

# Linear Manmade Structures, Hydroscape Fragmentation, And Ecological Consequences

Quan Dong



US Army Corps  
of Engineers®

# Hydroscape (Dong 2009)

- Surface water dominates: patches and flux
- Spatially heterogeneity: presence, depth, and flow of water
- Dominant process: water movement--flow
- Spatial patterns: water related patches, boundaries, ecotones, matrix and connectivity
- Spatial-temporal patterns: *seasonally shifting mosaic and pulsing connectivity*

# Outline

I. Introduction

II. Road

III. Levee

IV. Canal

V. Hydroscape fragmentation

VI. Conclusion and discussion



# Road

## I. general

- A. Thousands of studies
- B. Terrestrial and forest oriented
- C. Major agent of landscape fragmentation

# Road

## I. general

- A. Alter abiotic processes and conditions
- B. Alter biotic interactions, distribution and abundance
- C. Increase human domination over natural systems

# I. Five general mechanisms

- i. create new habitats;
- ii. block the movement and dispersal of organisms;
- iii. provide travel lanes,  
particularly for exotic species;
- iv. generate edge effects;
- v. fragment landscapes.

# Road

## II. Effects on hydroscape

- A. All major effects apply
- B. All major mechanisms operate
- C. Impose significant hydrologic effects  
thus might generate more serious impacts at the  
landscape scale

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# Levee

1. alter the hydrology and other physical processes
2. thus degrade natural habitats and influences biotic interactions
3. create conditions for human activities



## Levee: major hydrologic mechanisms

- i. obstruct the flow;
- ii. affect the spatial and temporal distribution of flow and depth:
  - a. reduce the regulatory capacity of watersheds and thus increase flow fluctuations of downstream water bodies,
  - b. create impoundments, and still and deep water conditions,
  - c. reduce or eliminate inundation in previously flood plains and wetlands, and thus create dry land;
- iii. alter the natural patterns of shifting mosaic and pulsed connectivity;
- iv. fragment rivers and flood plains, and interrupts the hydrologic continuity.

# Levee: major physical-chemical mechanisms

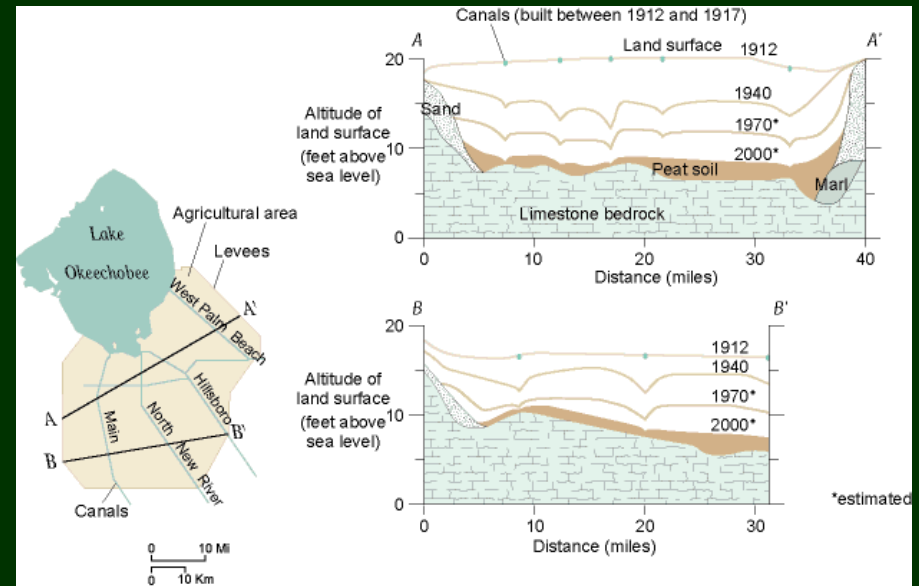
- i. block the movement of materials, including sediments, woody debris, and nutrients;
- ii. trap or screen out particles;
- iii. change turbidity levels;
- iv. alter sediment transport;
- v. change geomorphic features of the hydroscape;
- vi. modify the fate of contaminants;
- vii. change water quality.

## Levee: major ecological mechanisms

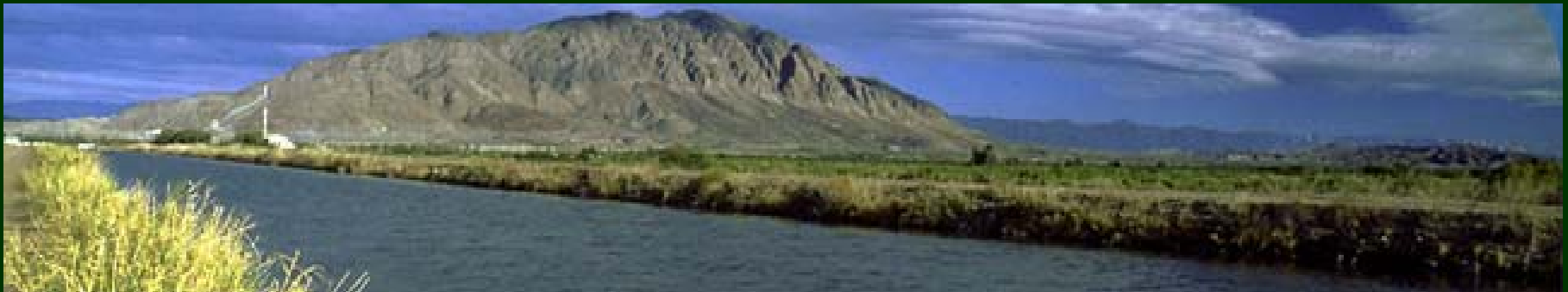
- i. Alter habitats:
  - a. create new habitats,
  - b. degrade habitats for previously adapted native species,
- ii. block the movement and dispersal of organisms,
- iii. provide travel lanes, particularly for exotic species,
- iv. generate edge effects,
- v. fragment hydroscapes, and alter the connectivity of populations, trophic structures, and ecosystem processes.

# Levee: increase human activities

- i. Land conversions;
- ii. Ground subsidence;



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# Canal

1. alter the hydrology and other physical processes,
2. thus degrade natural habitats and influences biotic interactions,
3. create conditions for human activities



# Canal: major hydrologic mechanisms

- i. Convey water flow,
- ii. Affect the spatial and temporal distribution of flow and depth:
  - a. drain water, reduce or eliminate inundation in previously wet areas, and thus create dry land,
  - b. create deep and permanent water conditions;
  - c. irrigate dry areas;
- iii. alter the natural patterns of shifting mosaic and pulsed connectivity.
- iv. fragment wetlands, and alter the hydrologic continuity.





# Canal: major physical-chemical mechanisms

- i. Transport materials;
- ii. Alter geomorphic features of the hydroscape;
- iii. Modify the fate of contaminants;
- iv. Change water quality.



# Canal: major ecological mechanisms

- i. Alter habitats:
  - a. create new habitats,
  - b. reduce or degrade habitats for previously adapted native species;
- ii. Facilitate or block the movement and dispersal of organisms,
- iii. Provide travel lanes, particularly for exotic species,
- iv. Generate edge effects,
- v. Fragment hydroscapes.
- vi. Alter the connectivity of populations, trophic structures, and ecosystem processes



# Canal: increase human activities

- i. Land conversions;
- ii. Navigation and recreational access to interior areas;
- iii. Others, oil pipe etc;



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# Fragmentation

leads to:

- a. isolation of one fragment from other similar areas
- b. decrease in the interior areas,
- c. increase in edges,
- d. reduction in the total area of certain types of patches,
- e. increase in the number of fragments.

As a result, the average sizes of previously dominant patches decrease.

alters the physical environment and physical processes, and causes changes in the distribution and abundance of animals, plants and microbes.

# Hydroscape Fragmentation

Key: Interrupt water flow,

leads to changes in:

- a. spatial-temporal distribution of physical-chemical processes,
- b. geomorphic configurations,
- c. previously continuous topographic, hydrologic, biogeochemical, and biological gradients, and generate punctuated distribution, discontinuity, and disconnectedness,
- d. the distribution and abundance of animals, plants and microbes.

1. Introduction
2. Road
3. Dam and levee
4. Canal
5. Hydroscape fragmentation
6. Conclusion and discussion

# Hydroscape Ecology

## significant contribution to landscape ecology

1. Clear demonstration of the linkage between processes and patterns
2. Clear illustration of the mechanic structures of a human-nature complex systems
3. Guidelines of ecological engineering at the hydroscape scales.



# History and New Trend

- Construction of linear structures
- Removal for multiple services and diverse interests:
  - Road modification,
  - Canal backfill,
  - Levee removal;



Stone, R. 2006. The End of Angkor. Science



# Critical Issues: movements!

- Water flow;
- Transport of materials: sediments, nutrients, and contaminants;
- Movement of organisms;

Right place, right time, right amount,

Seasonally shifting mosaic and pulsing connectivity

# Questions

