storms.

The town was turned upside-down Friday as storm waters raged through the main washes of the town, eroding roads and undermining railroad tracks.

On Friday afternoon, residents of Chula Vista and Vista del Cielo were issued pre-evacuation notices as floodwaters rose.

Most stayed home, taking a chance that flooding would not continue through the night, which it did not.

Further south along Western Avenue, children playing at Camp Little Park were rushed to safety by bystanders who just seconds before witnessed the Ephraim Canyon Wash crash over the Leyva Bridge and turn the street into a raging river.

At the point where Ephraim and Nogales washes converge, the water bottlenecked and flooded a portion of the El Dorado Motel parking lot, washing over the railroad tracks. Northbound train traffic was temporarily shut down.

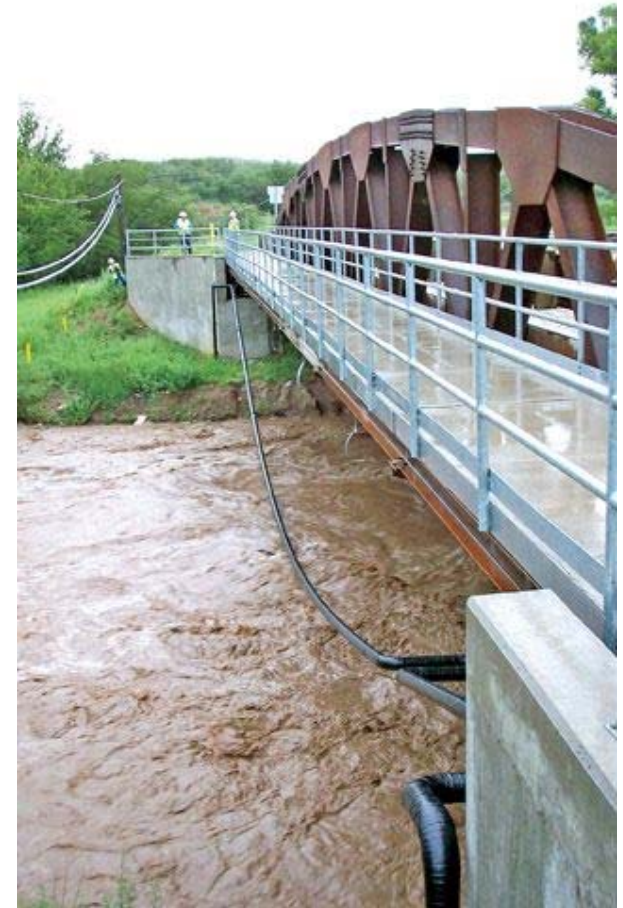


Heavy equipment and volunteers help clear the road in Nogales after Friday's storm. Photo by Manuel C. Coppola/Nogales International

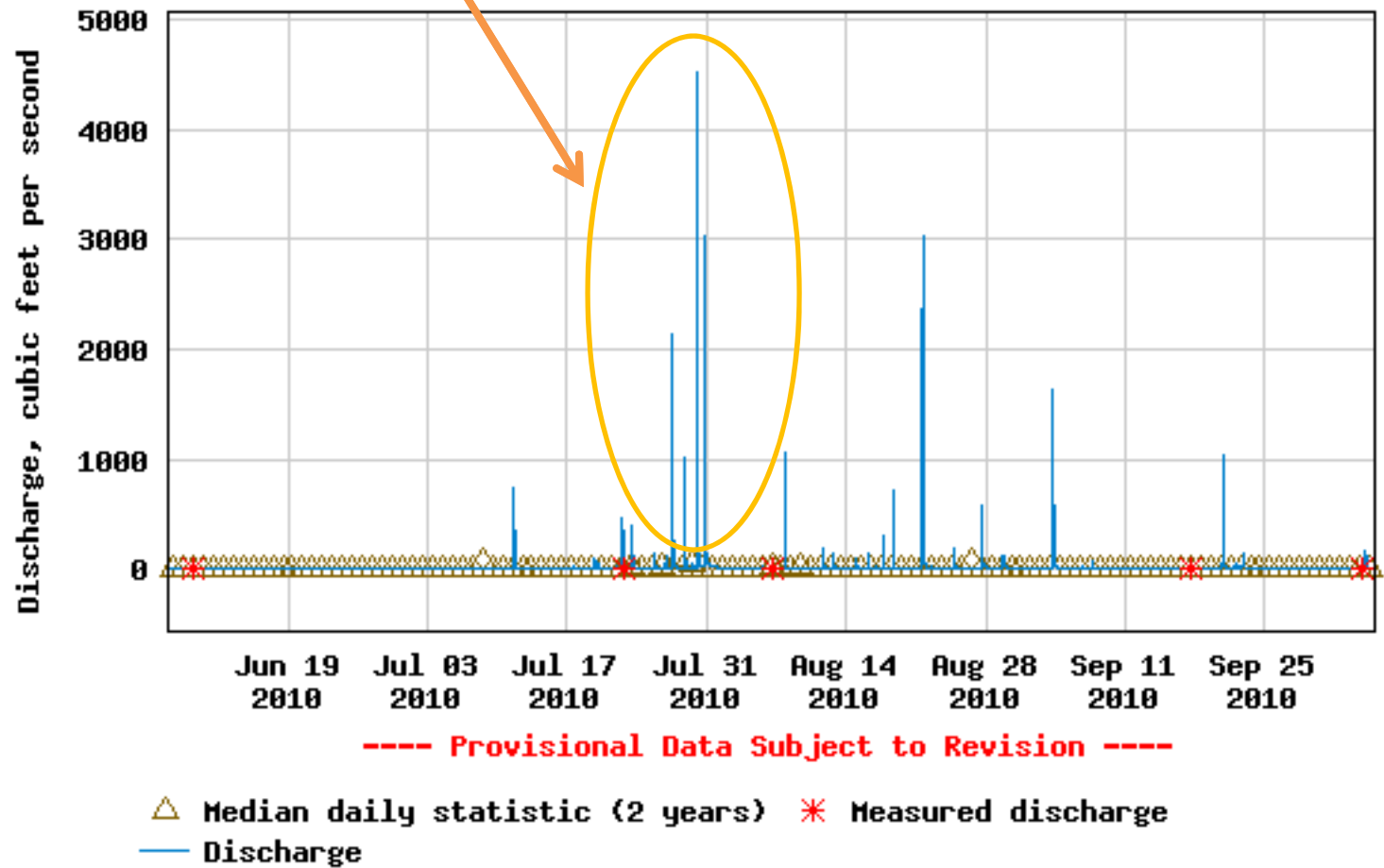
July 31, 2010

A Real Storm: *Downstream*

“John Hays, Floodplain Coordinator for Santa Cruz County...said Tuesday’s deluge was a 10-year event, meaning it had a 10-percent chance of occurring in any given year. He said the last time a 10-year event occurred in Nogales was in 2008” ...



USGS 09481000 NOGALES WASH AT NOGALES, AZ



http://waterdata.usgs.gov/az/nwis/uv?site_no=09481000

Flood Warning and modeling project in Nogales Sonora

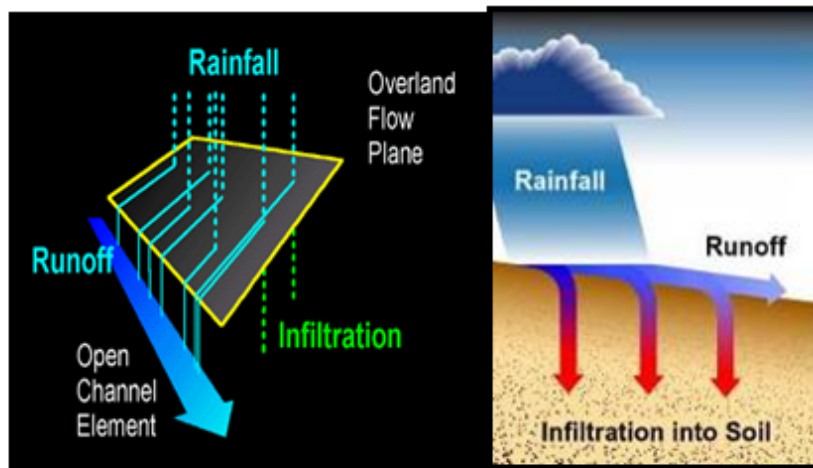
Rain Gages



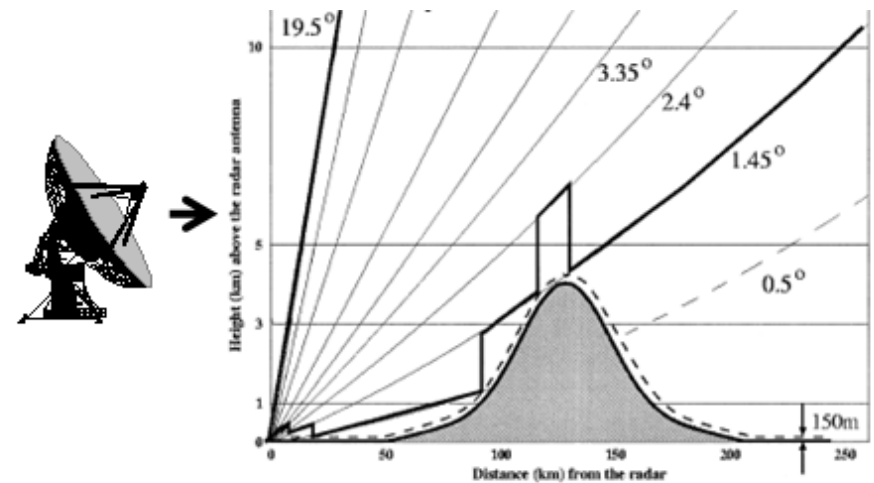
Precip On	Milimeters (mm)	Inches (in.)
7/31/2010	1.524	0.06
7/30/2010	52.07	2.05
7/29/2010	17.78	0.7
7/28/2010	7.62	0.3
7/27/2010	13.208	0.52
7/22/2010	7.112	0.28
7/20/2010	1.27	0.05
7/19/2010	24.384	0.96

NEW

- The NWS, UA, and USDA have developed and implemented a version of KINEROS2, adapted to flash flood prediction using radar precipitation product (K2/NWS) that displays graphs of both radar-derived rainfall and predicted runoff.



KINEROS2 model
(used with AGWA preprocessor)
(<http://www.tucson.ars.ag.gov/kineros/> &
<http://www.tucson.ars.ag.gov/agwa/>)



WSR-88D DHR product (Maddox et al, 2002)
1 km by 1 degree,
5-min **data** from summer 2003



Nogales Wash at Nogales Arizona



KINEROS2 Modeling Results

Michael Schaffner, NWS WRH

A collaborative partnership with NWS Tucson, USDA
Southwest Watershed Research Center, and the United
States Geological Survey (USGS)

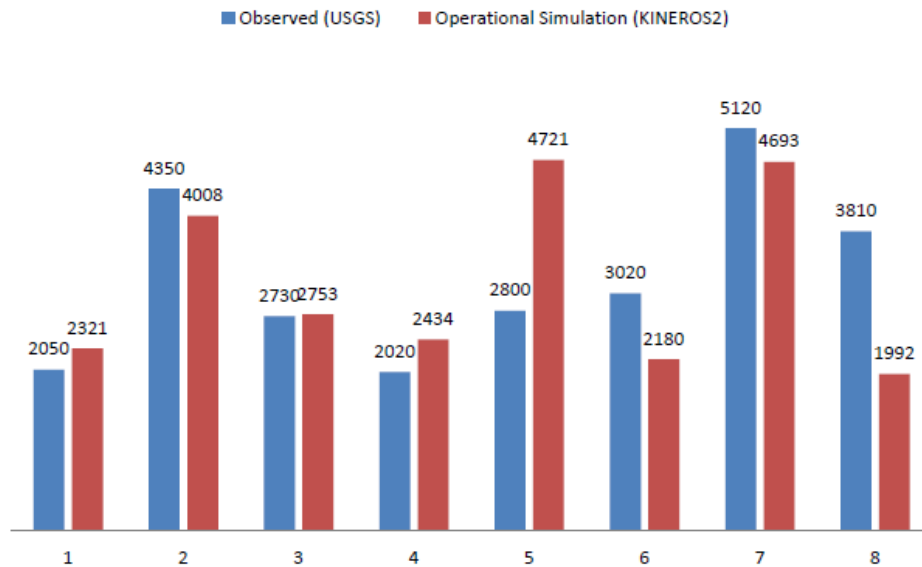


Calibrated with Stream Gage

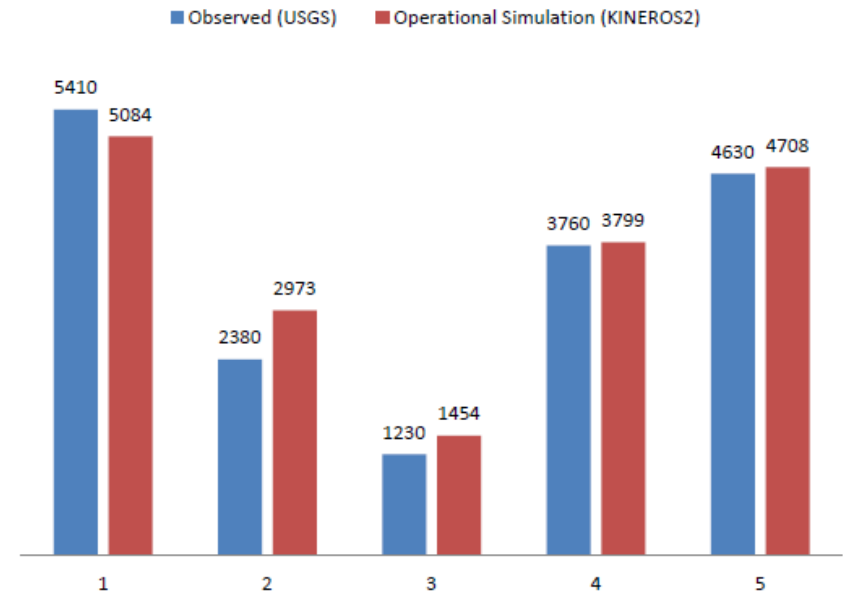
2014 Monsoon Events

2015 Monsoon Events

2014 Monsoon Peak Flow Events



2015 Monsoon Peak Flow Events



Working now to calibrate with Real-time Rainfall...

Hopes to employ this summer monsoon season!

Recommendations

1. Urban planning
 - Revegetation of Hot-Spots
 - City of Green Creeks
 - **Consider stormwater regulations**
2. Communication
 - Meetings, trainings, publications
 - Emergency Flood Warning System
3. Stormwater control
 - Detention Basins...



→ **Effective Binational Stormwater Program**

Recommendations



- Flood proofing structures*
- Relocation of structures and infrastructure*
- Flood warning
- Floodplain management
- Channel modification/enlargement
- Stormwater inlet improvements*
- Stormwater detention

(from Tetra Tech, IBWC, ACE 2005)

→ Effective Binational Stormwater Program



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NOGALES • MEXICO



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