Landscape Ecology for Watersheds

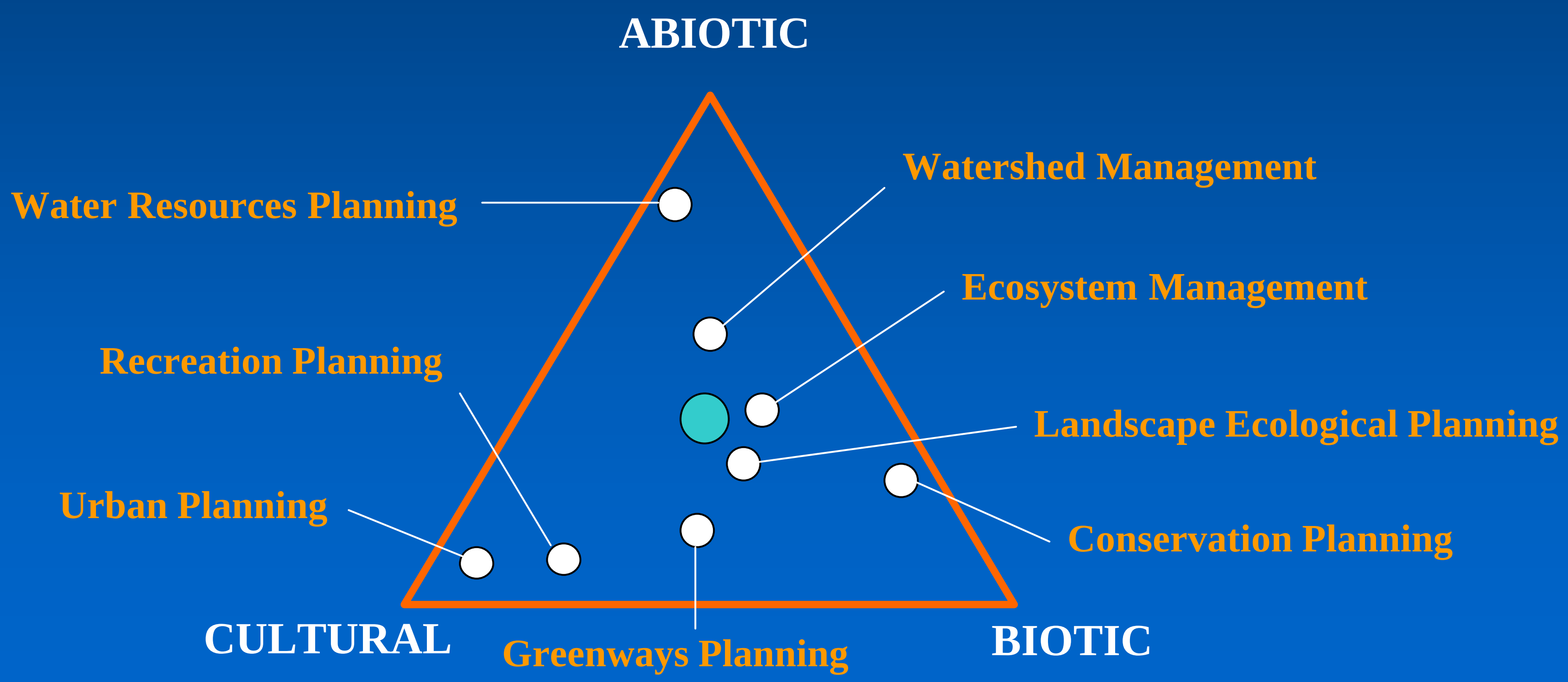
Jack F. Ahern, Professor of Landscape Architecture, LARP, UMASS
André Botequilha Leitão, Ph.D., LARP, UMASS; Geosystems Center, and Foundation for Science and Technology, Portugal.

Landscape Ecology for Watersheds

1. Landscape Ecology Principles
2. Applying Landscape Ecology to Watershed Planning
3. Spatial Strategies
4. Examples
5. Conclusions

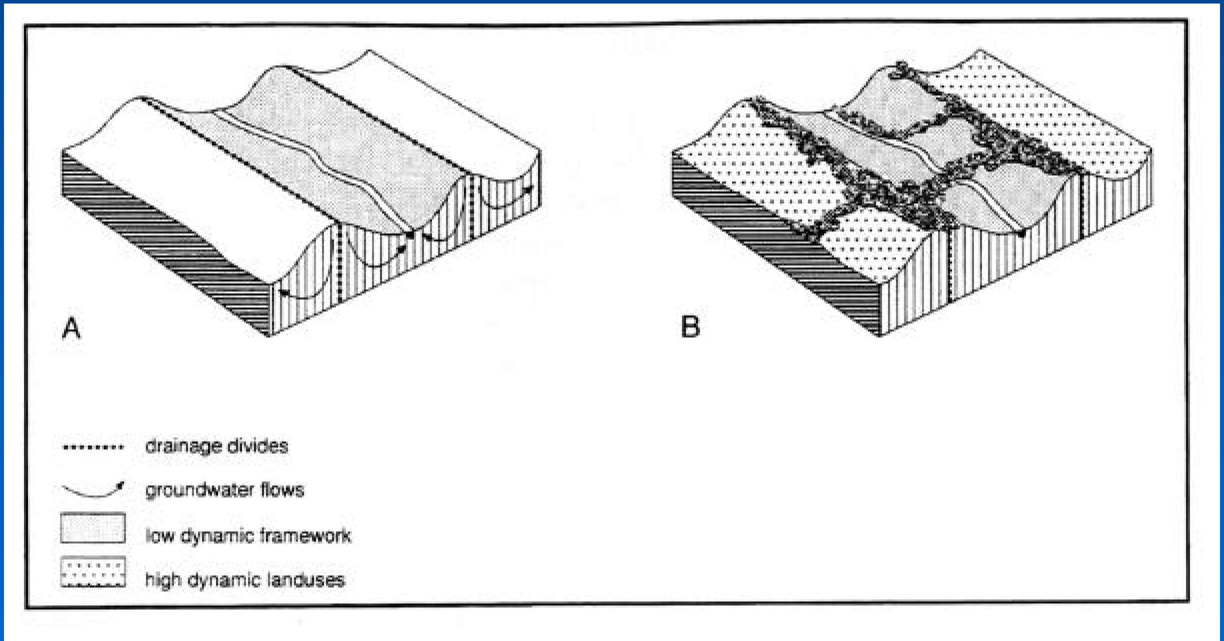
Landscape Ecology Principles - Systems View

- Watersheds are systems and should be approached holisticically, integrated
- Consider both components (water, land, animals, people) AND their interactions



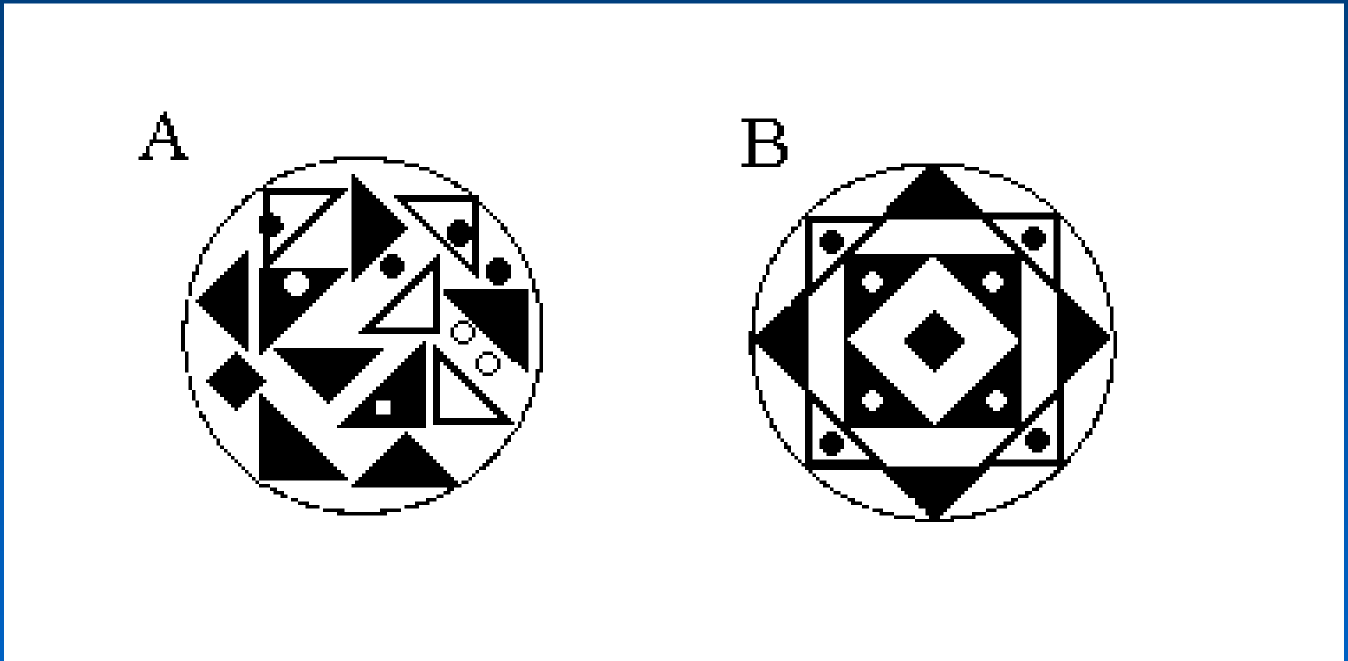
1. Landscape Ecology Principles - Systems View

- Consider also both Visible and Non-Visible components, e.g. surface and groundwater, AND their interactions, e.g in ecotones, e.g. wetlands, riparian corridors, aquifer recharge areas, etc.



1. Landscape Ecology Principles - Spatial Configuration

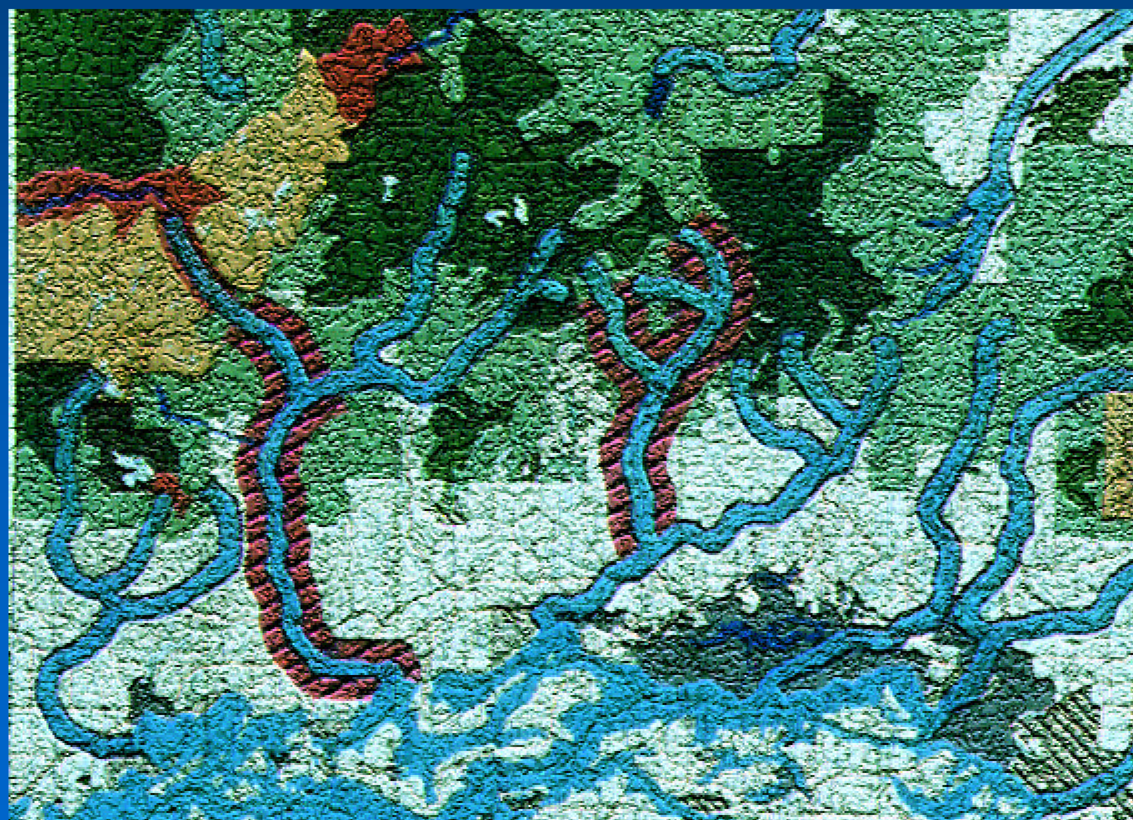
Spatial configuration matters !!



- **B** is **not** the **mere sum** of the several **components in A**.
  due to **different interactions** across system components, topological and chorological

1. Landscape Ecology Principles - Connectivity

- Connectivity is a key function in Watersheds
- Facilitates abiotic, biotic and cultural functions

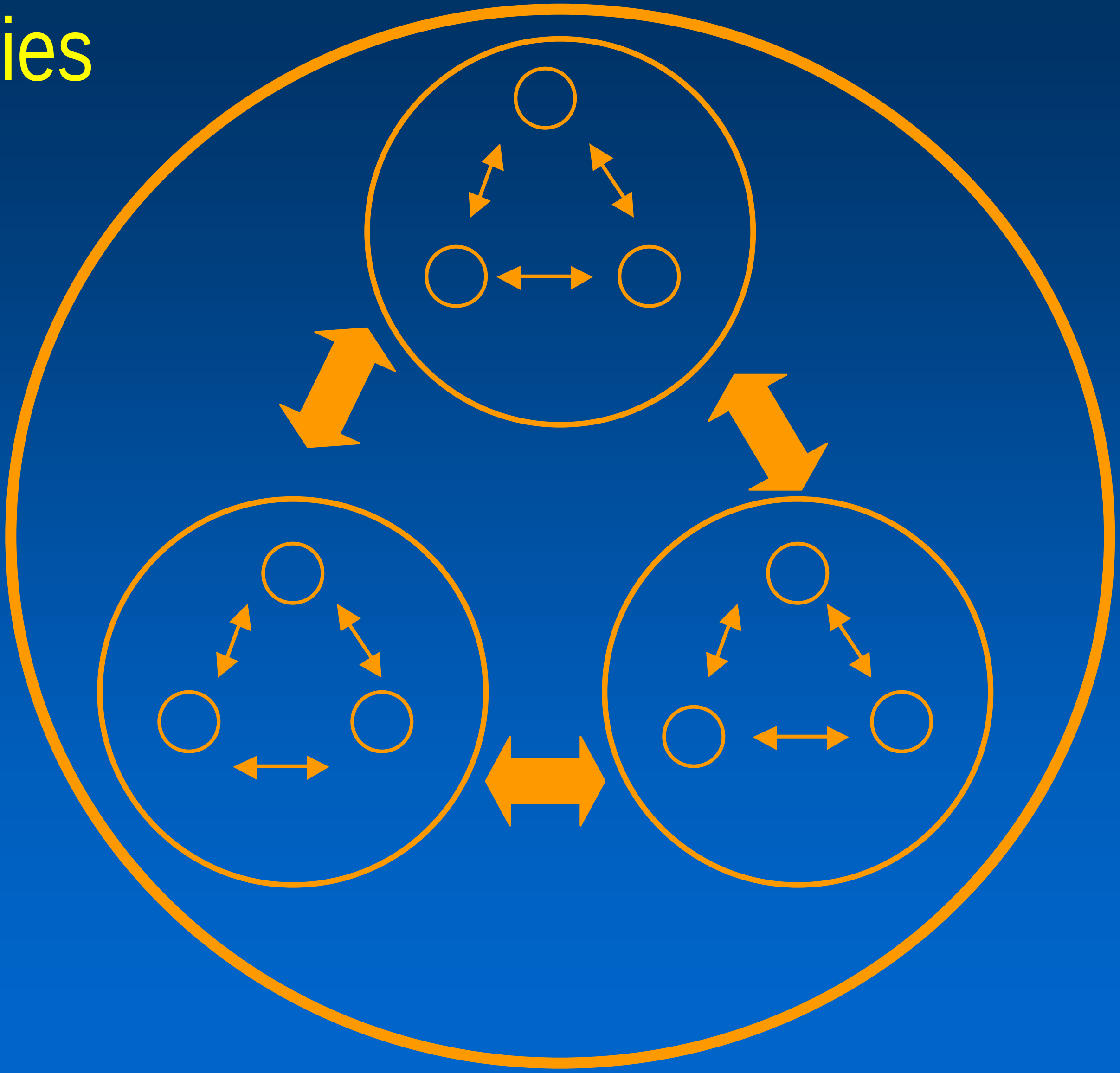


2. Applying Landscape Ecology to Watershed Planning

- Look at the Watershed holistically: land use and water, biodiversity and water, etc.
- Guide land use change to protect water supply
- Optimize: plan for multiple functions, e.g. protecting water features can also contribute to biodiversity goals

3. Spatial Strategies

- An expression of a complex planning strategy in simplifies spatial terms to guide future decisions and actions.



3. Spatial Strategies

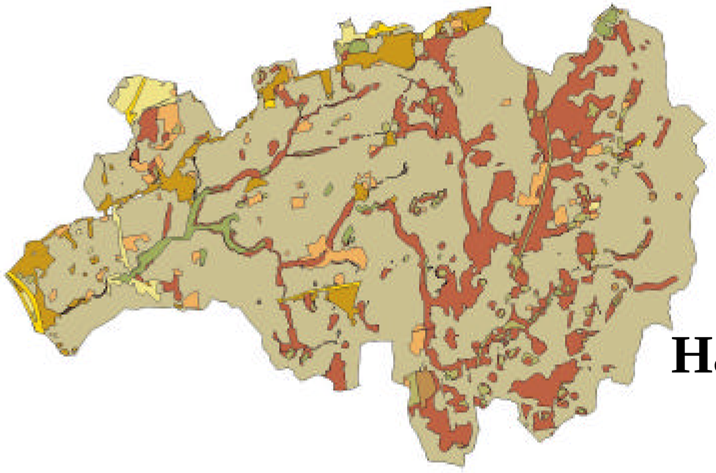
- Identify critical water resources to protect, e.g.:
  - Aquifer recharge areas
  - Riparian corridors
  - Wetlands and lakes
- Use Hydrological networks as a Framework for Connectivity to promote connection
  - Between critical resource areas, i.e. selected patches of forested wetlands and major water bodies
  - Across the entire watershed, i.e. from headwaters to downstream

3. Spatial Strategies

- Manage water resources for multiple uses, e.g.
  - Hydrology (abiotic)
  - Biodiversity (biotic)
  - Recreation (cultural)
- Which tools to use?
  - Scenarios
  - Keystone Indicators / Thresholds
  - Spatial Statistics (Landscape Metrics), Ecological Models (Habitat models), Water Models (Aquifer Recharge)

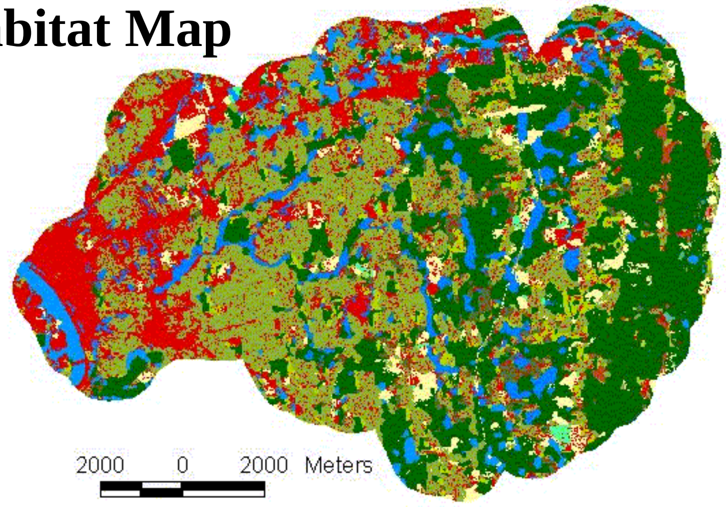
Alternative Future Scenarios and Models

Buildout Scenario



- **Spatial Concepts such as the Buildout are usefull to develop Planning Scenarios**

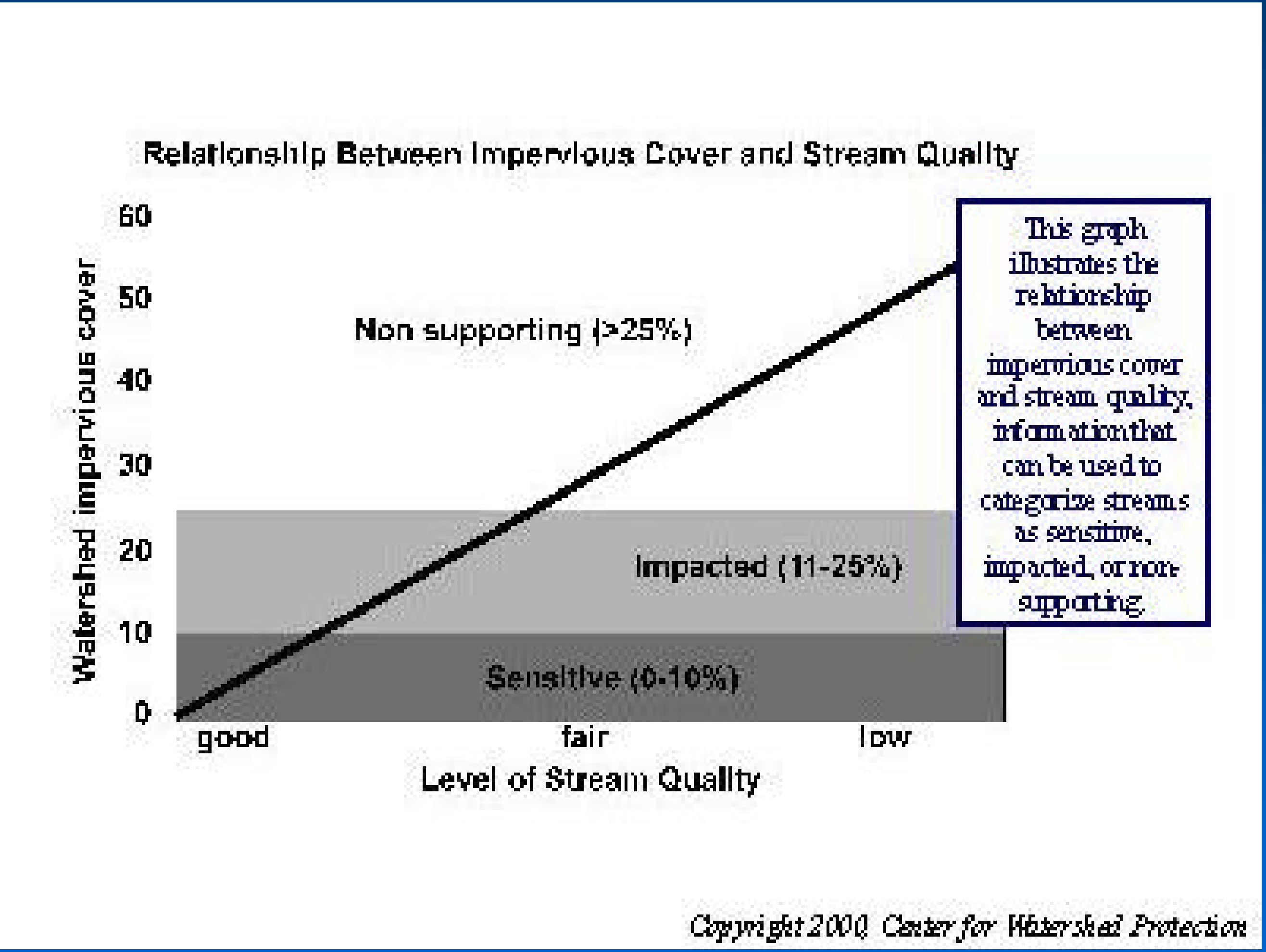
Habitat Map



- **Linking Ecological Habitat Models and planning techniques to build scenarios**

Indicators / Thresholds for Watershed Planning

- The amount of impervious cover is a keystone indicator for watersheds
- As a direct consequence of urban growth, as several ecological effects, e.g. affects stream quality, and aquifer recharge



Thresholds for Watershed Planning

Urban Stream Classif.	Stressed	Impacted	Degraded
Imperviousness	0-10%	11-25%	26-100%
Channel Stability	Stable	Unstable	Highly Unstable
Water Quality	Good	Fair	Fair-Poor
Stream Biodiversity	Good-Excellent	Fair-Poor	Poor
Planning Strategies	Identify, Protect large patches of critical resources	Defend / Restore riparian buffers	Urban infill, Redevelopment Opportunities, BMPs, e.g. Stormwater mgt.
Monitoring	GIS, LM, e.g.CAP	Edge Contrast	Management

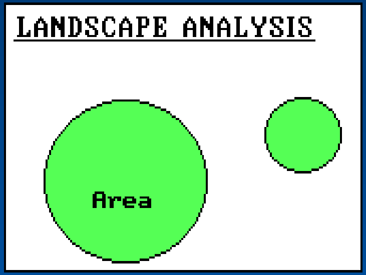
Based on a feature article on the “Pratice of Watershed Protection”, Center for Watershed Protection, USA.

Landscape Metrics

For example,

- Area Metrics

…Area per patch

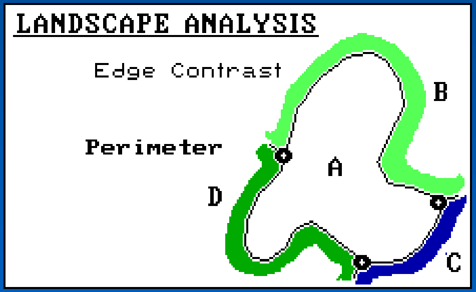


Size of individual patches is an important first-order assessment of landscape structure

- Edge Metrics

…Perimeter per patch

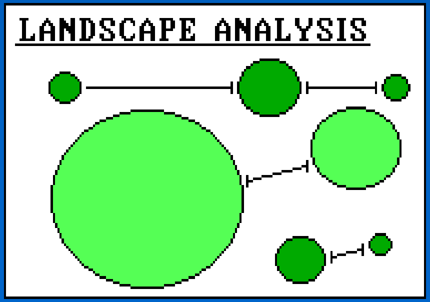
…Edge Contrast per patch



The amount and type of edge tracks the nature of the patch interface

- Nearest Neighbor Metrics

or Proximity Index Metrics



Distance among nearest neighboring patches tracks clumping tendency

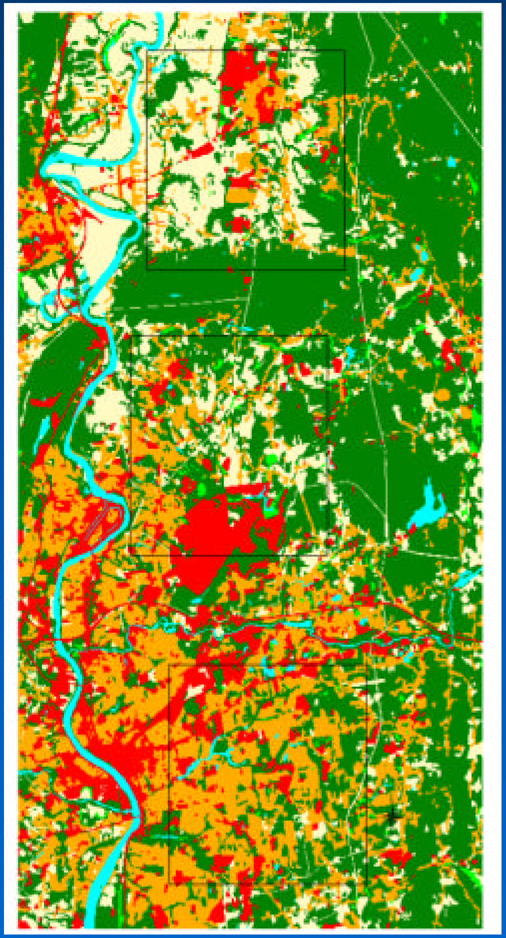
Graphics extracted from online slide presentation by Kevin McGarigal

4. Example Applications

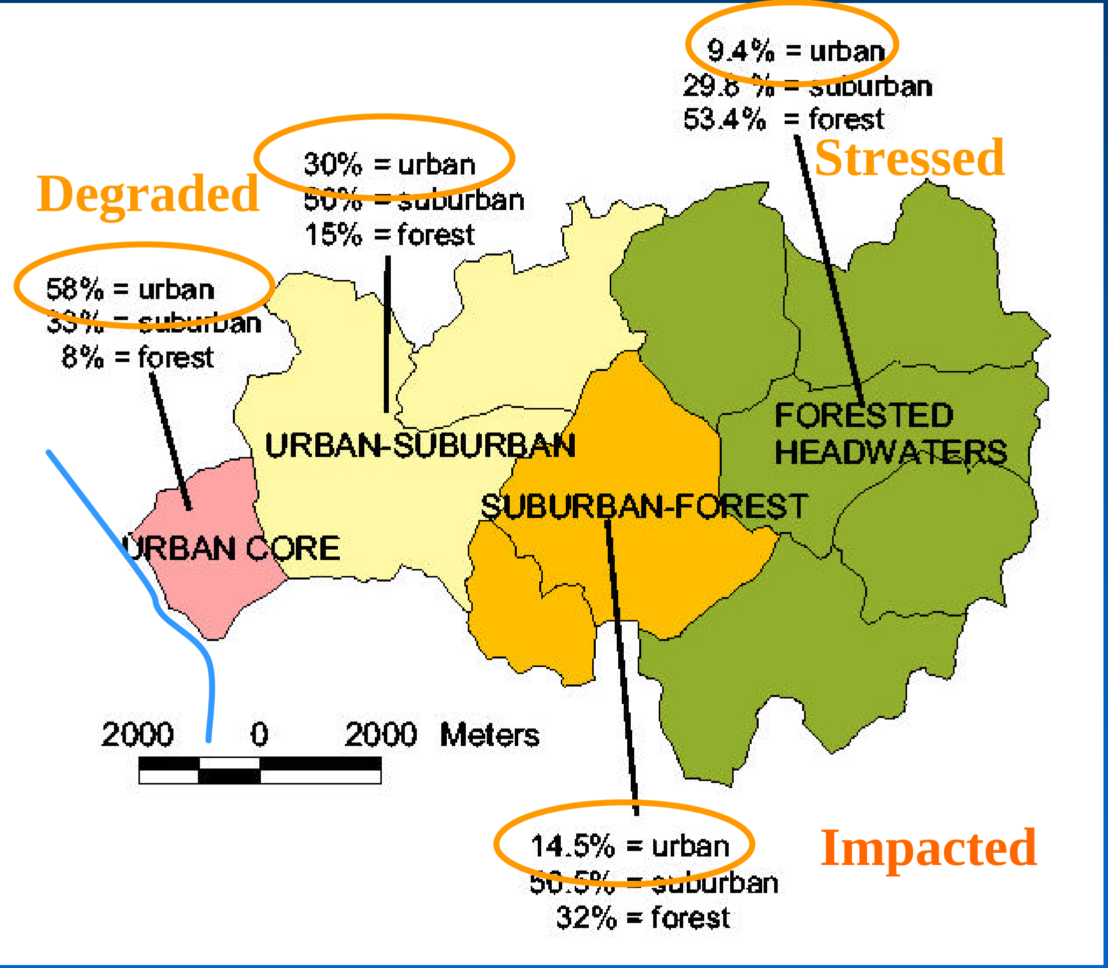
- *The Mill River Watershed Study, MA, USA*
  An urban-rural gradient

- *The SALSIM Research Project, Portugal*
  highly dynamic landscape with significant ground water issues

The Mill River

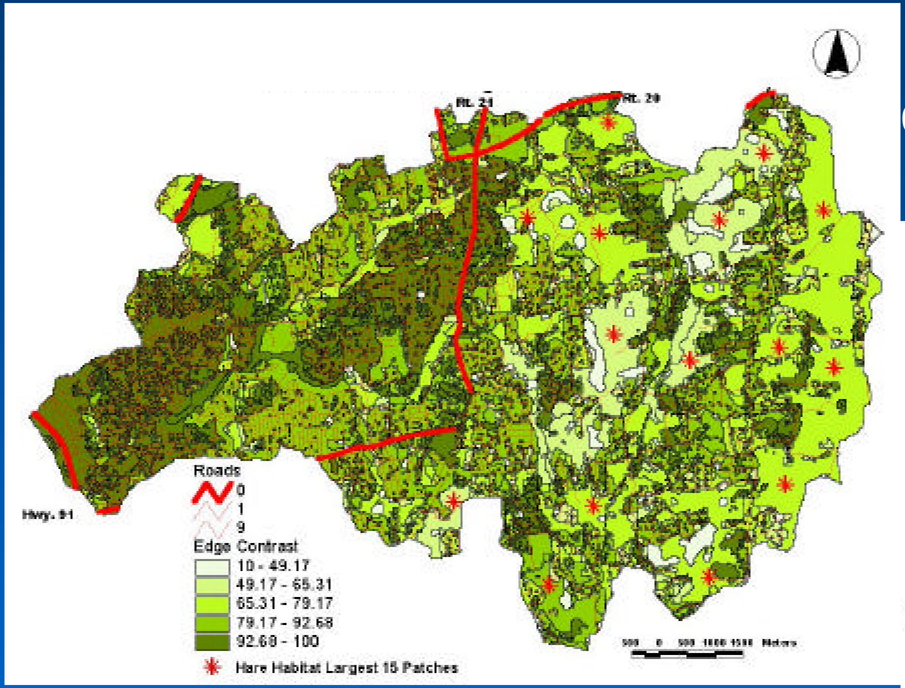


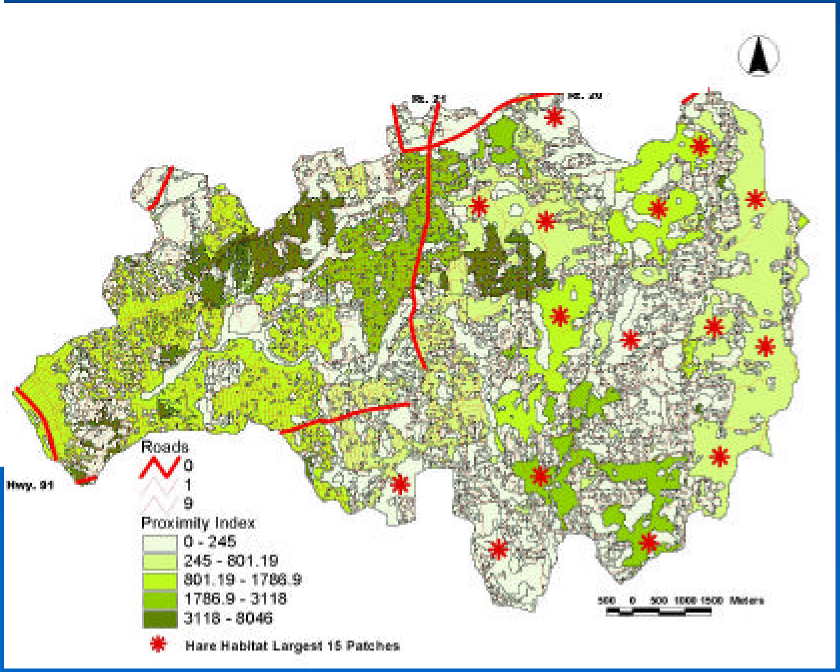
The Mill River Watershed Study, MA



Landscape Metrics

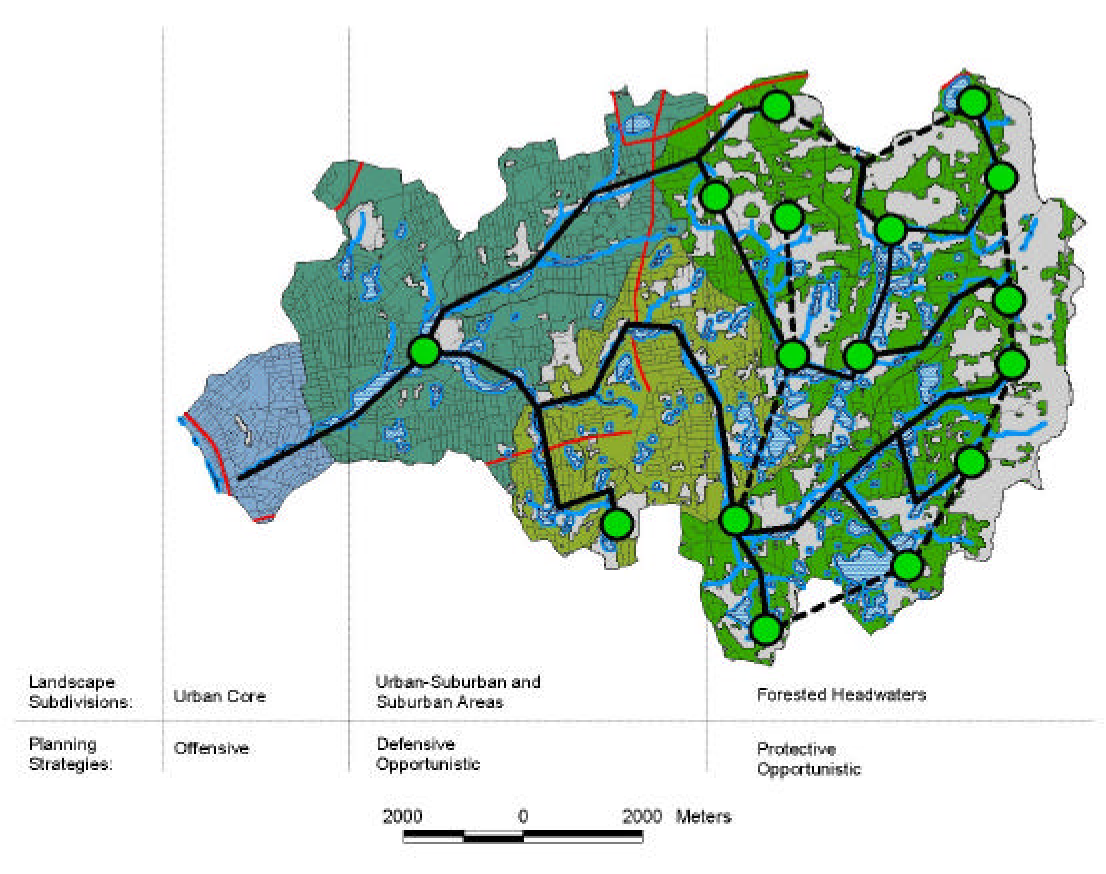
Metrics can be useful to **characterize** ecological **systems and inform spatial plans**





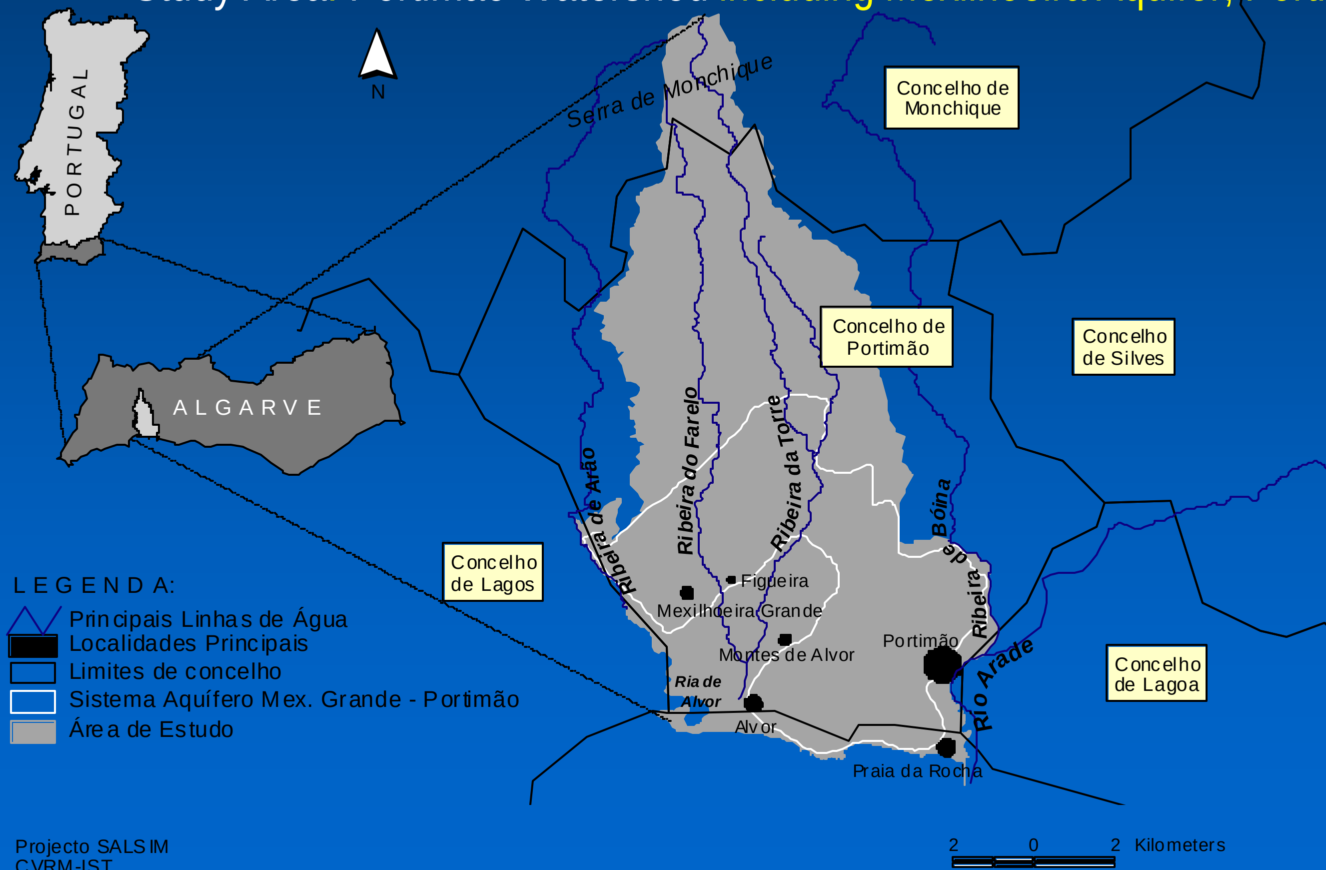
- **Edge Contrast** – spatial conflicts, e.g. water features and urban-industrial
- **Proximity Index** – connectivity for wildlife

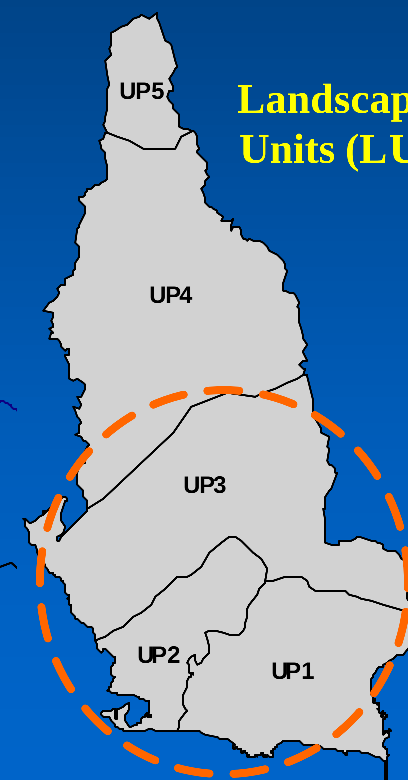
Planning for Water and Biodiversity in The Mill River Watershed



The SALSIM Research Project

- *SALSIM - Simulation and Optimization of Aquifer Systems subjected to Saline Intrusion*
- Study Area: Portimao Watershed including Mexilhoeira Aquifer, Portimao, Portugal

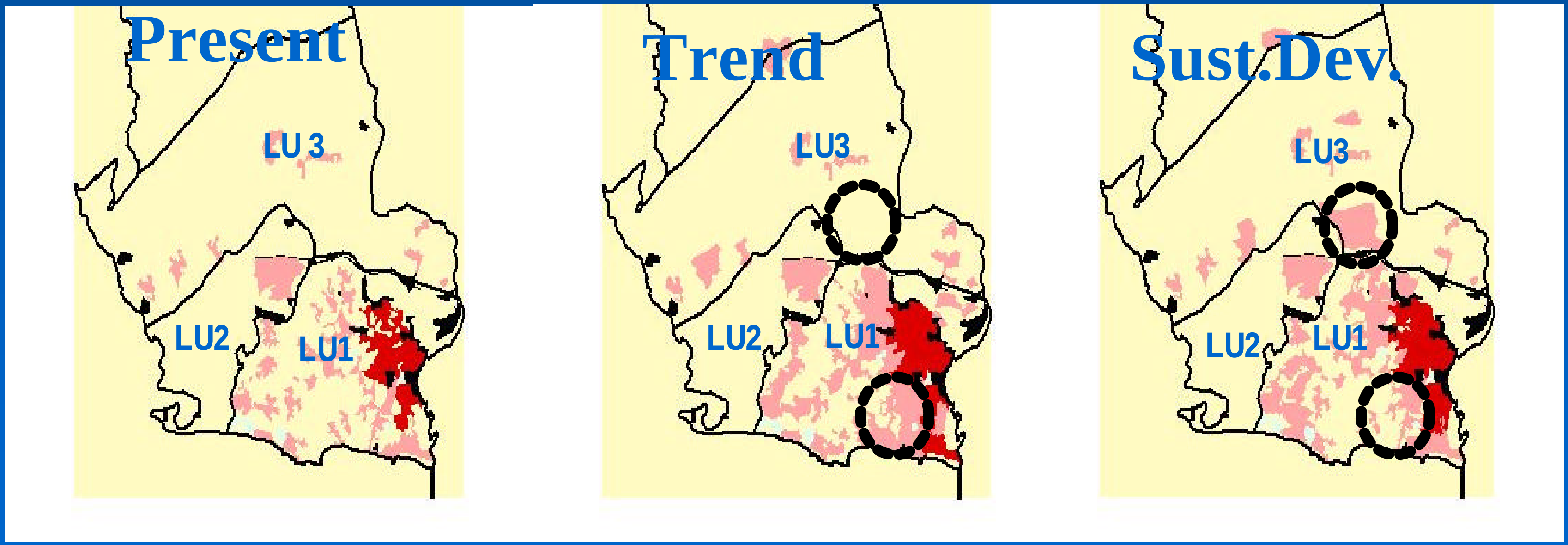




Watershed into Landscape Units

The Visible and Invisible Landscape

- SALSIM landscape planning component: relating **land use change** (visible) and **aquifer** recharge (invisible) through alternative planning future scenarios
- **Different spatial strategies** for urban growth = Trend and SD:
- **SD** generated c. 50% **less impacts** in aquifer recharge **than Trend**



Scenarios Impacts on Water Resources

- **Aquifer Recharge was c.50% more affected in the TREND when compared with SD**
- **Trade-off: LU3 stream water quality is potentially more affected in the SD**

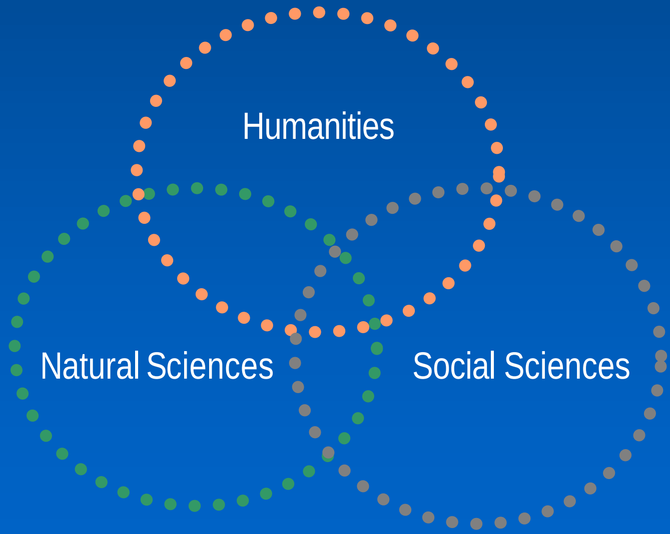
	1991 (Baseline)		Stream Classif.	Future Scenarios (2021)			
				TREND		Sust. Develop.	
	ha	%		ha	%	ha	%
LU 1	848	35	Degraded	1330	55	1240	51
LU 2	144	12	Impacted	144	12	144	12
LU 3	164	4	Stressed	266	**7**	376	10
Total	1162			1772		1772	

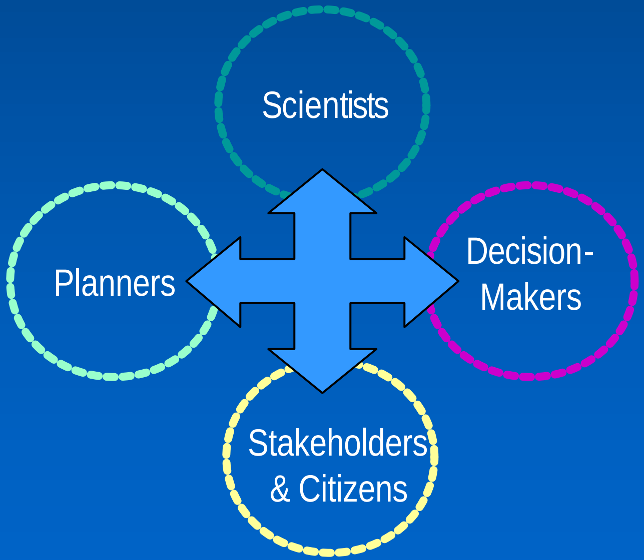
Conclusions

- Landscape ecology has several advantages for watershed planning:
- It is a spatial ecology
- Chorological perspective particularly useful in watershed planning
- Tools useful to measure and simulate change
- Link hydrological and ecological models

Planning for the Future

- Planning is both a Science and a Art, and Synthesis is one of its pillars;
- Solutions for the complex and multidimensional Challenges of the 21st C.





- Symbiosis between disciplines and its joint contribution to planning

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The Visible and Invisible Landscape

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- **Different spatial strategies** for the same urban growth = Trend and SD