Esta ponencia fue presentado por el Dr. George Veni
en el Primer Seminario Sobre el Manejo Sostenible de Karst
en Coban, Alta Verapaz, Guatemala el 16-19 de Julio de 2003.

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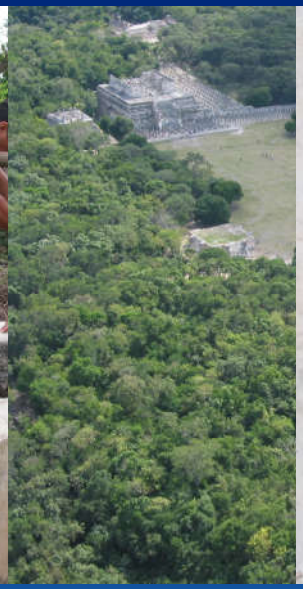
KARST MANAGEMENT

Resource and issue analysis

Define the limiting factors for the karst area's land use and development

Water Archeology Biology People and funds

Define areas critical to the protection of those resources and protect them

Determine if the karst area's carrying capacity is known

Manage impacts to the limits of the carrying capacity, buffered based on potential for accidents and uncertainty

Water resource management: a drainage basin approach

Addresses total water use and pollutant loading, a manageable and effective level for sustainable usage

Often defines or is related to

ecosystem boundaries

cultural/economic needs

regulatory authorities

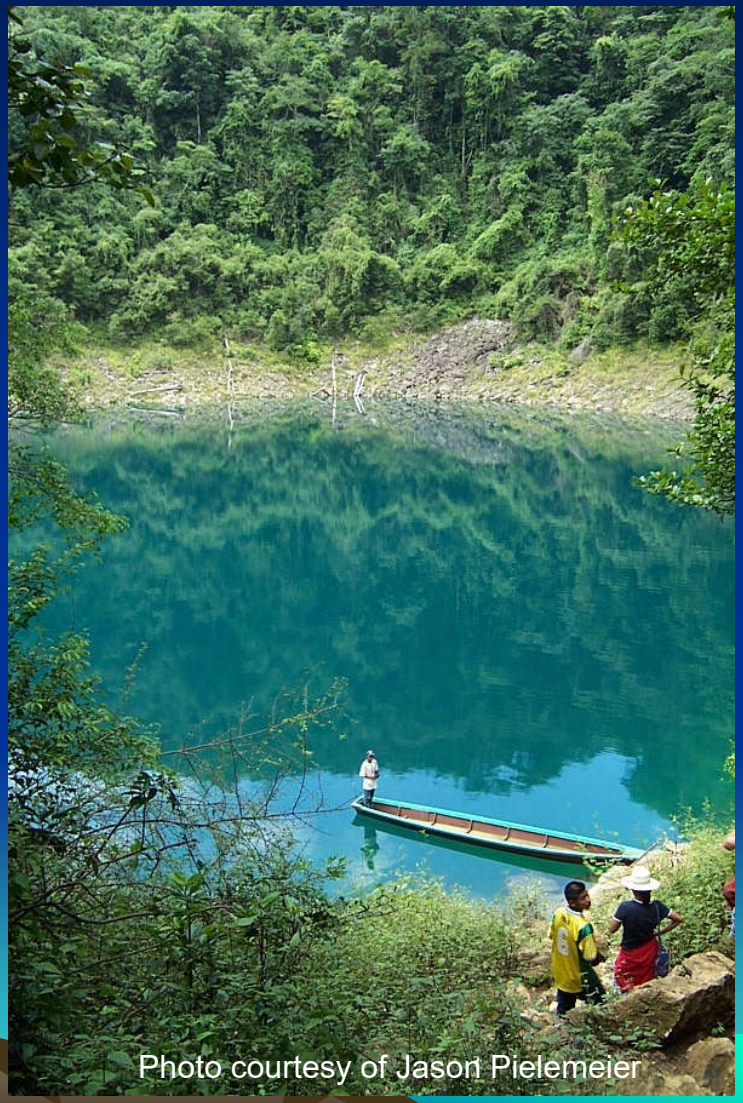


Photo courtesy of Jason Pielemeier

Critical drainage basin area delineation and vulnerability mapping

ASTM/EPA approach
European approach
Morphological approach

Water quality solutions

Prevent or restrict contaminants from karst

Ban hazardous materials, landfills, sewage facilities, stockfarms, & USTs

Double to triple containment with interstitial monitoring for pipelines, sewers, ASTs, and storage facilities.

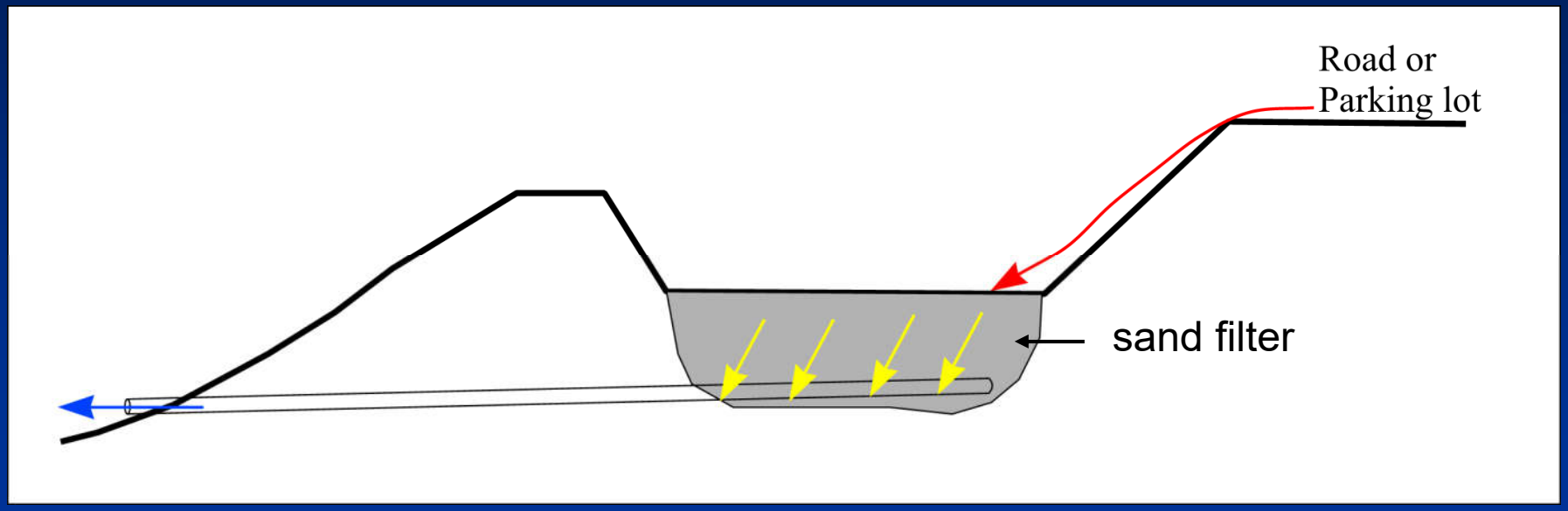
Regular monitoring of facilities to assure no leakage

Deed restrictions on activities

Restrict remaining contaminants from critical areas

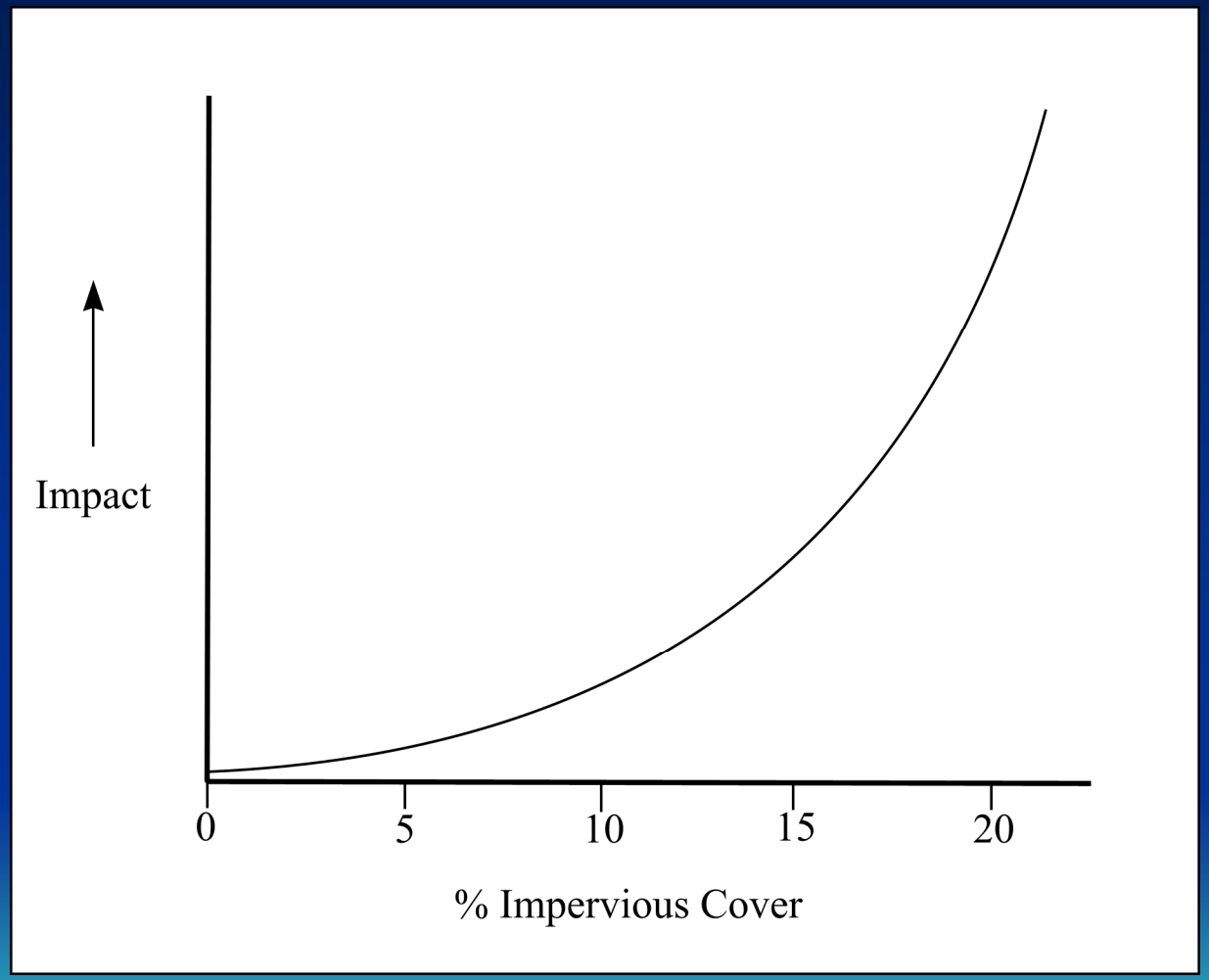
Minimize soil erosion at the source

Install mitigation measures
("Best Management Practices")



BMPs have limited effectiveness,
varying with the contaminant being filtered

Limit impervious cover to 15%



Purchase critical areas for protection

Water quantity solutions

Develop balanced/sustainable water usage
Discharge cannot exceed recharge!

Establish and meet your water budget

Conserve water
Reuse water
Harvest water

Photo courtesy of Jason Pielemeier

Enhance water quantity

Recharge dams

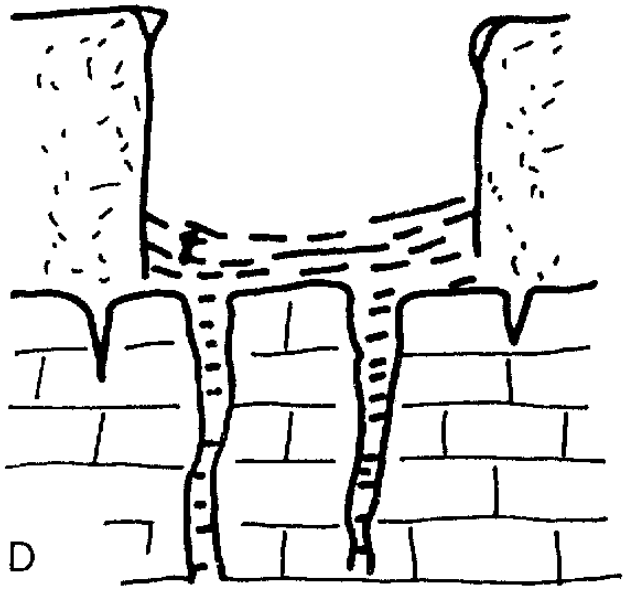
Effective with deep, slow flowing aquifers, not shallow, high velocity aquifers

Cloudseeding

Gaining in effectiveness
but not reliable yet for exceeding natural water budget

Solutions to engineering problems

Sinkhole collapse solutions



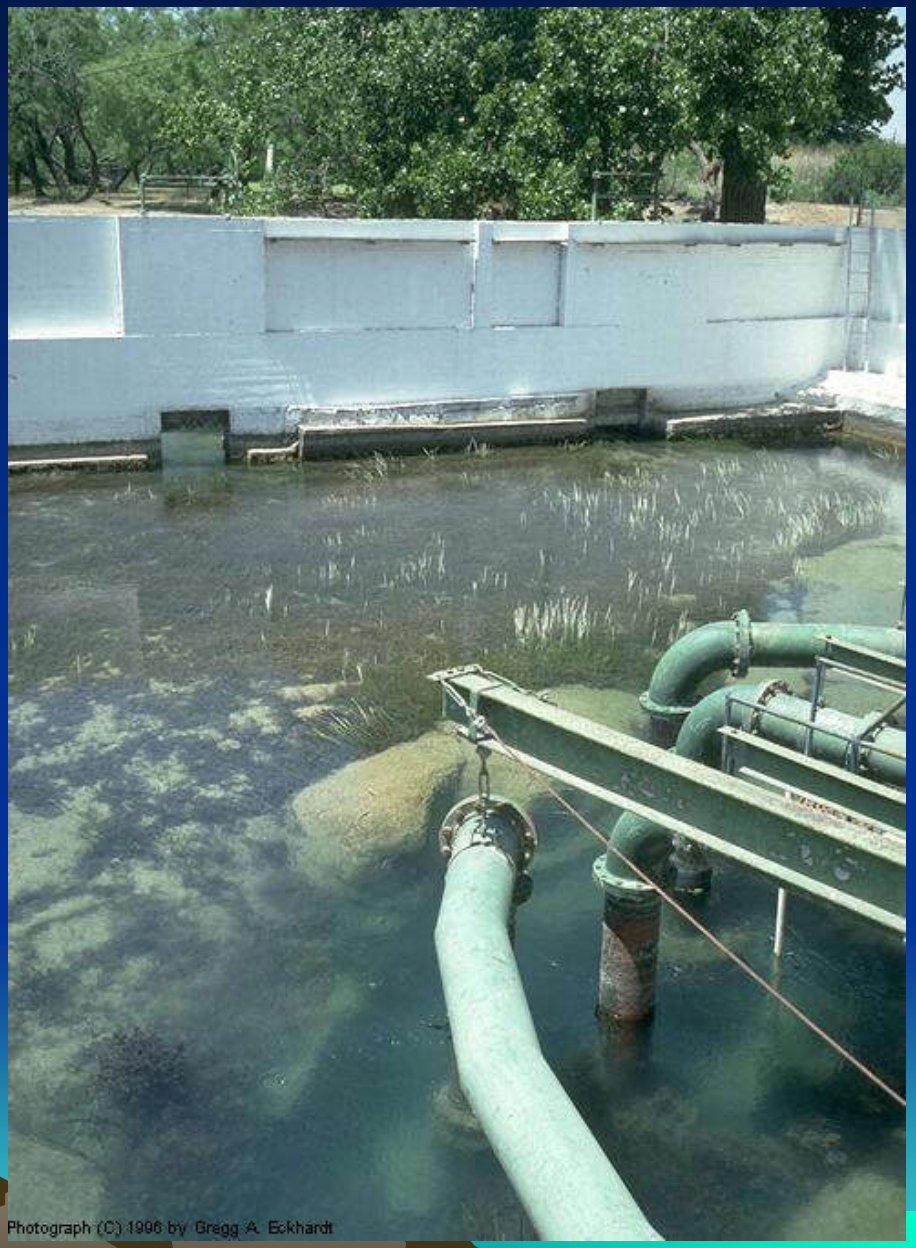
From: *Geomorphology & hydrology of karst terrains* (White, 1988)

Some engineering solutions
are not solutions

Dam grout curtains poorly effective

Example:
Amistad Dam
3850 grout holes
17,414 m^3 of grout

and the dam still leaks
32% gain at San Felipe Springs

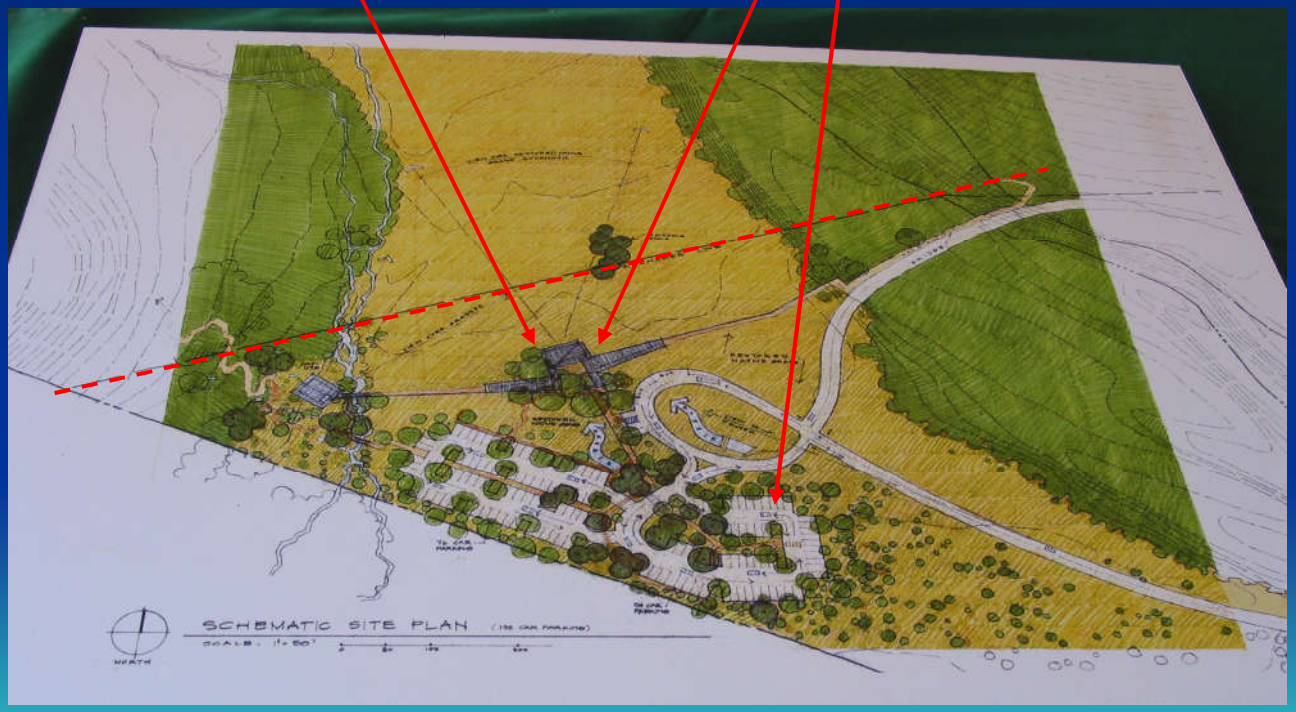


Cave management

Facilities for show caves and karst parks
Visitor centers prepare visitors for the cave and maximize experience

Location is near but off karst

Facilities include resource protection measures



For developed and undeveloped caves, develop management plan addressing:

Reasons for entry

Qualifications (scientific and safety)

Number of people per entry and frequency

Sampling and traveling protocols

“Leave no trace” goals

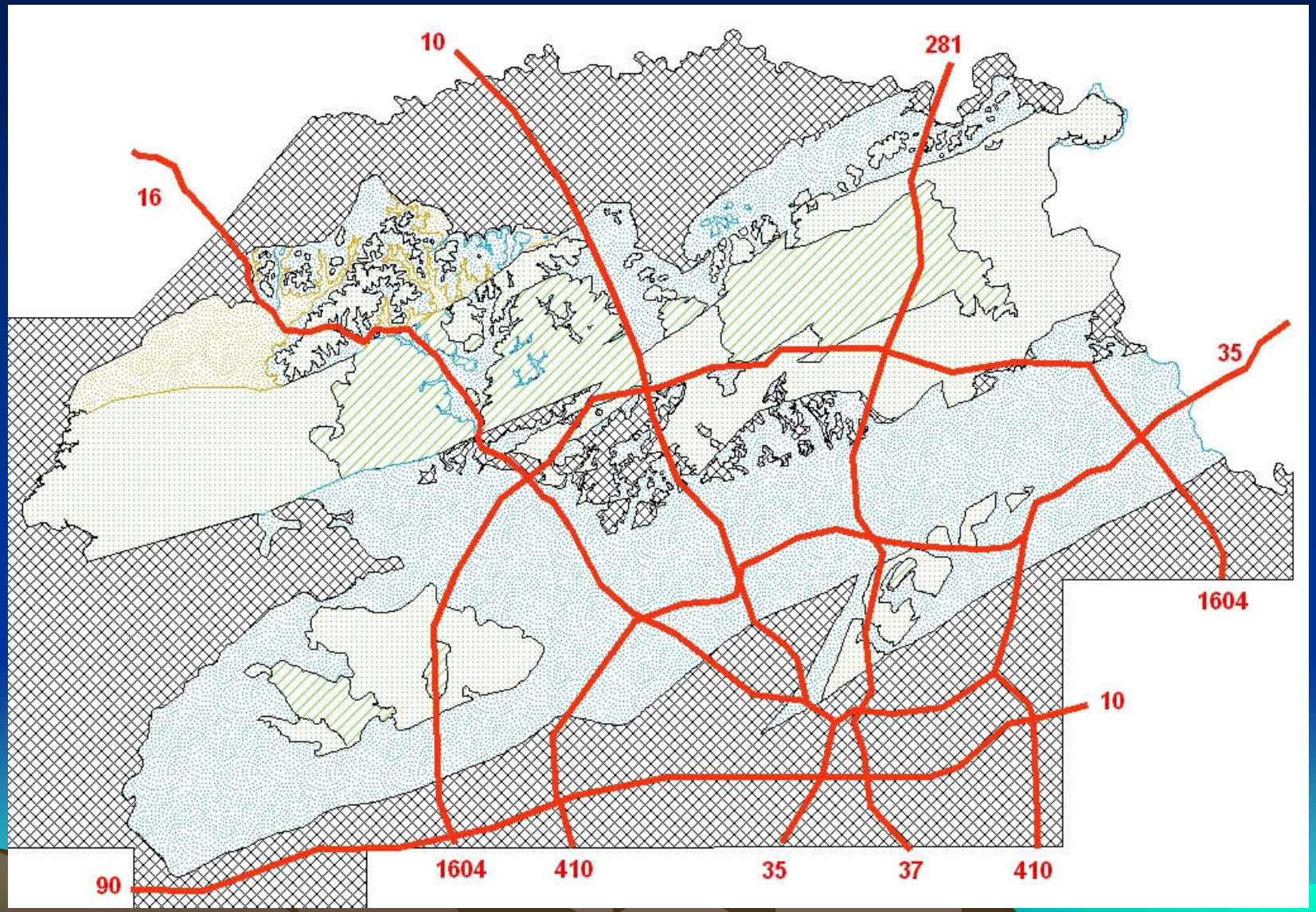
Identify cave's carrying capacity relative to:
Water resources
Ecosystem
Cultural and paleontological materials
Aesthetics
Safety

Maintenance
Trails: curbs and washing – discharge washwater appropriately

Speleothem cleaning

Speleothem repair

Habitat conservation plans

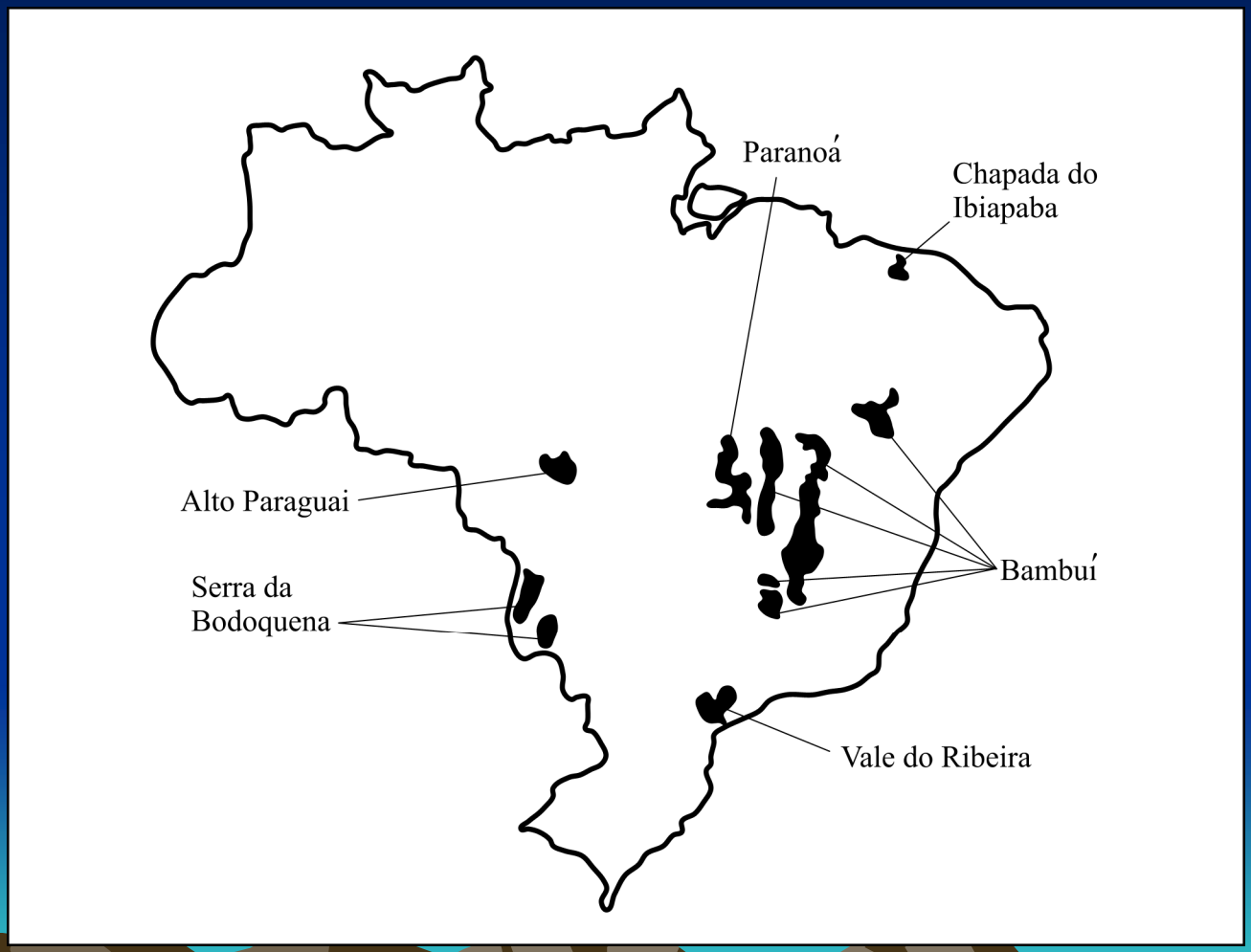


From: Veni (2002)

Cave and karst management laws
Cave and karst protection
Federal and state and laws

Surrogates for
cave and karst protection laws:
Groundwater laws
Wildlife laws
Antiquities laws
Federal and state parks

Brazil
A model for us all



Adapted from: *Caves of Brazil: the Brazilian Caves Win a New Ally* (CECAV, 2001)