

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).

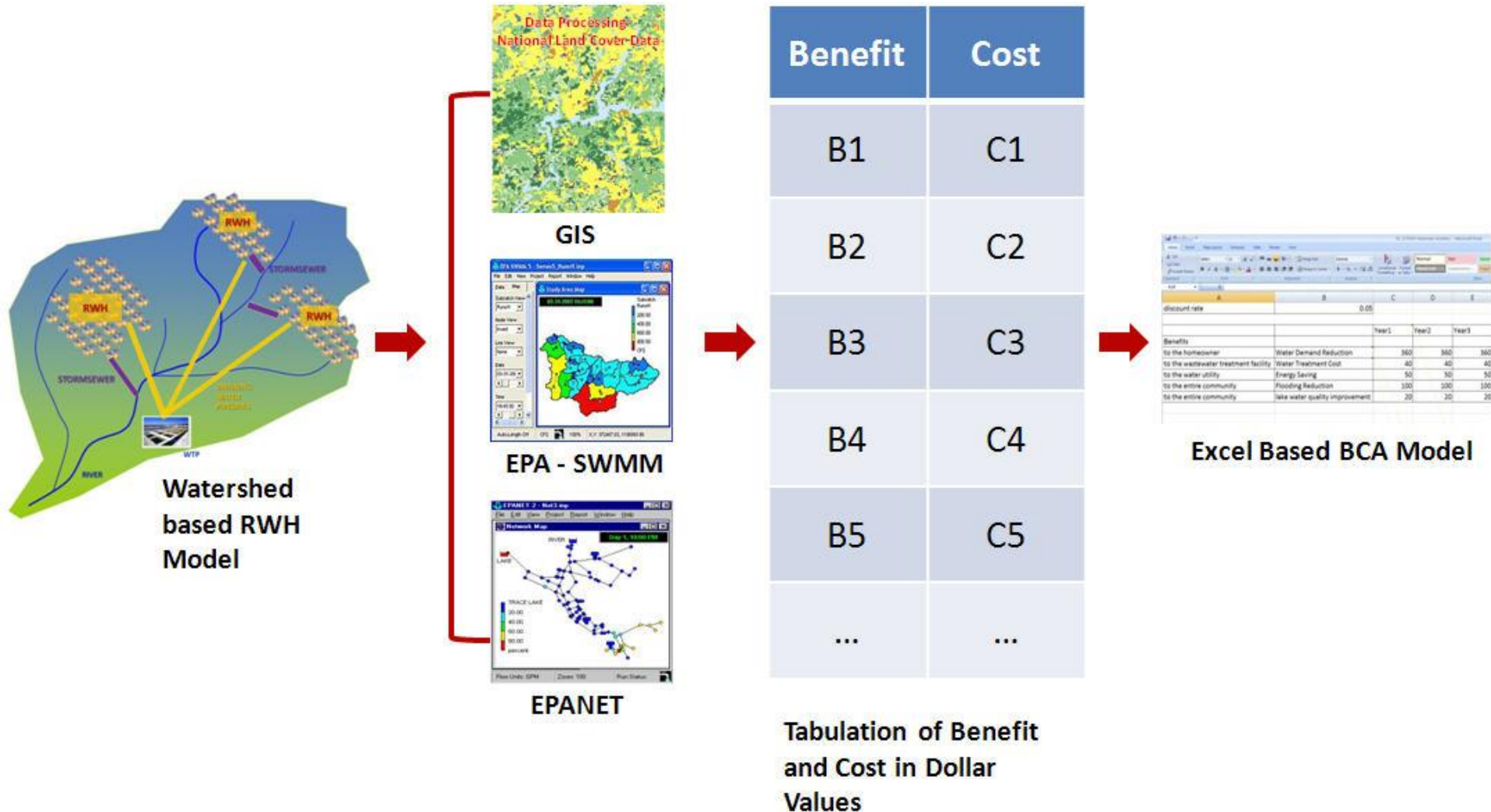
Roadblock to RHP Implementation

- **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



Benefit Cost Analysis (BCA)

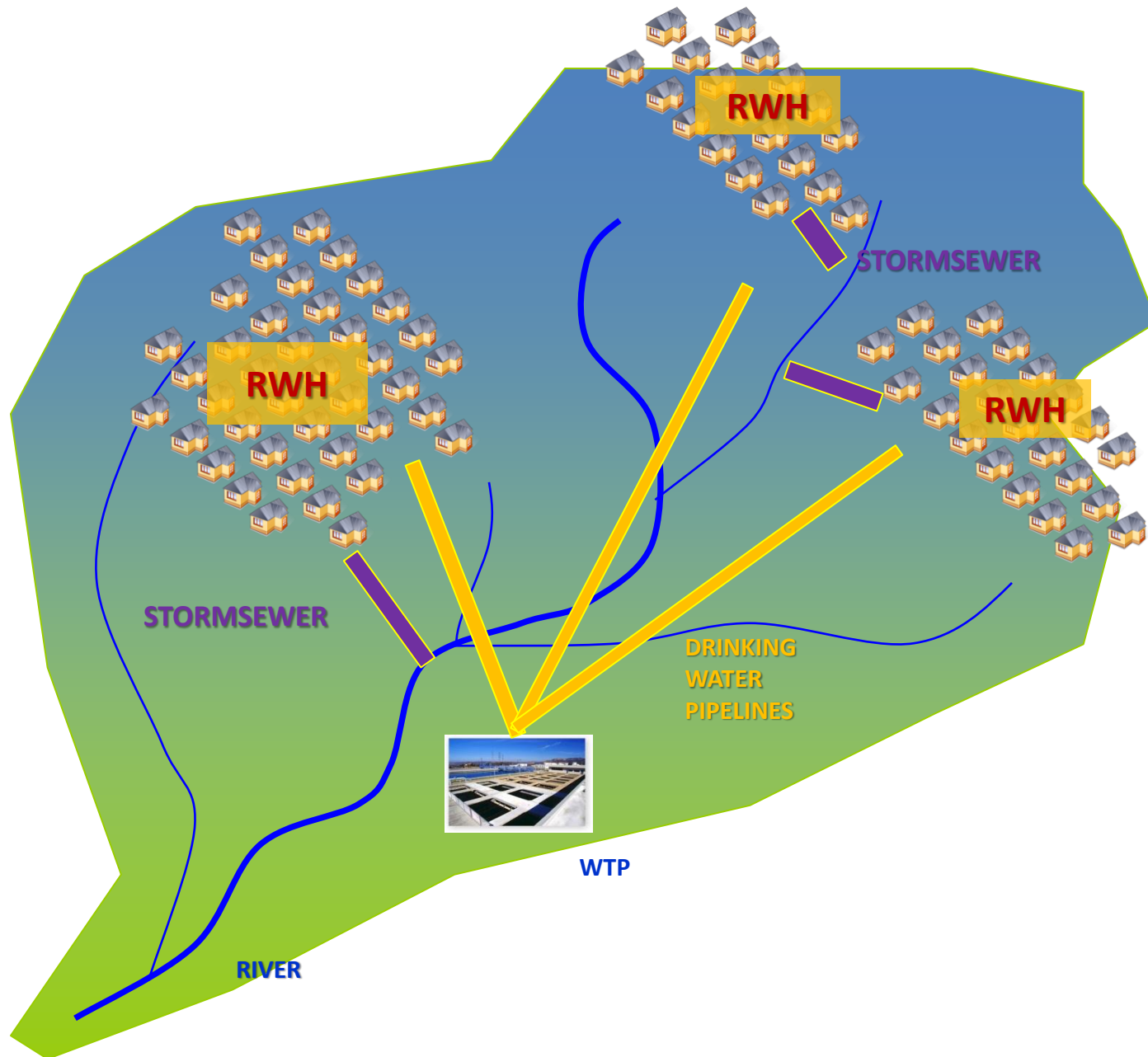
- *Step 1: defines the scope of the analysis* – population, elements of the project, location, timing, and characteristics of the work to be done.
- *Step 2: determines a project's full range of inputs and effects,* throughout project life cycle
- *Step 3: quantifies the costs and benefits* resulting 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

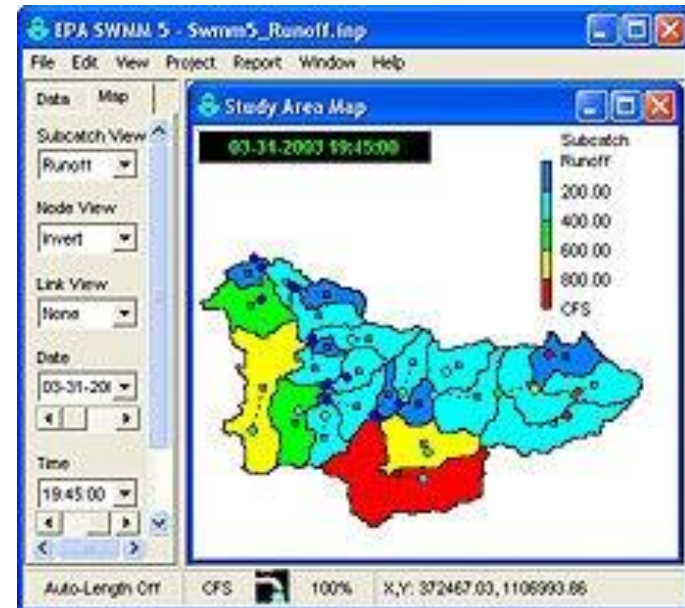
Decision-maker	Market	Non-Market
Homeowner	<p><u>Benefits:</u></p> <ul style="list-style-type: none"> i. (B1) lower water bill ii. (B2) Increase in property value 	<p><u>Benefits:</u></p> <ul style="list-style-type: none"> i. (B3) pride, 'warm glow' from saving the environment.
	<p><u>Costs:</u></p> <ul style="list-style-type: none"> i. (C1) Equipment installation (e.g. tank, pump etc.) and maintenance 	<p><u>Costs:</u></p>
City	<p><u>Benefits:</u></p> <ul style="list-style-type: none"> 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. 	<p><u>Benefits:</u></p> <ul style="list-style-type: none"> 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
	<p><u>Costs:</u></p> <ul style="list-style-type: none"> i. (C2) subsidy or a rebate program for RHP equipment 	<p><u>Costs:</u></p>

Step 2: A Spatial Representation



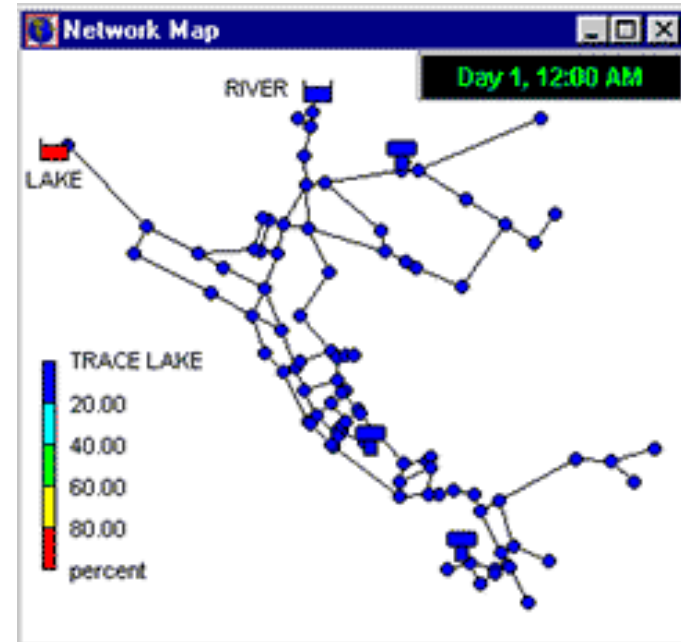
Step 3: Stormsewer Systems and Runoff

- 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.

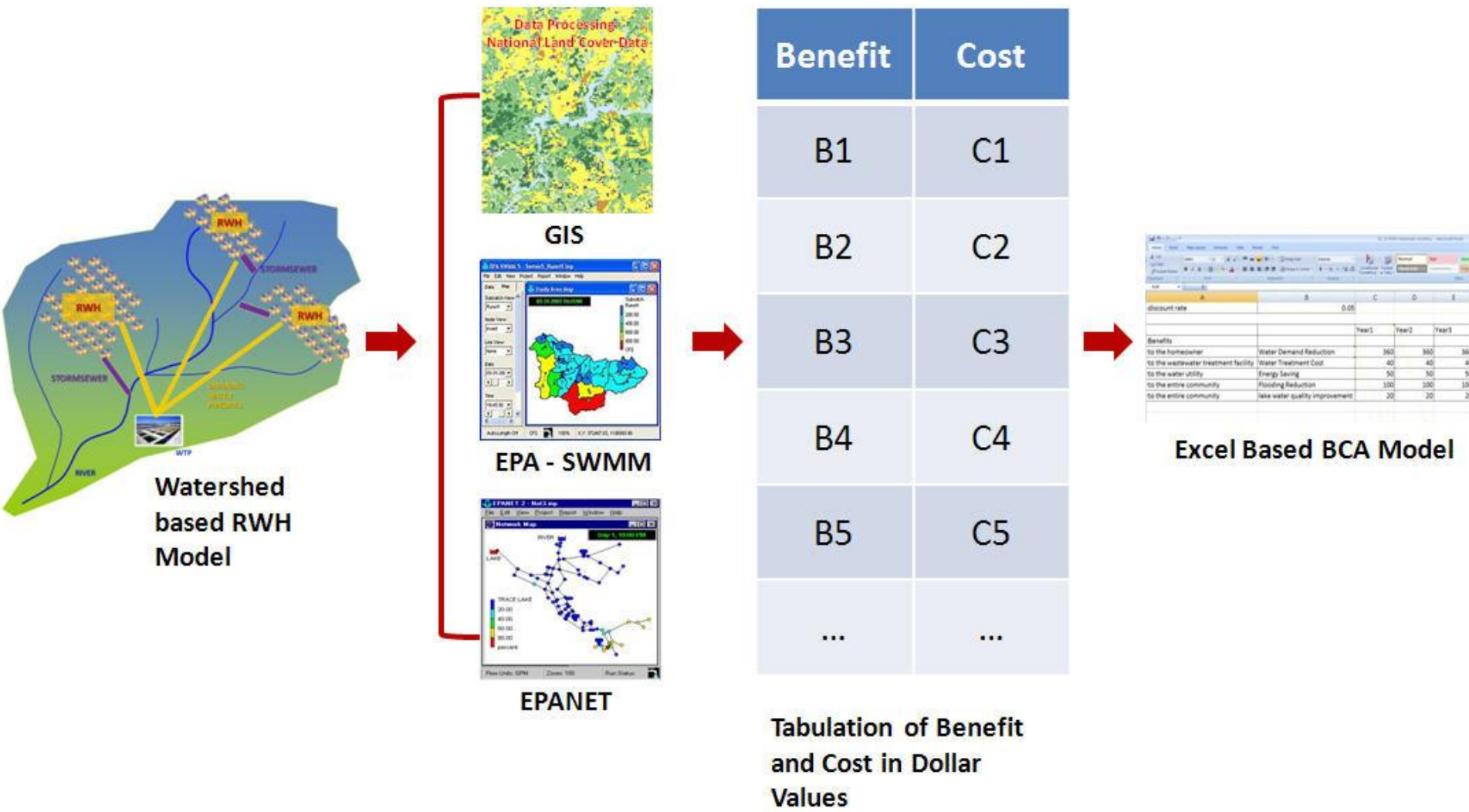


Step 5: Net Present Value of RHP

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

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

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

	Year1	Year2	Year3	
discount rate	0.05			
Benefits				
to the homeowner	Water Demand Reduction	360	360	360
to the wastewater treatment facility	Water Treatment Cost	40	40	40
to the water utility	Energy Saving	50	50	50
to the entire community	Flooding Reduction	100	100	100
to the entire community	lake water quality improvement	20	20	20

Excel Based BCA Model

Tabulation of Benefit and Cost in Dollar Values

Data Acquisition and Process

The screenshot displays the USGS The National Map Seamless Data Distribution System Viewer. The interface includes a top navigation bar with the USGS logo and the text "The National Map". Below this, the title "The National Map Seamless Data Distribution System Viewer" is displayed, along with a "Help!" button. The main area features a map of a region with a color-coded topographic and land cover overlay. To the left of the map is a toolbar with categories: Move (directional arrows), Zoom (in, out, reset), Select (point, lasso, rectangle), Misc (info, print, home), and Download (download, print, home). Below the toolbar is a "Define Area By Coordinates" link. The right side of the interface contains a "Current Active Layer" dropdown menu set to "GNIS Names (text)". Below this is a "Download Layers" section with a "Raster" category containing checked options for "NED" and "NLCD 1992 Land Cover". A "Display Legend/Layers" section lists various data layers, with "States 7.5M" and "World Bndy" checked. At the bottom of the map area, a scale bar indicates 77 miles. The footer contains the text "Welcome to the Seamless Data Distribution System" and "Tool selected = Zoom In".

USGS The National Map

The National Map Seamless Data Distribution System Viewer

Help!

Move

Zoom

Select

Misc

Download

Define Area By Coordinates

Current Active Layer

GNIS Names (text)

Download Layers

Raster

NED

1/3" NED

1/9" NED

NLCD 1992 Land Cover

Display Legend/Layers

Layer

Visible

Hi-Res Ortho Index

1m Ortho Index

BTS Roads Index

NLCD 2001 Index

NLCD 1992 Index

1/9" NED Index

1/3" NED Index

NED Index

SRTM 30m Index

SRTM 90m Index

MODIS NDVI Index

Counties 2M

State Labels

States 7.5M

World Bndy

Utility Lines 100K

Interstate Labels

USGS

77mi

Welcome to the Seamless Data Distribution System

Tool selected = Zoom In

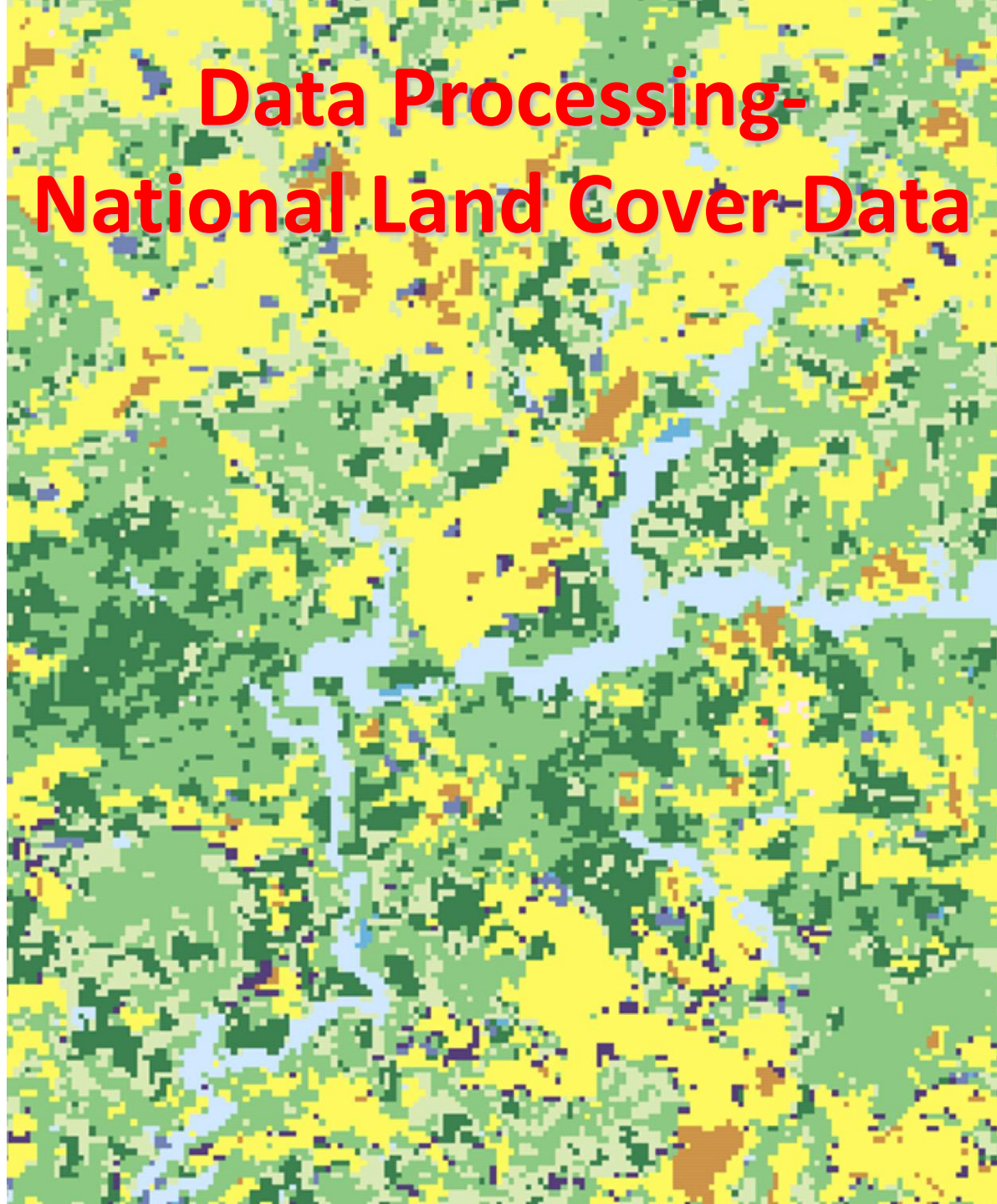
U.S. Department of the Interior || U.S. Geological Survey || EROS Data Center
URL: <http://seamless.usgs.gov/index.htm> || Maintainer: webmapping@usgs.gov || Last Modified: Fri 02 May 2003

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

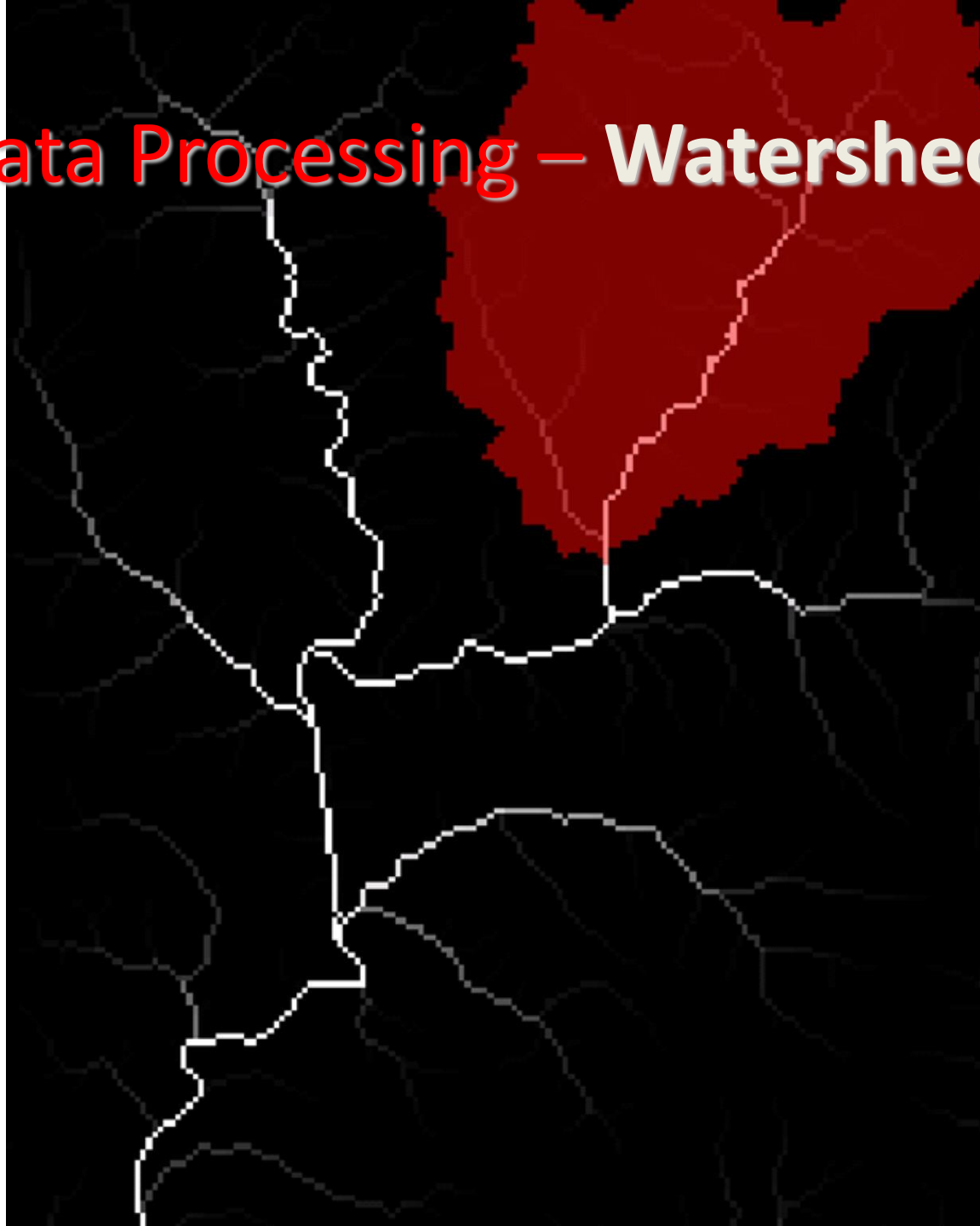
Data Processing- National Elevation Data

30 * 30 m NED

Data Processing- National Land Cover Data



Data Processing – Watershed I

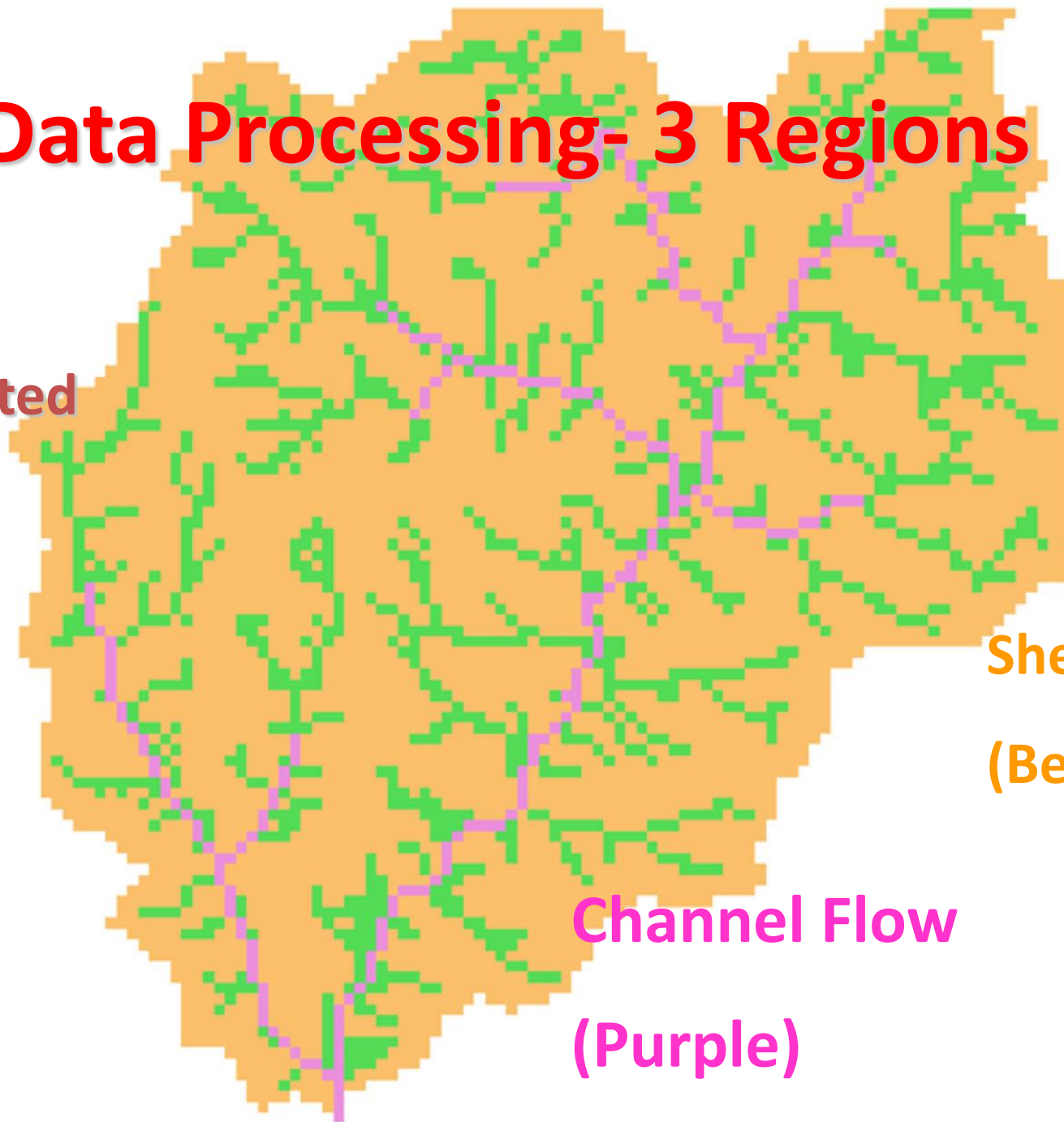


Data Processing- 3 Regions

Concentrated
Region
(Green)

Sheet Region
(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**.

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Thank you, any questions?

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