Landscape Ecology for Watersheds

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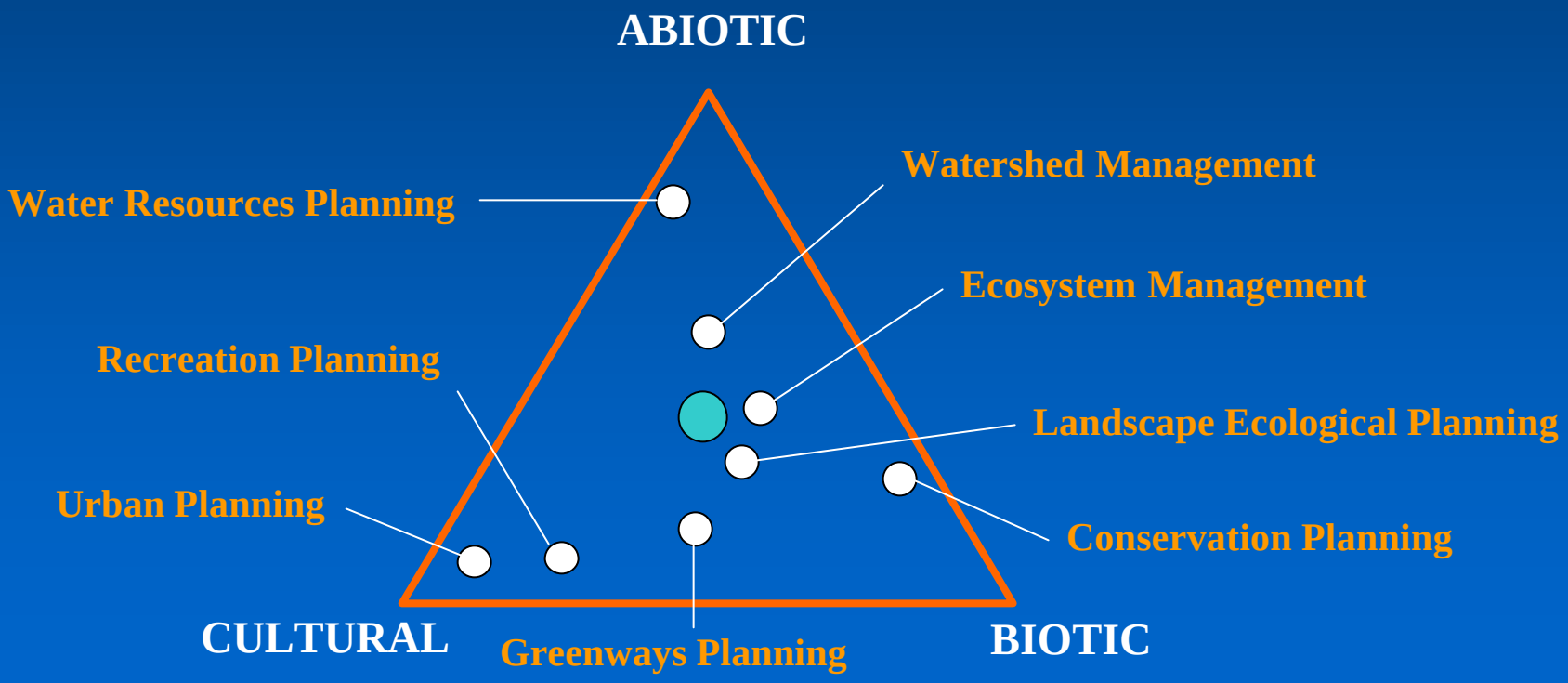
Landscape Ecology for Watersheds

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

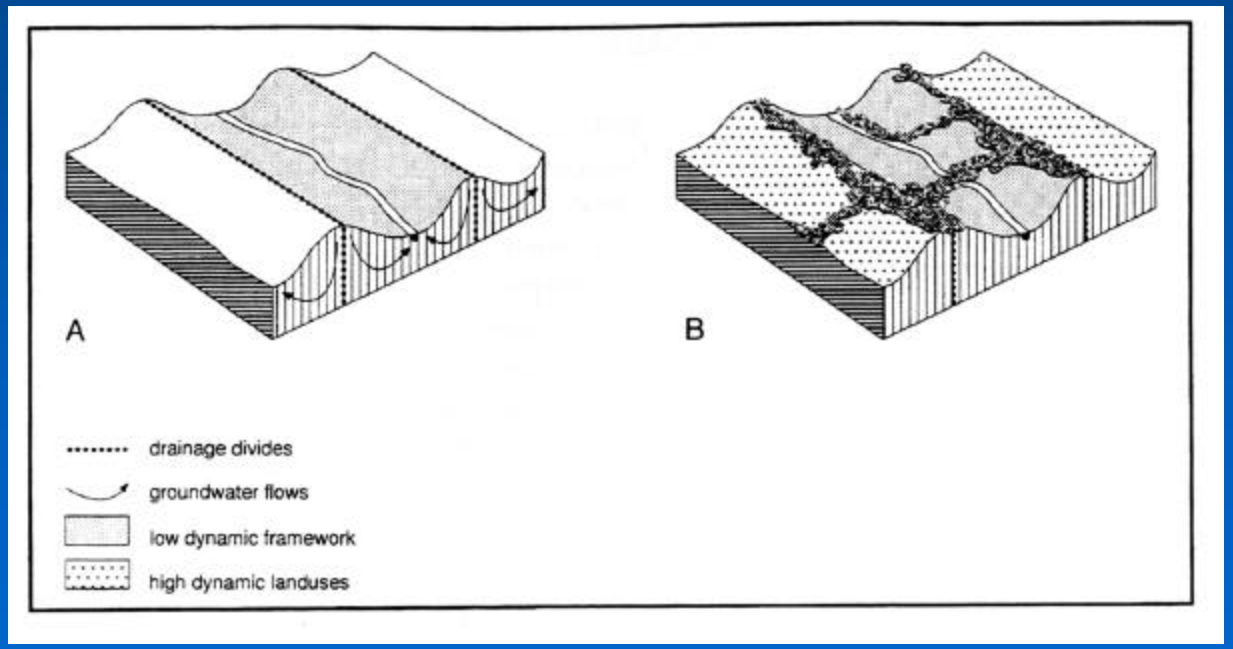
Landscape Ecology Principles - Systems View

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



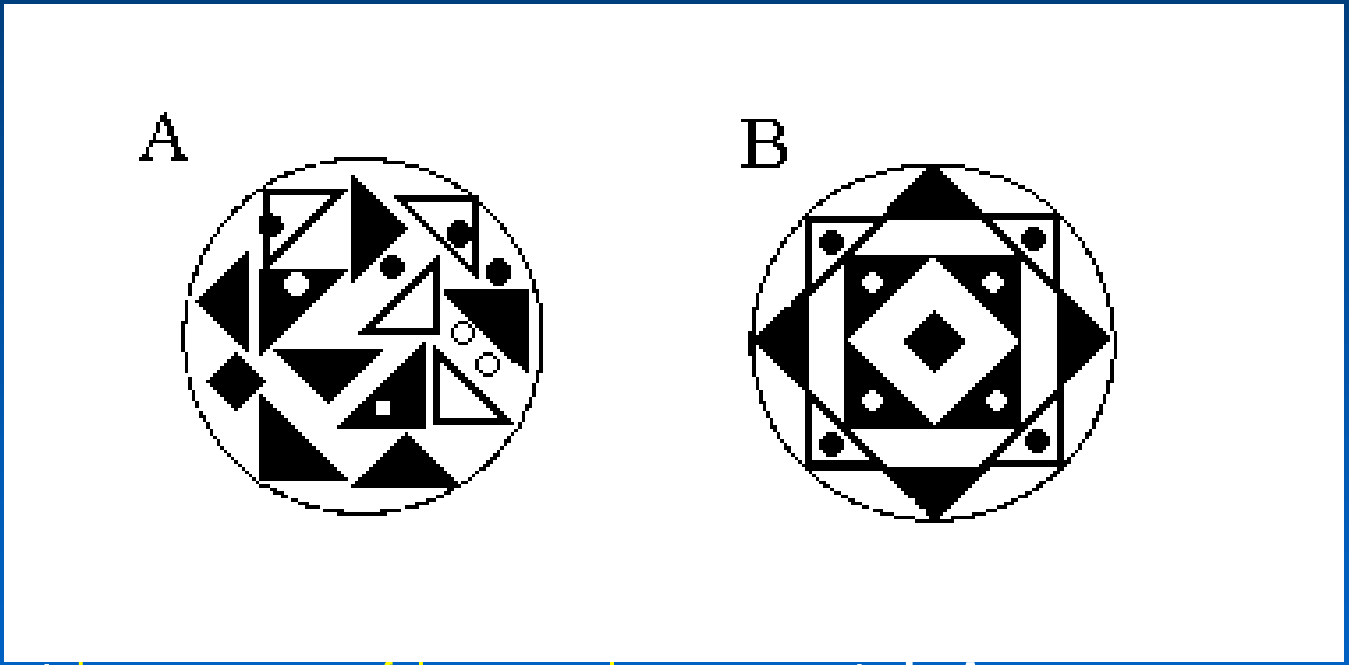
1. Landscape Ecology Principles - Systems View

- 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

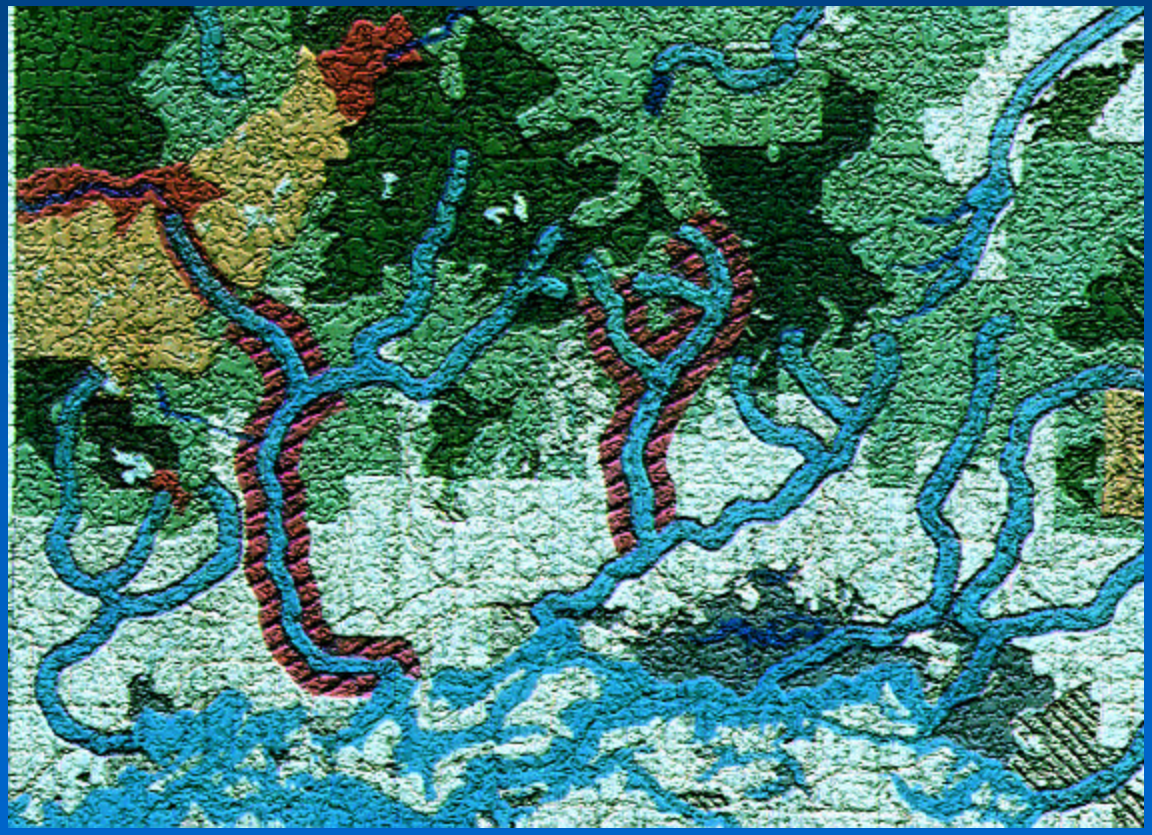
Spatial configuration matters !!



- **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

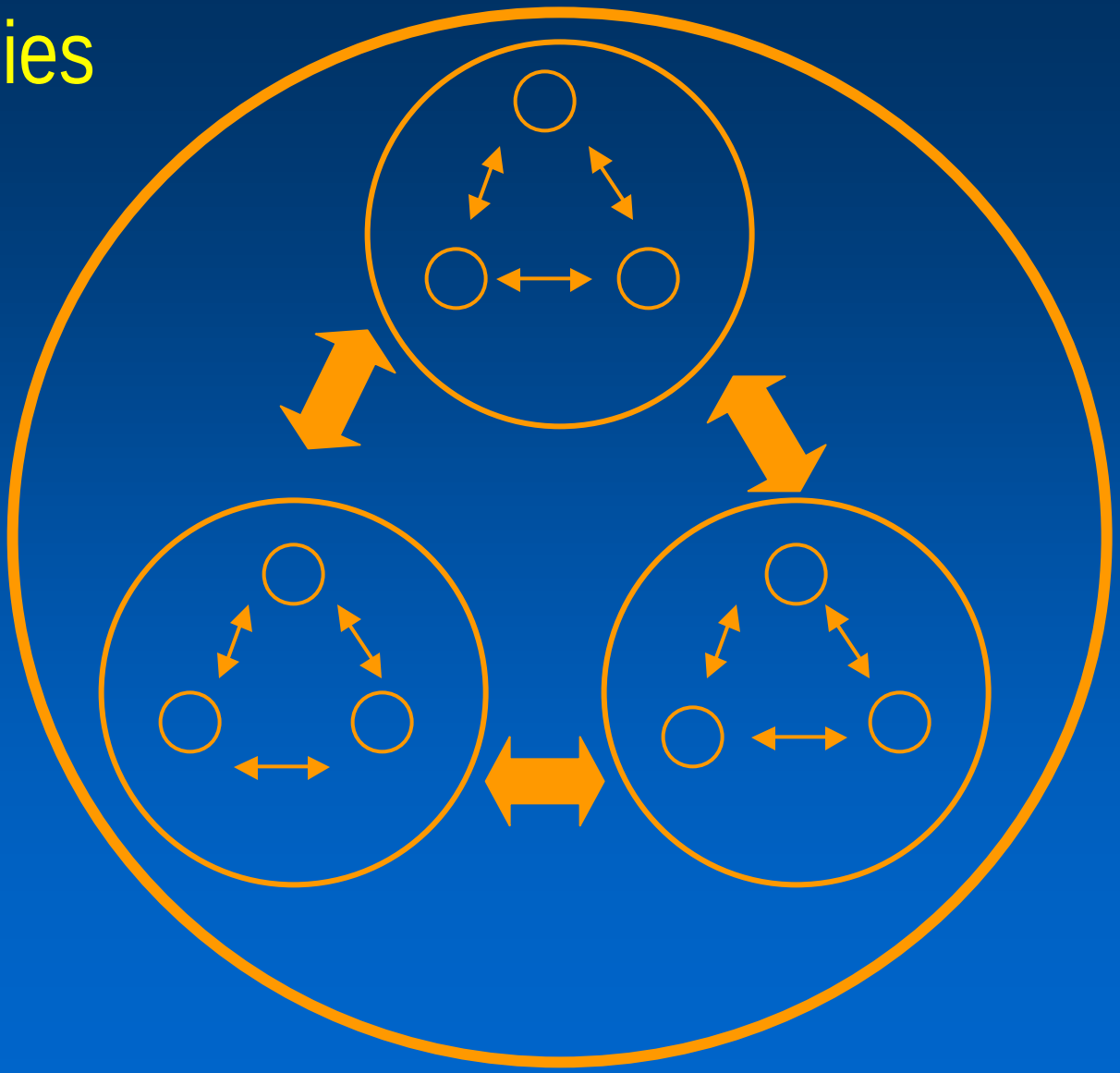


2. Applying Landscape Ecology to Watershed Planning

- 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

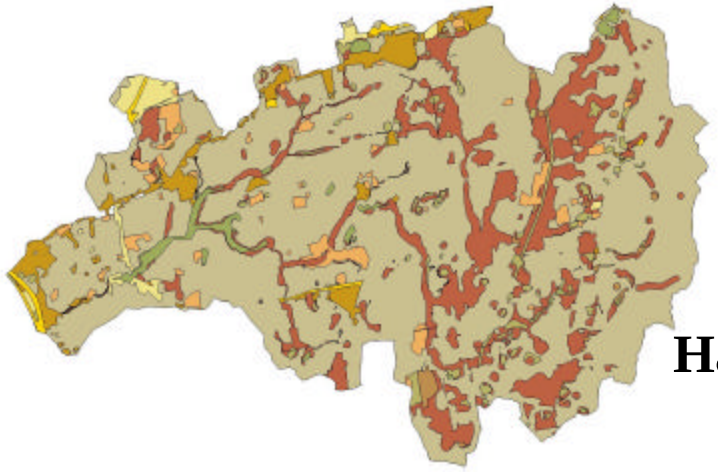
- Identify critical water resources to protect, e.g.:
  - Aquifer recharge areas
  - Riparian corridors
  - Wetlands and lakes
- Use Hydrological networks as a Framework for Connectivity to promote connection
  - Between critical resource areas, i.e. selected patches of forested wetlands and major water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

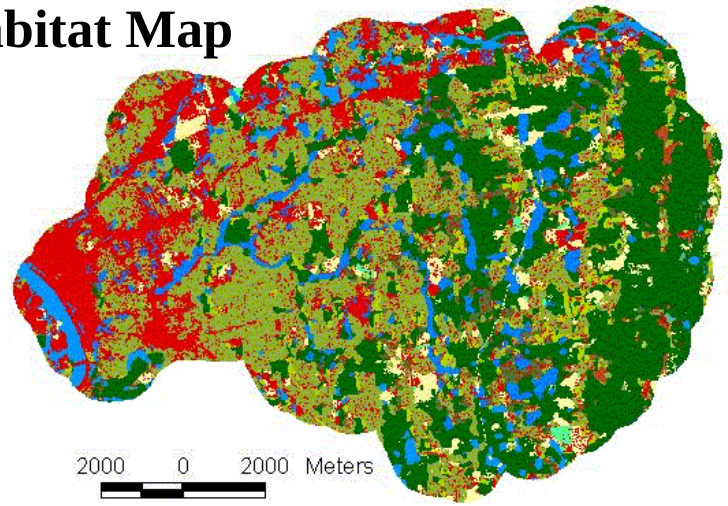
Alternative Future Scenarios and Models

Buildout Scenario



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

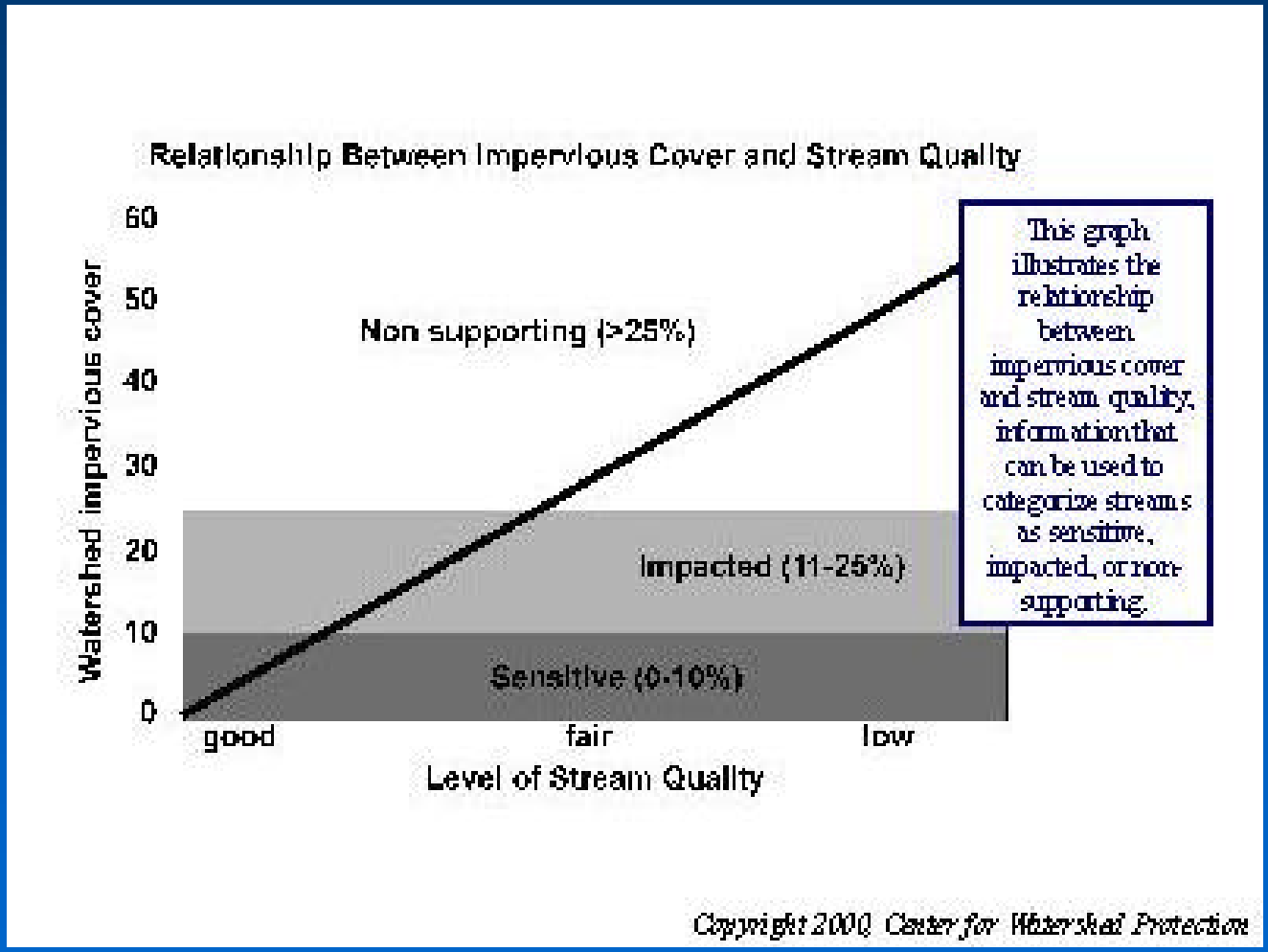
Habitat Map



- **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

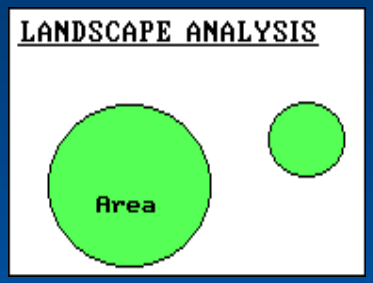
Based on a feature article on the "Pratice of Watershed Protection", Center for Watershed Protection, USA.

Landscape Metrics

For example,

- Area Metrics

  …Area per patch

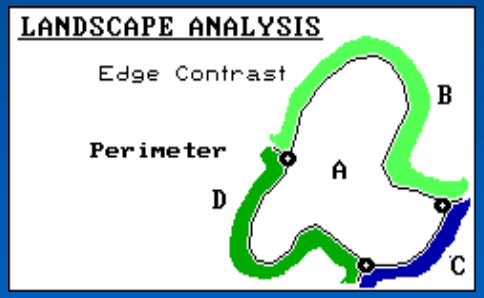


Size of individual patches is an important first-order assessment of landscape structure

- Edge Metrics

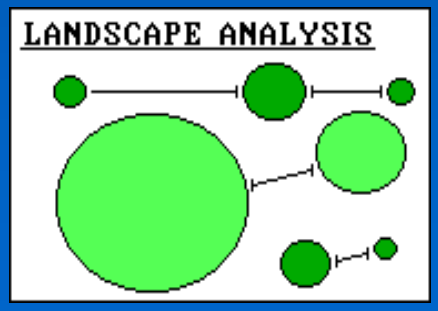
  …Perimeter per patch

  …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

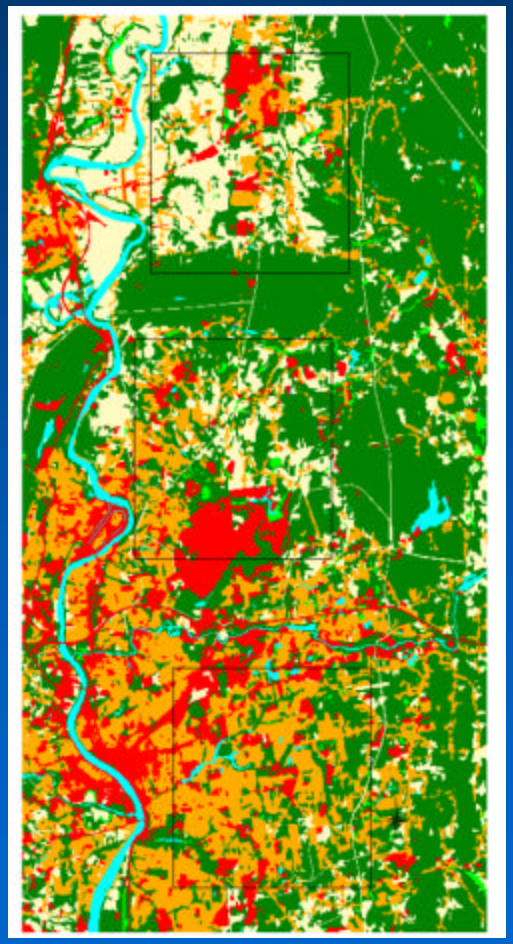
Graphics extracted from online slide presentation by Kevin McGarigal

4. Example Applications

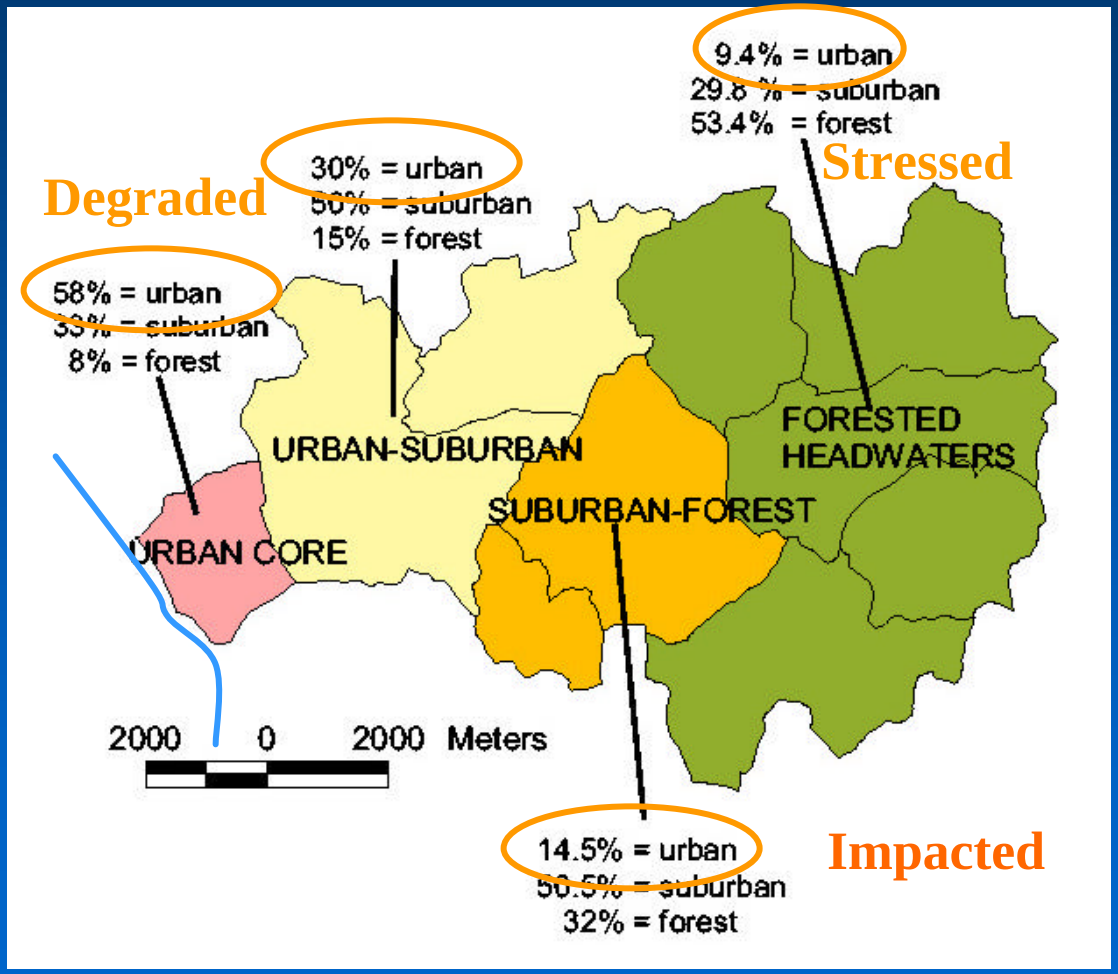
- *The Mill River Watershed Study, MA, USA*
  An urban-rural gradient

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

The Mill River

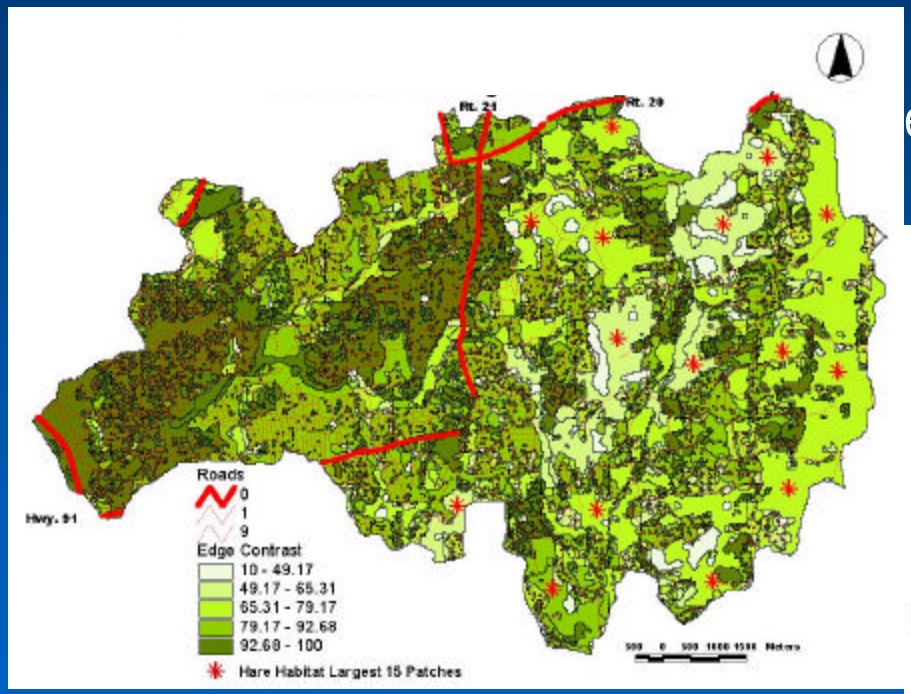


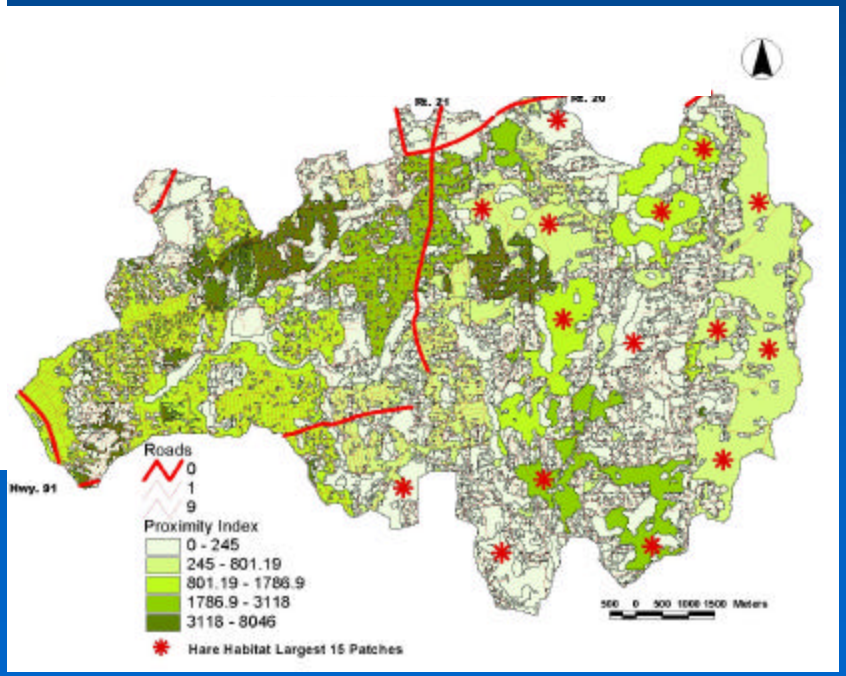
The Mill River Watershed Study, MA



Landscape Metrics

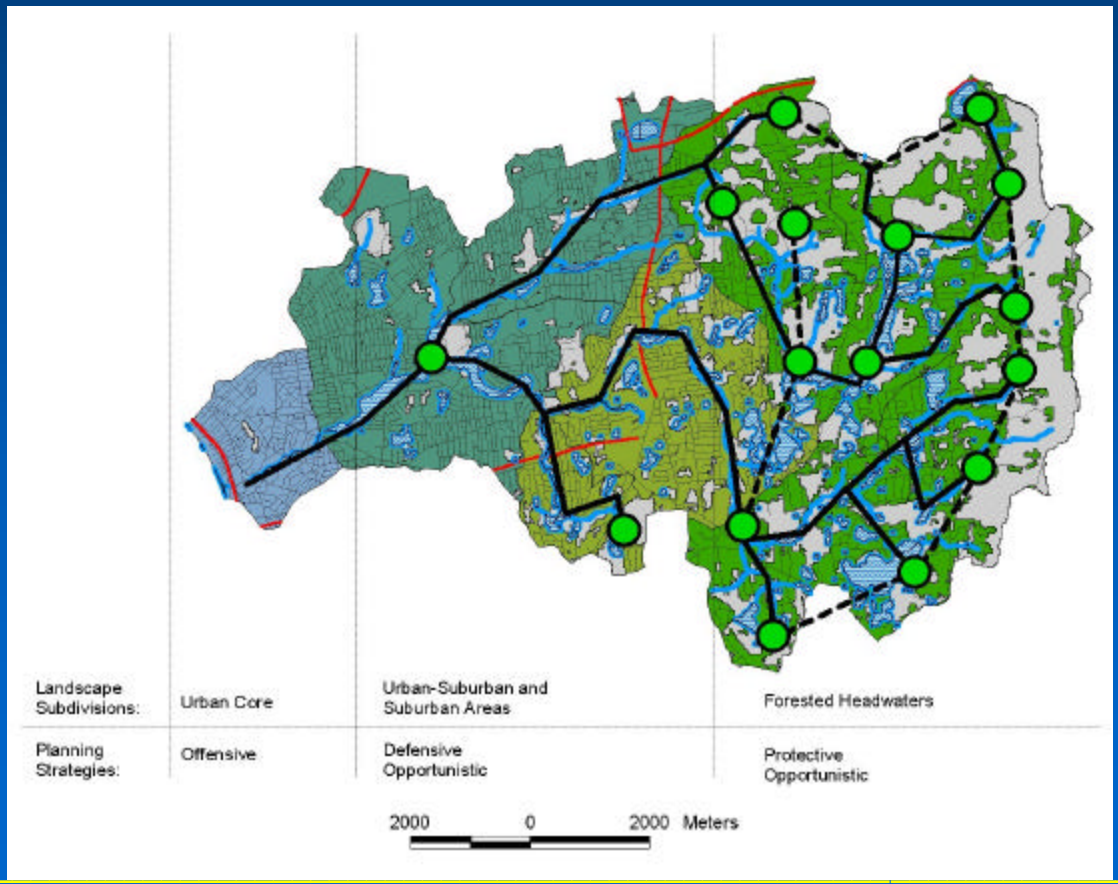
Metrics can be useful to **characterize** ecological **systems and inform spatial plans**





- **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



Landscape Ecology for Watersheds. Ahern, J. and Botequilha Leitão, A.

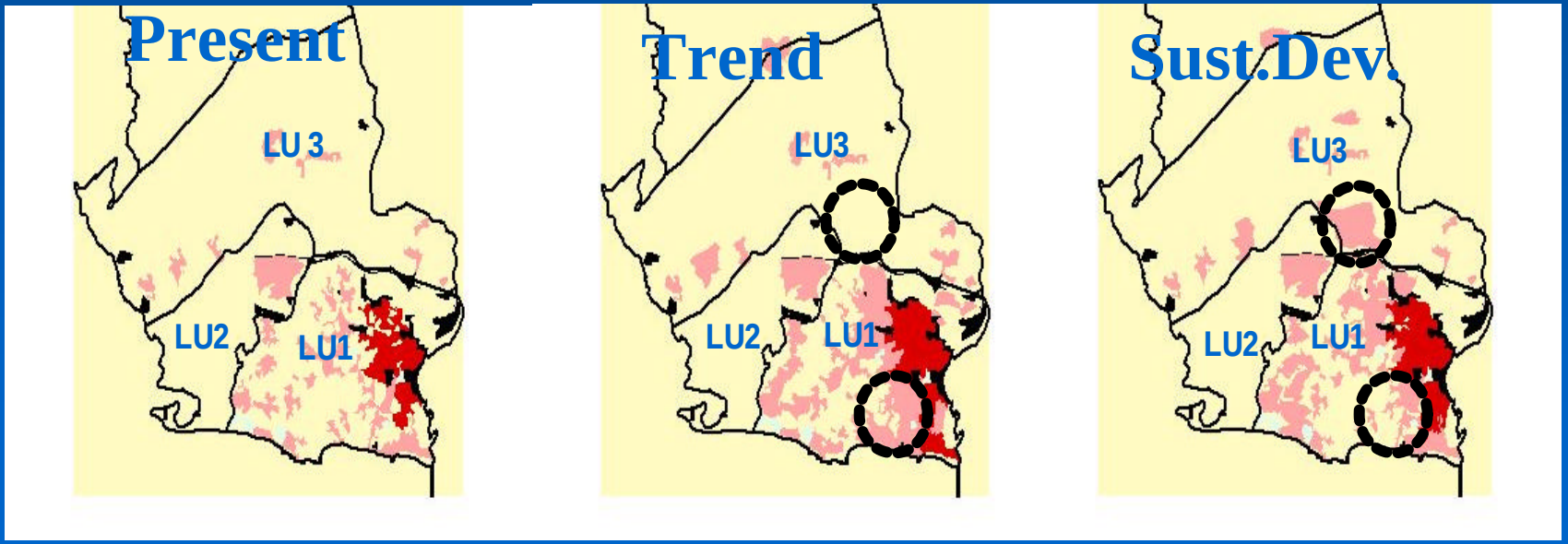
The SALSIM Research Project

- *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**

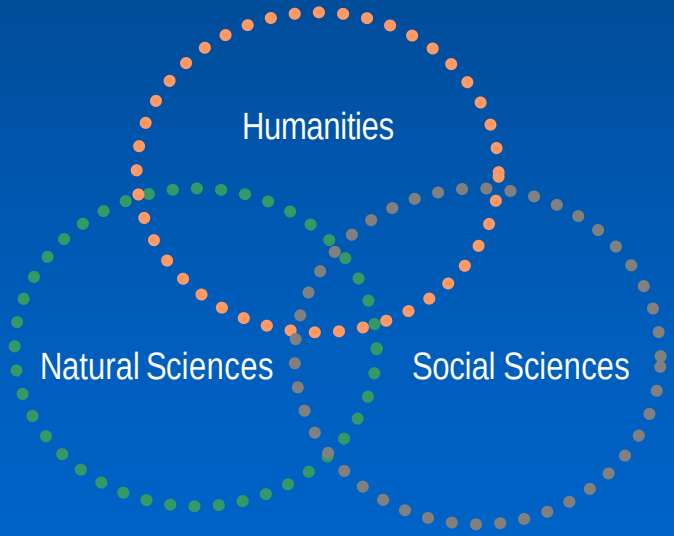
	1991 (Baseline)		Stream Classif.	Future Scenarios (2021)			
				TREND		Sust. Develop.	
	ha	%		ha	%	ha	%
LU 1	848	35	Degraded	1330	55	1240	51
LU 2	144	12	Impacted	144	12	144	12
LU 3	164	4	Stressed	266	**7**	376	10
Total	1162			1772		1772	

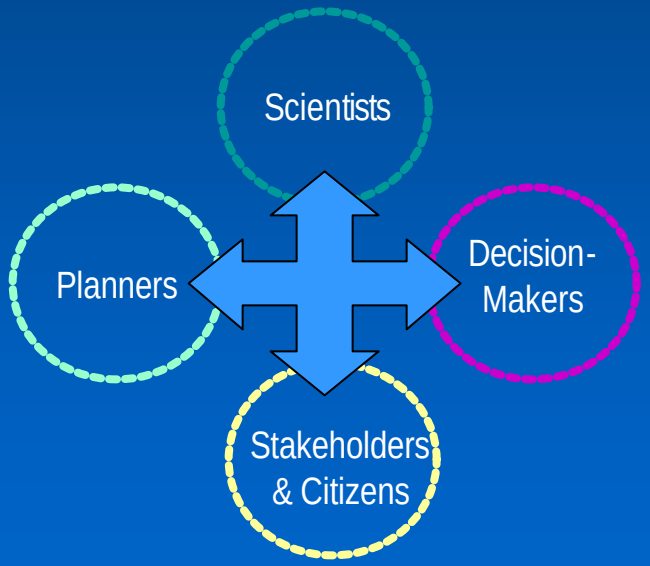
Conclusions

- 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

- SALSIM landscape planning component: relating **land use change** (visible) and **aquifer** recharge (invisible) through alternative planning future scenarios

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