Implementing Decision Analysis Framework on E.coli Problem in Lake Tuscaloosa

Urban Water Systems
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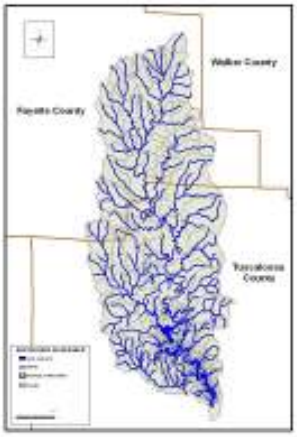
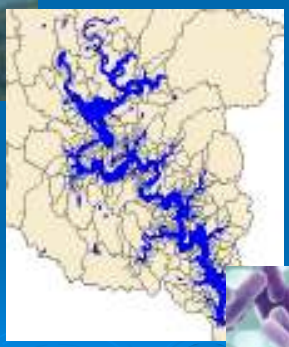
Jan. 28 2008



The Problem:

High Levels of E.coli in Lake Tuscaloosa



Indicator Bacteria

- Used as indicators for actual pathogens
- The group includes E.coli, Fecal Coliform, Enterococci and others
- These indicators were selected because:
  - Same origin as the pathogens (warm blooded animals feces)
  - Less susceptible to treatment or other removal mechanisms
- If an indicator was found this assumed that pathogens could be present

E.coli

- E.coli is short for Escherichia Coli
- Lives in the intestines of warm blooded animals
- Type of fecal coliform bacteria
- Good indicator for pathogens in fresh water because of high correlations with gastroenteritis in fresh water environments
- These bacteria need certain conditions of warm soil and availability of nutrients to promote the recolonization and growth in the soil (Whitman et al., 2006)

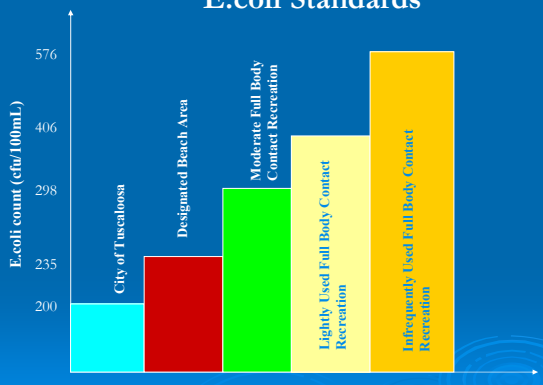
E.coli

- There are hundreds of strains of E.coli, most of them are harmless
- One strain E.coli O157:H7 produces powerful toxin and causes food borne and water borne illnesses
- It may cause damage to kidneys, pancreas, brain, and other organs in humans (Clark, 2005)
- These infections cost the US annually $405 million (2003 dollars) (Clark, 2005).
- E.coli's measuring unit is colony forming units (cfu) per 100mL

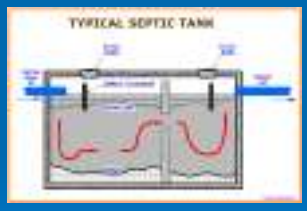
Sources of E.coli

- There many sources of E.coli, such as
  - Failing septic tanks
  - Failing sewer systems (Sanitary Sewer Overflows)
  - Polluted storm drains
  - Illegal fecal discharges from boats
  - Animal manure

E.coli Standards

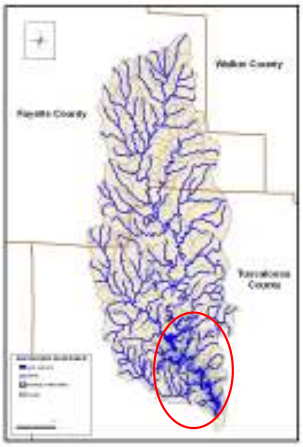


Perceived cause from previous studies

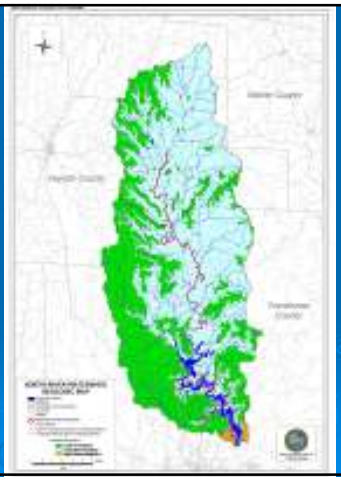


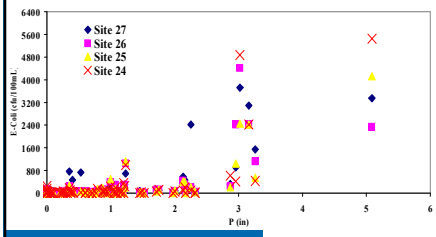
Lake Tuscaloosa Watershed

- Area: 425 sq miles
- Lake Tuscaloosa was constructed in 1970
- 11% of the lake surface and volume were lost due to sedimentation
- ADEM tested the water in the lake 98-02
  - Lower part very good quality
  - Upper part high algae and undesirable as a water supply



Geology



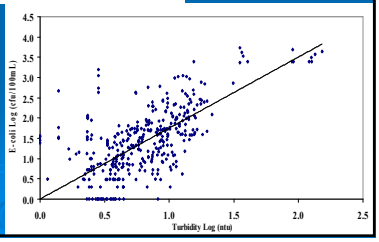


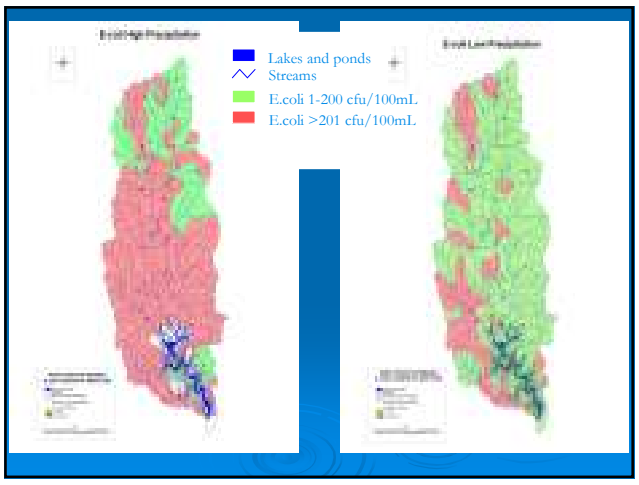
E.coli count during different precipitation events 98-07
• Above 1" of rain

Correlation between turbidity and E.coli readings

ANOVA Test
P <0.005
R^2 = 0.51
Anderson Darling = 3.67 >1
Turb prob. plot is Log Normal

ntu: nephelometric turbidity units



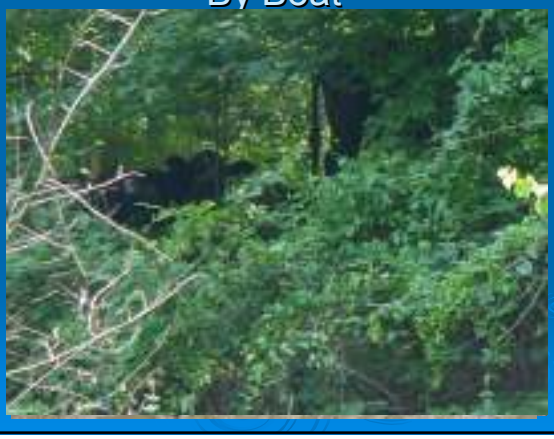


Observations in North River Basin

238 sq miles
(56% of watershed)

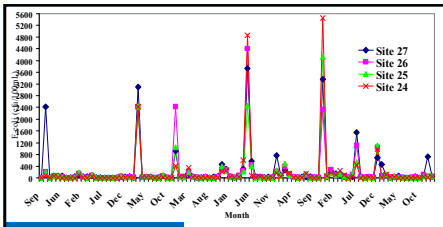
- 5 miles up North River
- Aerial photos provided by Black Warrior River Keepers

By Boat



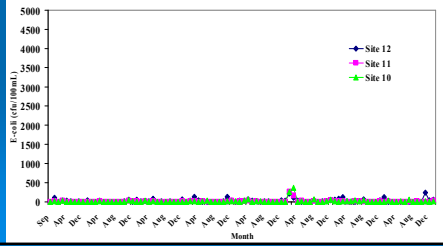
Aerial Photos

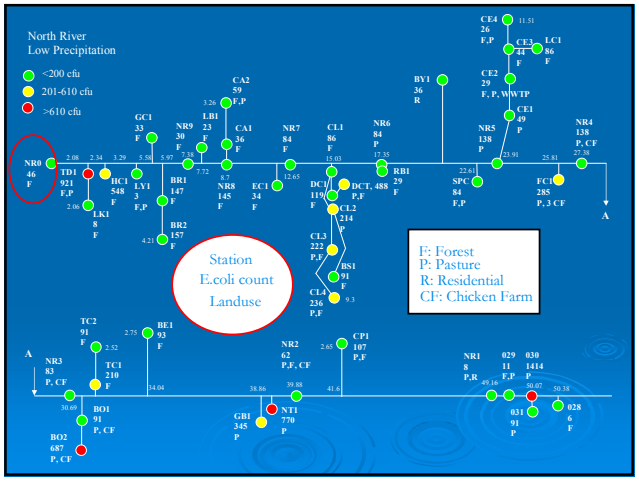
Water Quality Testing - City

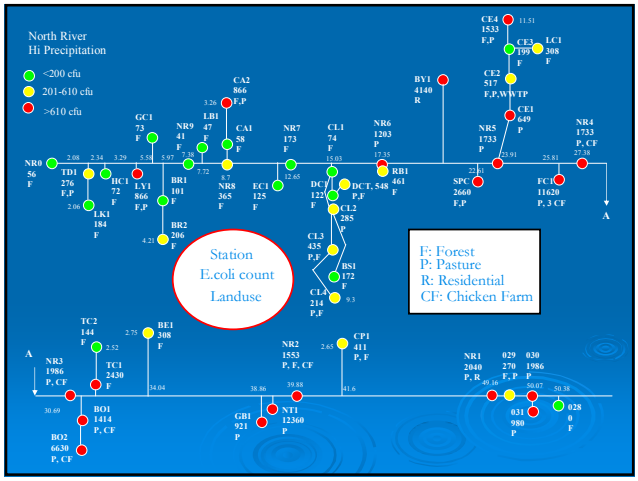


E.coli Data from City of Tuscaloosa sampling locations North part of Lake

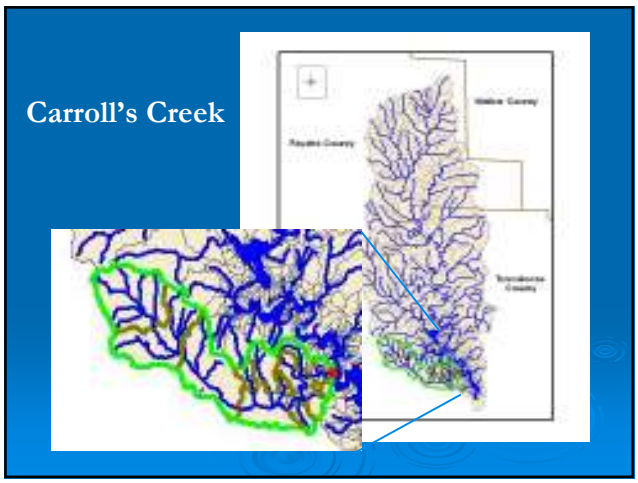
E.coli Data from City of Tuscaloosa sampling locations South part of Lake



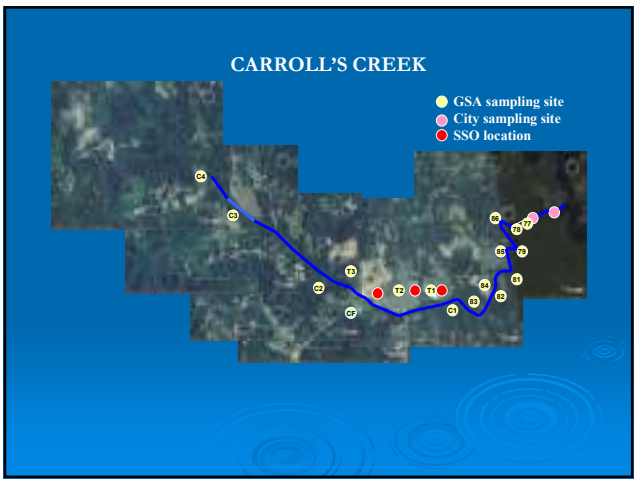


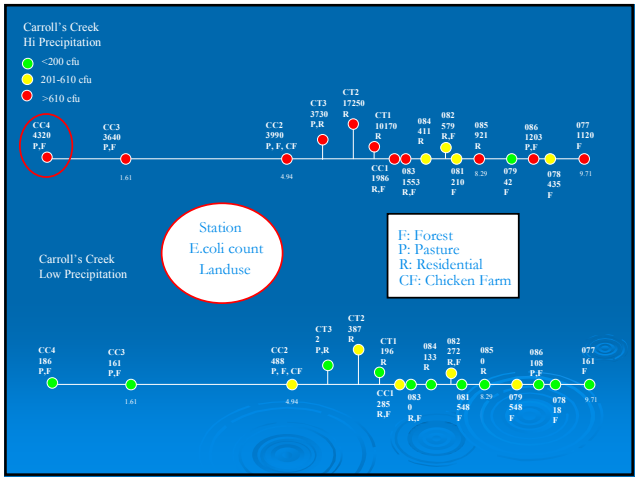


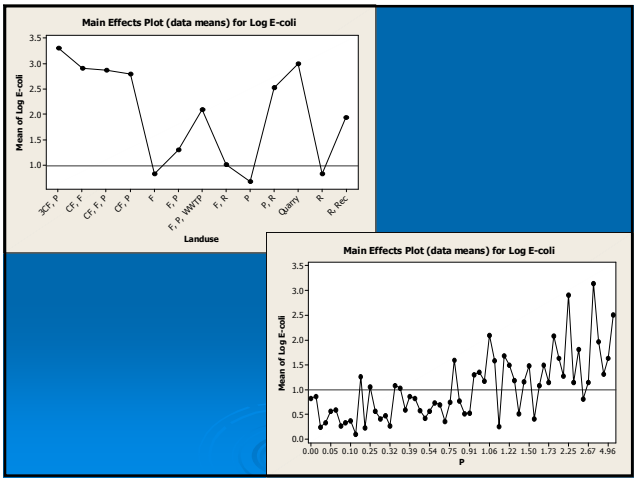
Carroll's Creek



CARROLL'S CREEK







Choosing Systems

Since the 1960's every few years organizations, institutions, and engineering groups say that we need to improve the decision making in terms of implemented systems

"Inadequate planning is a persistent fundamental problem ... Planning documents are often specific and clear as to the physical and financial inputs, personnel, activities and expected physical results. But thorough assessment of the overall objectives, the target groups, and the external factors which determine success or failure is often lacking". NORAD, 1990

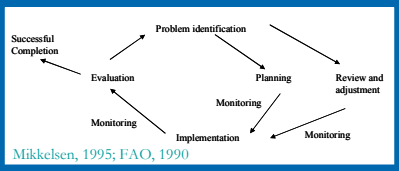
Butterworth and Soussan (2001), UNEP (2002), WHO (2003C), and Oldfield (2006) in their surveys and studies have come up with a list of general reasons behind systems' failure. These reasons are the following.

- Poor community involvement
- Financial and economic problems
- Lack of resources (material, machinery, manpower) for operation and maintenance
- Lack of education about water and sanitary problems
- Social and cultural problems
- Lack of professional and skilled individuals

Cont'd

- Poor enforcement of laws and regulations
- Inadequate or non existing policies
- Balancing between developing new systems and maintaining old ones
- Unavailability of supporting infrastructure
- Lack of data and information to support decisions

Stage in System Life Cycle to Choose Systems



Mikkelsen, 1995; FAO, 1990

Detailed activities for project life-cycle are (Cho and Gibson, 2001)

Project Assessment/ Feasibility	Programming	Schematic Design	Design Development	Construction Documents	Construction

- The most important activity in the project lifecycle
- This is where the different potential system(s) are chosen for the project
- The outcome of this activity affects the entire project and it leads to its success or failure

Stakeholders

(User, Owner, neighbor, influencer, etc)

Stakeholder	Description
City of Tuscaloosa (Water and Wastewater Management)	- Use the lake as a water supply for the City of Tuscaloosa
City of Tuscaloosa (City Council)	- Work with different entities to sustain the lake quality - Sustain the lake as an economic attraction for different types of development
General public using the lake for recreation purposes	- People go to the lake for fishing, swimming, skiing, boating, etc
Residents around the lake	- Consider the lake as an attraction point
Farmers (Cattle/Agriculture)	- Have land and property in the watershed

Facets

- Public Health
- Education and Training
- Finance and Economic
- Environment and Ecology
- Resources
- Ancillary Infrastructure
- Social and Cultural
- Regulatory

Stakeholders' Objectives

FACETS	OBJECTIVES
Education & Training	Educate the public about the watershed and its importance locally and regionally
	Keep the lake's website and media updated with information concerning E.coli counts and threats
	Improve training sessions for workers and public personnel responsible about the lake and the watershed
	Educate landowners about protecting the watershed from potential pollutants, such as E.coli, generated off of their properties
	Educate and inform policy makers and government officials about the lake and the potential E.coli threats
	Introduce stricter regulations to protect public health

Potential Solutions

- Reduce accessibility from pastures to waterbodies
- Confine pasture animals
- Implement more rigorous stormwater runoff control for chicken farms
  - Runoff barriers
  - Compost units
- Stricter environmental regulations in watershed
- Replace the sewer network

In addition to these potential solutions:

- Develop an educational program for the different stakeholders
- Develop and enforce regulations that would help the progress and advancement of the area under consideration
- Consider financial options for the implementation of solutions
- Balance between existing and needed infrastructure for solutions robustness and sustainability

Discussion

- Environmental control solutions need to be robust, sustainable, reliable, etc
- This can be achieved by having a clear and well defined pre-project plan that considers all stakeholders objectives that can be categorized through the facets