Decision Support Tool for Rainwater Harvesting Program Implementation

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Introduction

- The so-called 'soft solutions', such as rainwater harvesting, aim to 'make the most of what we have' rather than using massive physical infrastructure projects that store and supply water over long distances (Brooks et al., 2009).

- According to an unofficial count, currently about 30 cities in the U.S. offer discounts and rebates to its residents to install RHP. For more detail see http://www.bushmanusa.com/rainwater-harvesting-rebates.php

In California…

- When the California State Assembly's Select Committee on Regional approached to Addressing the State's Water Crisis hosted a May 2012 hearing on the "The Future of Stormwater: Capture, Store and Supply" in Los Angeles, the Los Angeles Department of Public Works estimated significantly lower future costs for captured rainwater ($100-$300 per acre-foot) versus current imported water supplies ($800 per acre-foot).

- California Legislature continues their efforts to send legislation to the Governor's Office to amend the California Water Code to "enact a Rainwater Capture Act which would authorize residential, commercial, and governmental landowners to install, maintain, and operate rain barrel systems, as defined, and rainwater capture systems, as defined, for specified purposes, provided that the systems comply with specified requirements."

Potential Benefits of RHP

- Reduced peak discharge values
- Improved water quality in open channels
- Potable water demand reduction
- Carbon savings from decrease in energy use required to treat and deliver potable water
- Lower likelihood of Combined Sewer Overflow (CSO) events.
- Concern about the sustainability of urban water supply is a strong motivation to understand the potential of rainwater use and on-site water recycling in urbanized cities (Furumai, 2008).

Roadblock to RHP Implementation

- Water prices in the US are among the lowest worldwide. For example, the typical U.S. household uses twice the amount of water than in Europe, but the annual household cost of water is roughly the same (Kloss, December 2008).

- US western water rights, which prohibit rainwater harvesting in some areas where it is not considered a private resource (Kloss, December 2008).

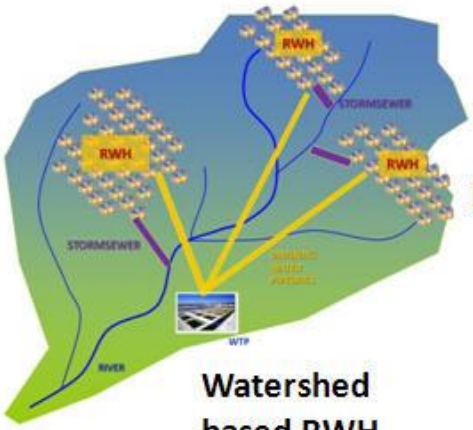
- Neither the Uniform Plumbing Code in the US nor the International Plumbing Code has regulations in their potable or stormwater sections for rainwater harvesting (Kloss, December 2008).

Objectives

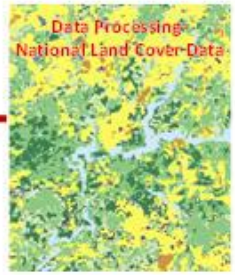
- to describe and characterize the numerous benefits and costs of a RHP and present a methodology for conducting a formal Benefit Cost Analysis (BCA).
  - considering the relationship among economic development, environmental quality, and social equity

- to estimate the total economic values of harvested rainwater
- to describe the conditions where RHP is a sustainable and effective policy to implement
- to determine the optimized scale (local user, city, district or regional levels) to implement RHP

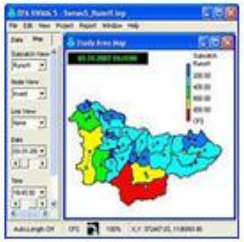
Framework of Decision Support Tool for Rainwater Harvesting Program Implementation



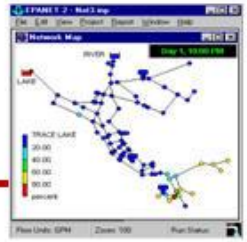
Watershed based RWH Model



GIS



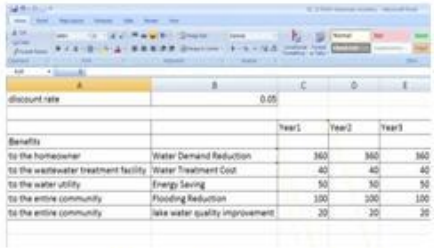
EPA - SWMM



EPANET

Benefit	Cost
B1	C1
B2	C2
B3	C3
B4	C4
B5	C5
…	…

Tabulation of Benefit and Cost in Dollar Values



Excel Based BCA Model

Benefit Cost Analysis (BCA)

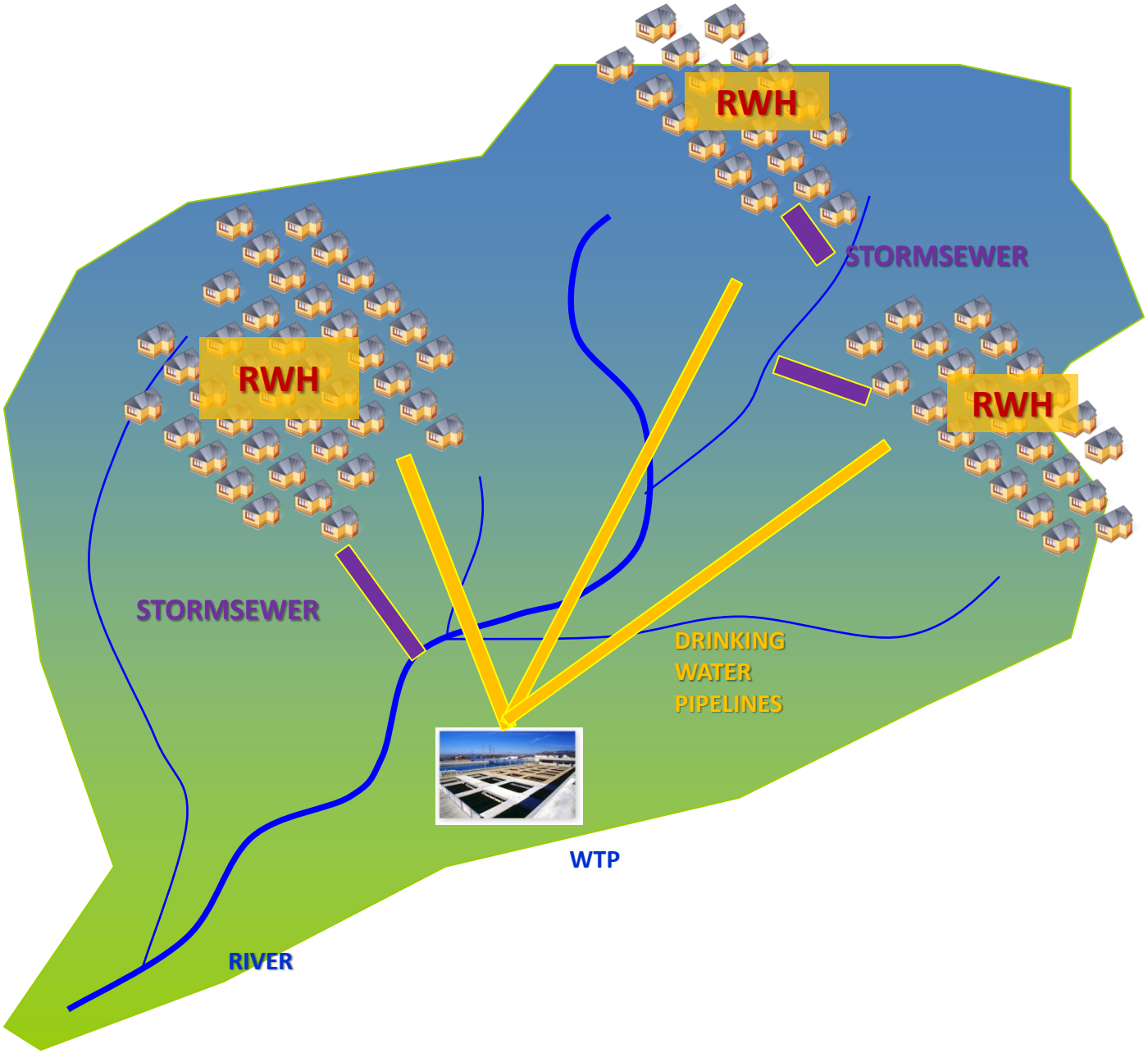
- *Step 1*: defines the scope of the analysis – population, elements of the project, location, timing, and characteristics of the work to be done.
- *Step 2*: determines a project's full range of inputs and effects, throughout project life cycle
- *Step 3*: quantifies the costs and benefits resulting from the project's inputs and effects, or qualitatively describe the cost or benefit, including degree of uncertainty and expected timing of impacts (long-term or short-term).
- *Step 4*: compares the benefits and costs of the project, either in terms of net benefits or in terms of a benefit-cost ratio.

Step 1: Assignment of Benefits and Costs

Table 1: Taxonomy of Benefits and Costs of Rainwater Harvesting

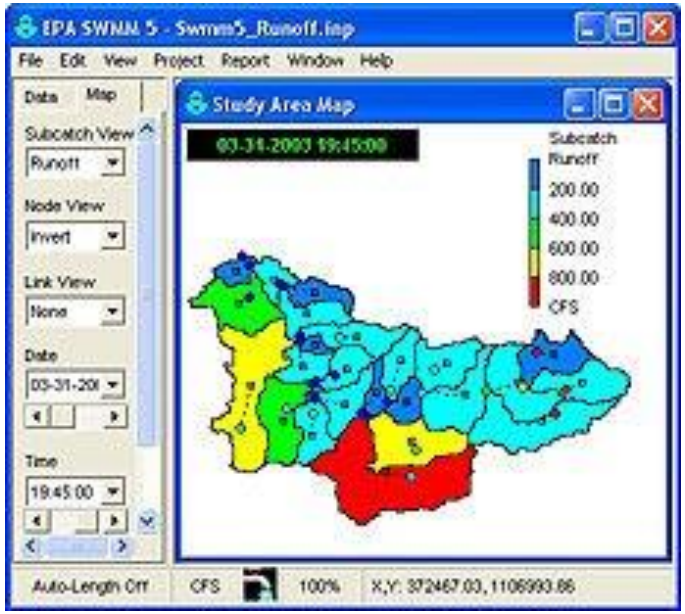
Decision-maker	Market	Non-Market
Homeowner	Benefits: i. (B1) lower water bill ii. (B2) Increase in property value	Benefits: i. (B3) pride, 'warm glow' from saving the environment.
	Costs: i. (C1) Equipment installation (e.g. tank, pump etc.) and maintenance	Costs:
City	Benefits: i. (B4) energy saving from lower production of water from alternative sources (groundwater pumping and/or surface conveyance). ii. (B5) reduction in installation and maintenance cost of water utility infrastructure.	Benefits: i. (B6) improved water quality in receiving waterways due to less polluted runoff. ii. (B7) lower likelihood of combined sewer overflow (CSO) and resulting damage iii. (B8) Carbon saving from reduction in energy required to send water over long distances
	Costs: i. (C2) subsidy or a rebate program for RHP equipment	Costs:

Step 2: A Spatial Representation



Step 3: Stormsewer Systems and Runoff

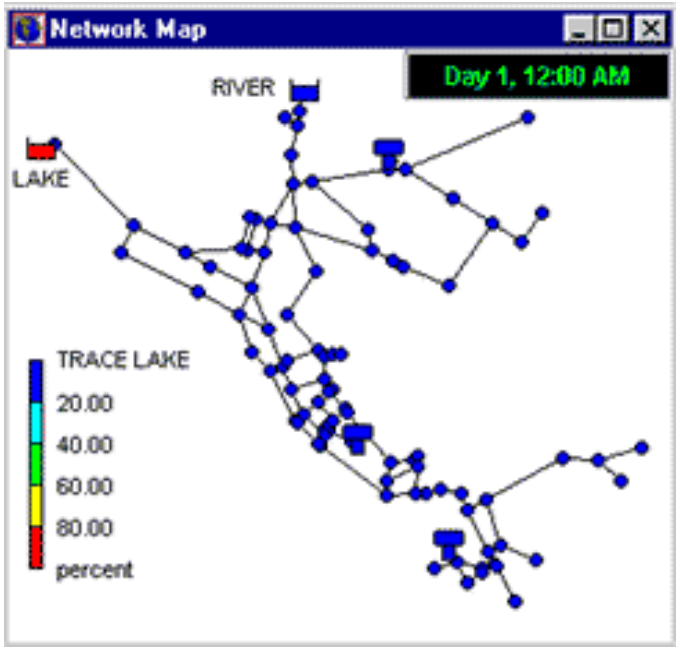
- This will be done with EPA SWMM, which will help calculate B6.
- SWMM, as defined by the EPA, is a dynamic rainfall-runoff simulation model used for single event or long-term (continuous) simulation of runoff quantity and quality from primarily urban areas; modeling pollutant washoff from specific land uses during storm events.



Step 4: Drinking Water Distribution Systems

- Will be done with EPANET, which will help calculate B4, B5 and B8

- to analyze hydraulics, water quality, and energy consumption within the drinking water distribution systems; quantification of water/energy savings, associated greenhouse gas emission reductions, and economic benefits due to delay of additional water infrastructures.



Step 5: Net Present Value of RHP

$$Homeowner\_NPV = \frac{\sum_{t=0}^{t=T}(B1_t - C1_t)}{(1+R)^t}$$

$$City\_NPV = \frac{\sum_{t=0}^{t=T}(B4_t + B5_t + B6_t + B7_t + B8_t - C2_t)}{(1+R)^t}$$

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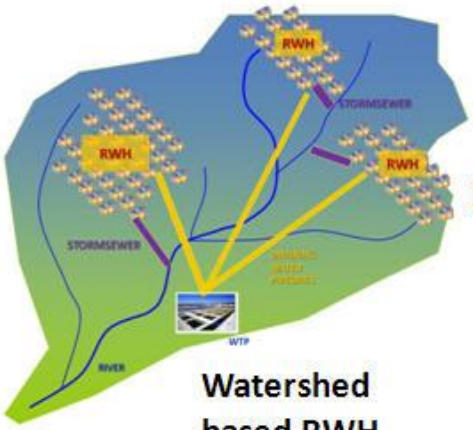

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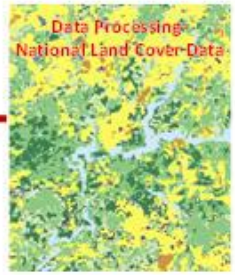

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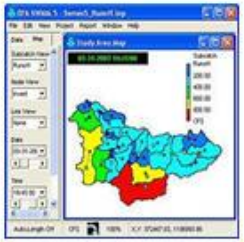

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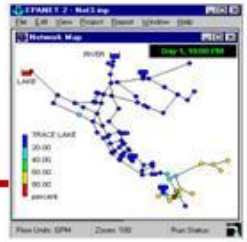

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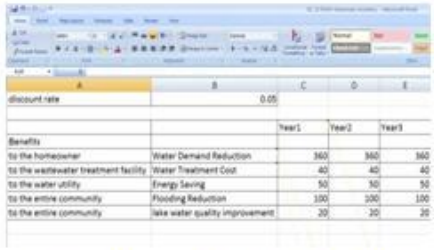
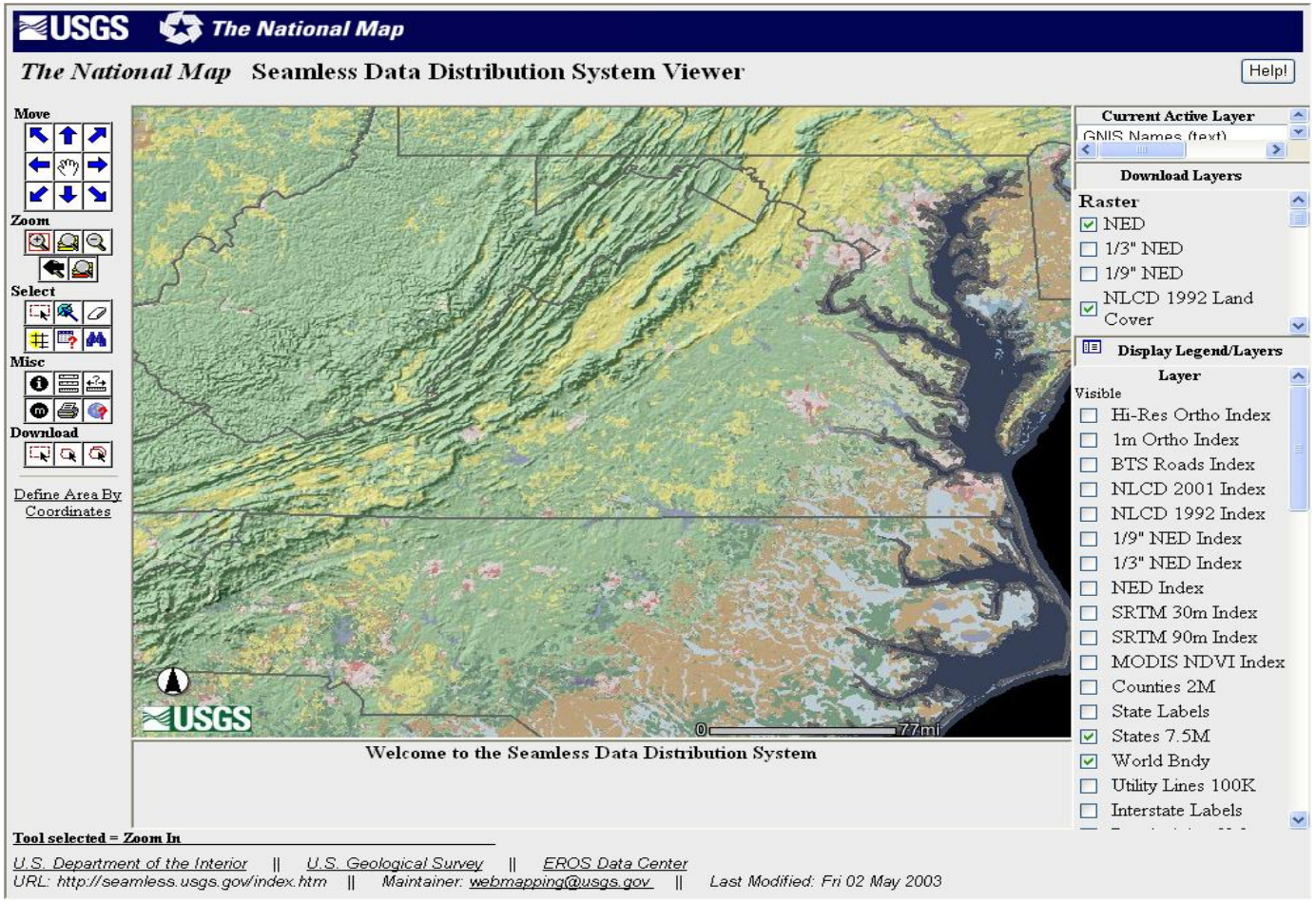


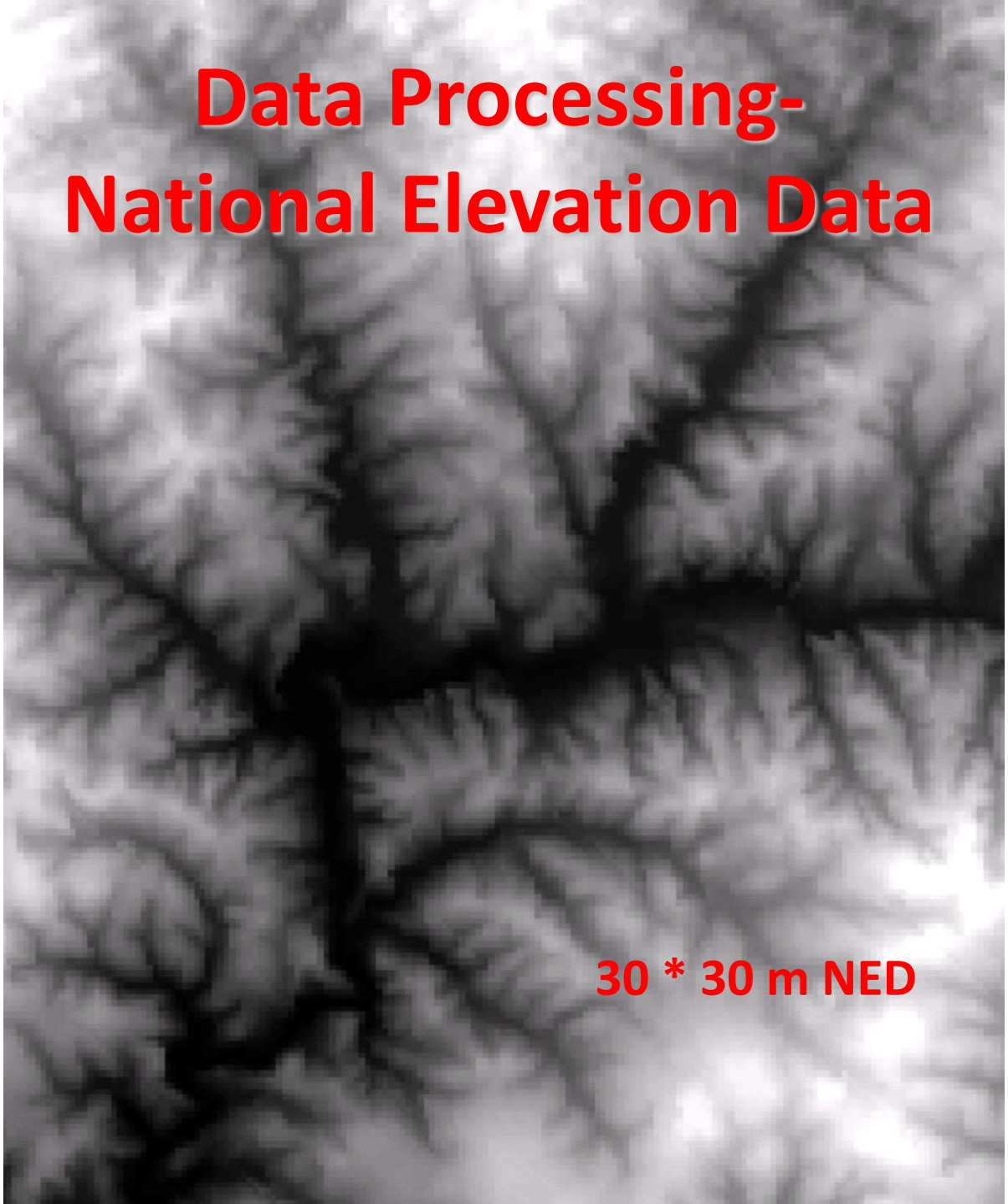
Excel Based BCA Model

Data Acquisition and Process

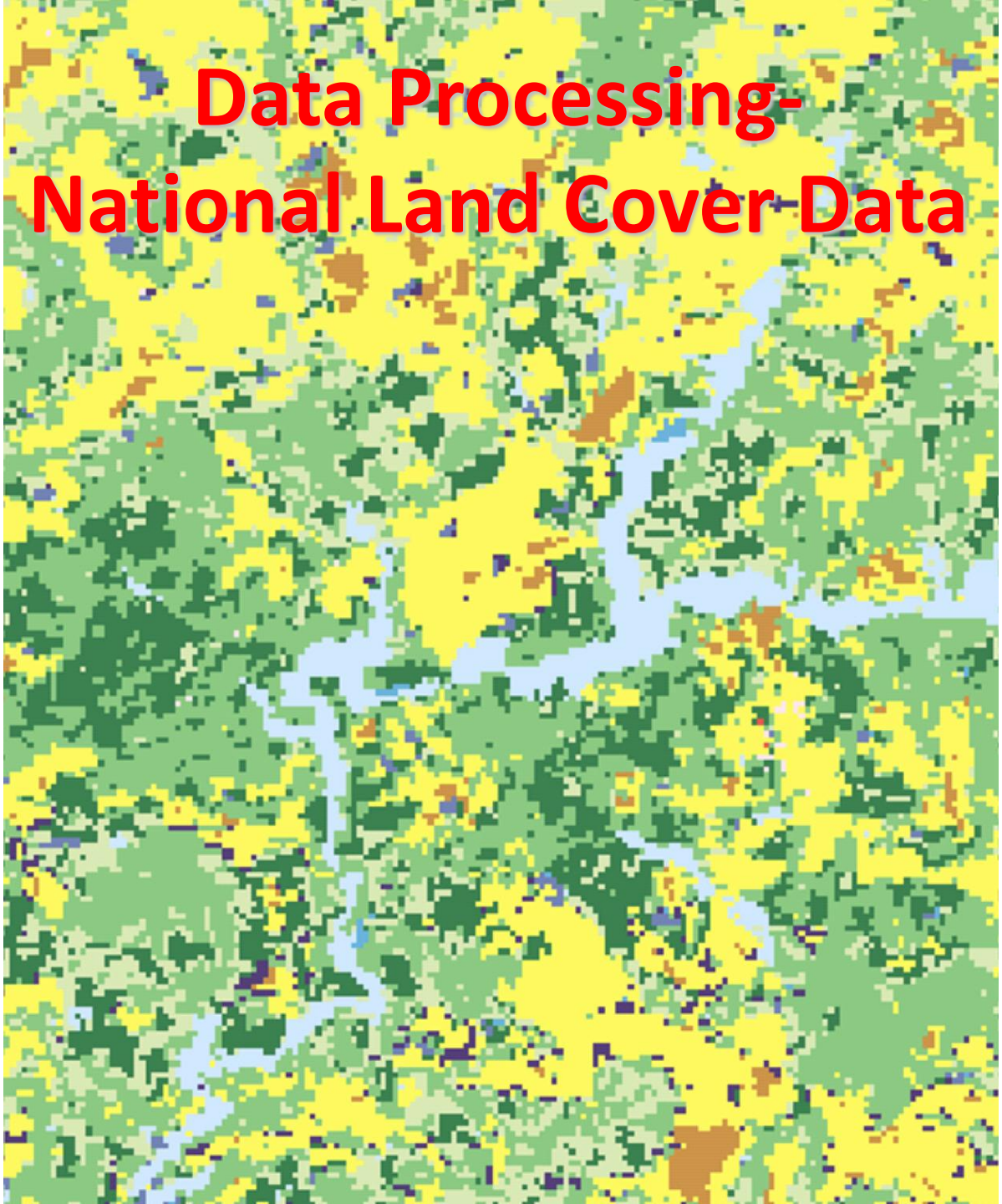


http://seamless.usgs.gov/viewer.htm

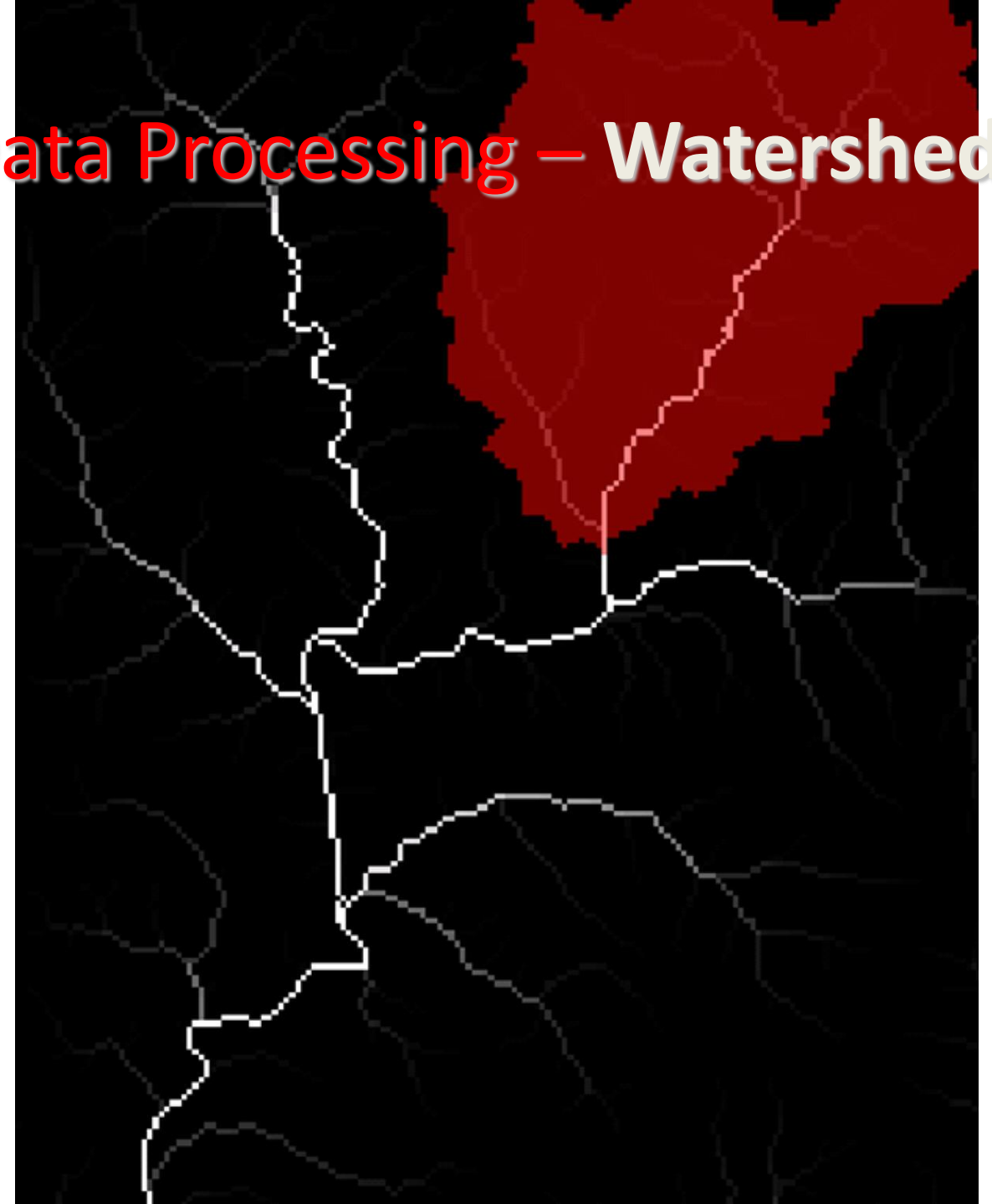
Data Processing- National Elevation Data



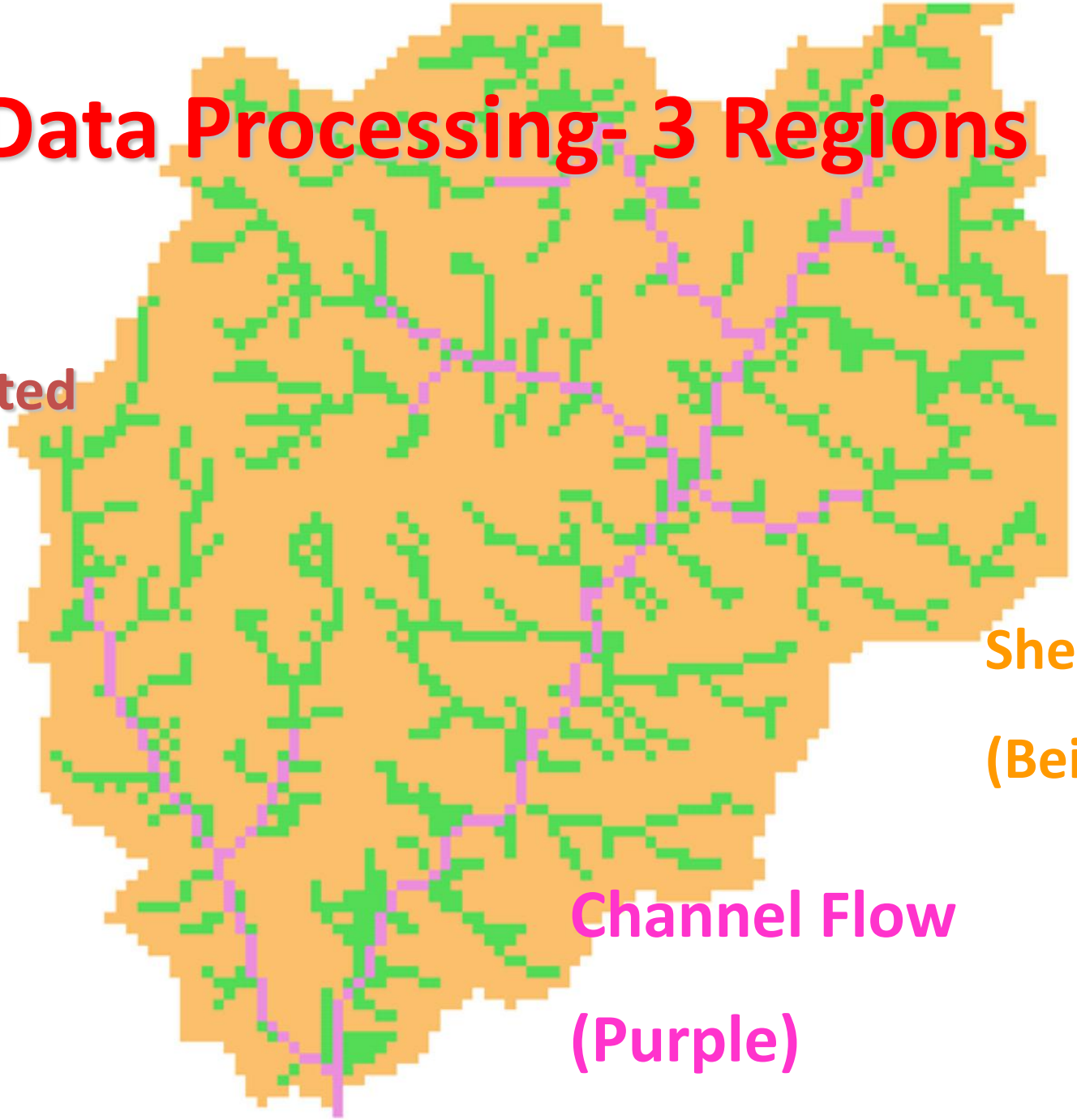
Data Processing- National Land Cover Data



Data Processing – Watershed I



Data Processing- 3 Regions



Concentrated Region (Green)

Sheet Regio (Beige)

Channel Flow (Purple)

Broader Impacts & Next Steps

- This project will focus on retrofitting the existing developments, which will have broader impacts because there is already a tremendous amount of built infrastructure in urban cities.

- This outcome will supplement the knowledge base of the economic and environmental impacts, which will help formulate future management strategies to minimize environmental impacts, maximize public satisfaction and safety in urban cities.

- The authors plan to submit the proposal to *NSF Environmental Sustainability Program during January 2013*.

Acknowledgements

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Thank you, any questions?

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