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Theories, methods and strategies for sustainable landscape planning

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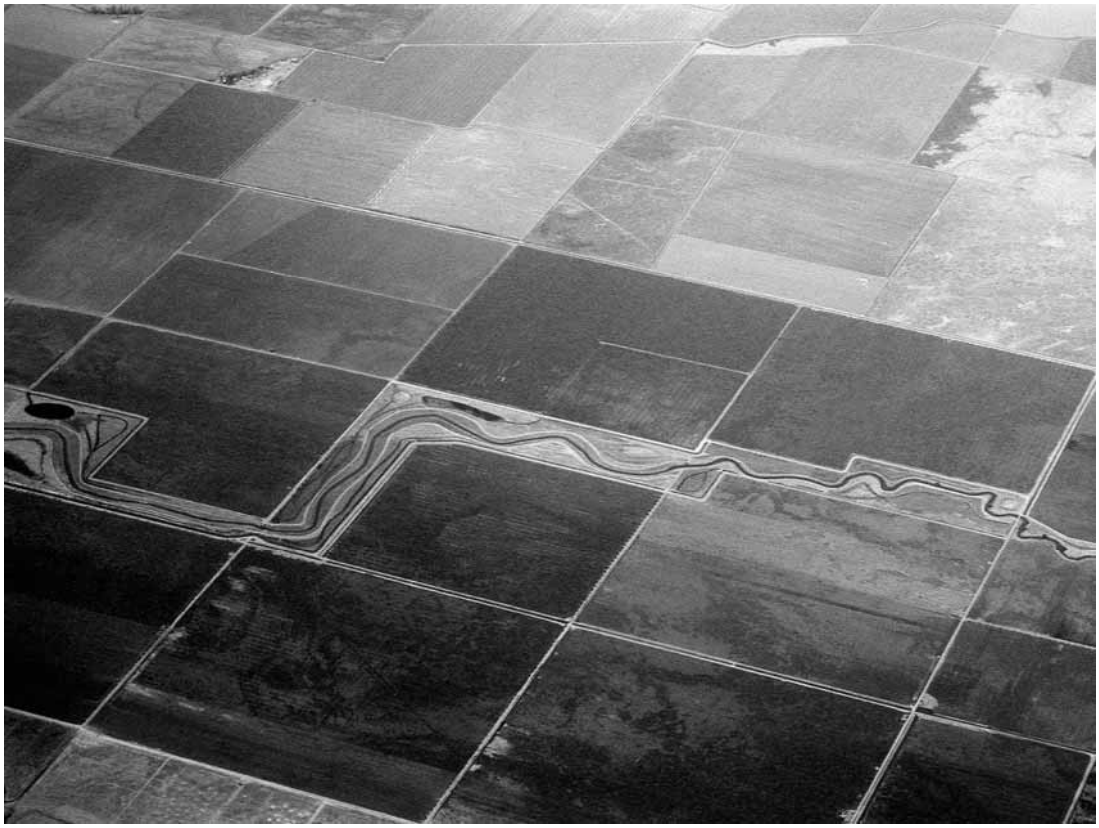

Abstract

The objective of this paper is to review briefly the theory of contemporary sustainable landscape planning, to present a typology of landscape-planning methods and apply the typology to several landscape-planning frameworks and methods. Sustainability is an international policy goal with multiple dimensions and implications for planning. Landscape planning prescribes alternative spatial configurations of land uses, which are widely understood as a key factor in planning for sustainability. Selected methods for sustainable landscape planning are reviewed according to the typology presented. Challenges, barriers and strategies to the implementation of sustainable landscape planning are discussed with recommendations and methods referenced.

Keywords: sustainability; landscape planning; spatial configuration

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Introduction

This chapter discusses theory, methods and challenges to sustainable landscape planning. Four principle sectors of planning have been recognized historically: physical/spatial, policy, social and economic (Fabos 1985; Burchell and Sternlieb 1978). Sustainable planning, as defined here is closely related with physical planning, which aims to optimize the distribution and allocation of land, often in a space-limited context (Van Lier 1998; Botequilha Leitão 2001). Sustainable planning aspires to link knowledge about sustainability with actions to achieve it. Sustainable planning thus 'implements' or 'operationalizes' the principles of sustainability in planning theory and practice.

Landscape-ecological planning is a specialization within landscape planning that focuses on spatial planning, the organization of uses and relationships of land uses to achieve explicit goals (e.g. habitat improvement, sustainability). While the landscape-ecological planning approach is characterized by a focus on the linkage of ecological patterns and processes, it also includes the actions and values of humans, and social and economic dimensions (Hersperger 1994). Finally, landscape-ecological planning adopts the landscape as the principle spatial unit of research and planning recommendations. Promoting sustainability has become an overarching principle of land-use planning (Forman 1995). This chapter will focus on sustainable landscape planning, as understood through theory, classified according to a proposed typology which is applied to several existing landscape-planning frameworks/models.

A typology for classifying sustainable landscape-planning methods

For operational planning practice, it is useful to organize the number of approaches, frameworks and methods currently available for sustainable landscape planning under a typology. This is not intended as a comprehensive analysis or review of the subject, but rather as framework useful for understanding the similarities and differences between selected existing landscape planning methods. The following typology is offered as a basis for this organization. The typology includes five subcategories: (i) theoretical orientation: substantive or procedural; (ii) resource or goal orientations; (iii) interdisciplinary / transdisciplinary; (iv) strategic orientation and (v) spatial concepts.

Theoretical orientation

Ndubisi argues there are two fundamental types of theory in landscape planning: substantive and procedural (1997). Substantive theories are descriptive and prescriptive and originate from basic research in the natural and social sciences and the humanities. Substantive theories support a better understanding of the landscape as an interface of natural and cultural processes and articulate the ideology, purpose and principles of sustainable landscape planning. The value of the information derived from substantive theories is a function of how the information is organized, presented and understood by planners. Island biogeography and metapopulation theory are examples of substantive theories that are increasingly applied in landscape-ecological planning. These theories are particularly relevant when planning is focused on biodiversity conservation or restoration. The application of these theories has led to criticism by ecologists who argue, for example, that conservation corridors are not a panacea to solve the biodiversity crisis, and that corridors may cause unintended negative effects on biodiversity for example by enabling the spread of diseases or

invasive species (Simberloff and Cox 1987). Other examples of substantive theories that have influenced landscape planning include prospect and refuge, central place and transactive and participative theory (Appleton 1975; Friedmann 1973).

Procedural theories offer recommendations for putting substantive theory into practice. They focus on methodological issues, such as suitability analysis, optimal land-use allocation, and applied landscape-ecological planning. Planners draw on substantive theories for information and guidelines but use procedural theories as a framework to organize information in a form that readily permits the more direct application of information in addressing landscape-planning problems (Ndubisi 1997). An informed planner, therefore, will be aware of the substantive theories that guide and inform the operational methods that are applied in planning.

Resource or goal orientation

Planning methods can also be understood and classified according to their resource or goal orientation. The abiotic–biotic–cultural (ABC) model is useful to describe the specific goals addressed in planning and the level of integration between these goals (Ahern 1995). In this model, abiotic goals include water resources, soil and air quality. Biotic goals focus on biodiversity in general, including individual species and habitat protection and ecological restoration. Cultural goals are human-based and include: transportation, land use, recreation, historic preservation and economic goals. Figure 1 presents an array of planning types graphically organized within a triangle that represents the ABC model. In this diagram a number of planning sectors or themes are located according to their emphasis and level of integration within the ABC resources. The figure shows that an evolution is occurring towards a more integrated planning perspective as represented by the central circle.

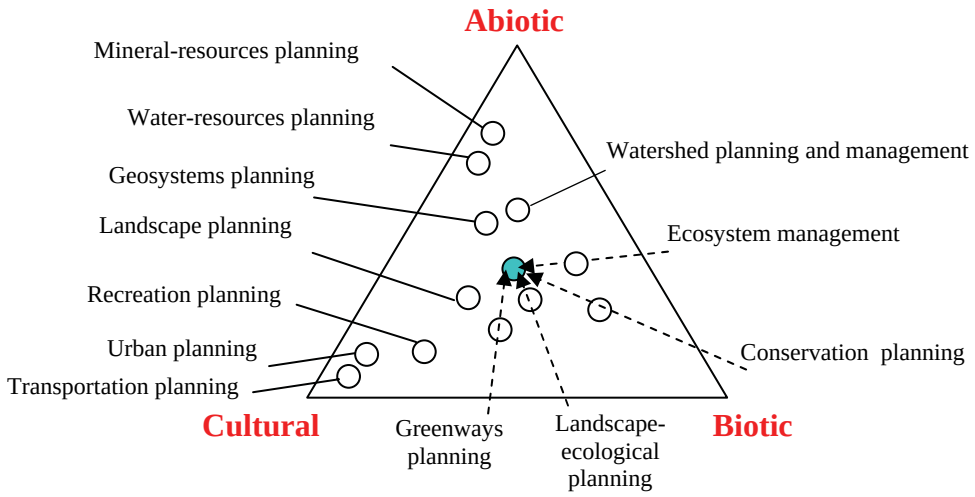


Figure 1. The abiotic, biotic and cultural resource-planning continuum (courtesy of A.B. Leitao)

Interdisciplinarity and transdisciplinarity

The trend towards interdisciplinarity and transdisciplinarity is central to sustainable planning and provides another useful tool to understand and classify planning methods. As discussed above, planning is arguably evolving towards an integrated or balanced approach wherein multiple abiotic, biotic and cultural goals are simultaneously pursued. Historically, this integration has involved knowledge and participation from multiple disciplines, initially under a multidisciplinary approach in which disciplines operated with minimal interaction and collaboration. Under the interdisciplinary approach, researchers and professionals from multiple disciplines collaborated, shared information and achieved a higher level of synthesis and integration. Contemporary researchers argue that transdisciplinarity represents a yet higher level of integration in which professionals, non-academic and academic participants participate in a process in which knowledge is shared across disciplines and all participants are engaged in decision making (Tress, Tress and Fry 2005). Under the transdisciplinary model, planning may become more integrated with research, enabling the multidimensional challenge of sustainability to be understood more rigorously with many disciplines involved, and the public (i.e. stakeholders, elected officials) are similarly involved in planning and decision making. The level of transdisciplinarity has become a key indicator of rigorous sustainability planning.

Strategic orientation

Planning methods can also be classified and understood according to their strategic orientation: protective, defensive, offensive or opportunistic (Ahern 1995). These strategies, in essence, define the planning context with respect to the macro-drivers of change in a given landscape and the strategic nature of the planners' response. Defining these strategies also helps to place the planning activity within a broader context, which is particularly important when planning methods are transferred or adopted for use in different locations, contexts or for different applications.

When the existing landscape supports sustainable processes and patterns, a protective strategy may be employed. Essentially, this strategy defines an eventual or optimal landscape pattern that is proactively protected from change while the landscape around it may be allowed to change. Benton MacKaye's (1962) vision of a metropolitan open-space system structured by a system of protected 'dams' and 'levees' is a classic example from North America. It can be effective to prevent landscape fragmentation in urbanizing landscapes by pre-defining a patch and corridor network for protection, for example. This strategy employs planning knowledge, regulation and land acquisition to achieve the desired spatial configuration (goal).

When the existing landscape is already fragmented, and core areas already limited in area and isolated, a defensive strategy is often applied. This strategy seeks to arrest / control the negative processes of fragmentation or urbanization. As a last resort, the defensive strategy is often necessary, but it can also be seen as a reactionary strategy which attempts to 'catch up with' or 'put on the brakes', against the inevitable process of landscape change, in defence of an ever-decreasing nature (Sijmons 1990).

An offensive strategy is based on a vision or a possible landscape configuration that is articulated, understood and accepted as a goal. The offensive strategy differs from protective and defensive strategies in that it employs restoration, or reconstruction, to re-build landscape elements in previously disturbed or fragmented landscapes. The offensive strategy relies on planning knowledge, knowledge of

ecological restoration, and significant public support / funding. It requires, by definition, the displacement or replacement of intensive land uses (e.g. urbanization, agriculture) with extensive land uses. This strategy is often practiced in locations where intensive land use has produced a cultural landscape with limited opportunities for nature protection or defence. The offensive strategy essentially involves 'putting nature back' into the landscape, according to an accepted vision or plan. It is rarely practiced because it is expensive and often politically sensitive.

A landscape often contains unique elements or configurations that represent special opportunities for sustainable landscape planning. These unique elements may or may not be optimally located, but represent the potential to provide particular desired functions. The rails-to-trails movement in the USA is a good example of opportunistic greenway planning (Little 1990; Flink and Searns 1993). This strategy is dependent on the presence of certain unique landscape elements, such as abandoned rail corridors. The opportunistic strategy involves recognition of special opportunities to add other functions to these corridors and to effect future landscape configuration to support ecological or cultural processes.

A planner should be aware of the drivers of change in a given landscape with respect to the goals of a particular plan. This awareness is the basis for informing a planner's choice of methods and of engaging the appropriate participants in the planning process.

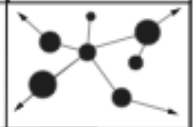
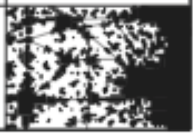
Spatial Concept	Examples & References	Metaphors & Synonyms	Diagram
Containment	• Cloister • Fortification • Greenbelt • Refuge	• Border • Barrier • Wall • Harness • Levee	
Grid	• U.S. 1785 Land Ordinance Survey • International School	• Network • Rational • Authority • Eglatarian • Anthropocentric	
Interdigitation	• The New Exploration (MacKaye, 1962) • Pattern Language (Alexander et al 1977) • Forman 1990a	• Harmony • Biocentric • Interdependent • Complementary	
Segregation	• Compartment Model (Odum, 1969) • Euclidian Zoning (USA) • MAB Biosphere Reserves	• Controlled • Strategic • Compromise • quid pro quo	
Network	• National Ecological Network (Netherlands) • U.S. Interstate Highway System	• Integrated • Linked • Nodes & Corridors • Stepping Stones	
Framework	• CASCO, Plan Stork (de Bruin et al, 1987) • Hydrological Framework (van Buuren & Kerkstra, 1993)	• Integrated Network • Topological & Chorological • Low Dynamic	
Laissez faire *(defacto no strategy)*	• Suburban sprawl • Megalopolis (Gottman, 1961) • Edge City (Garreau, 1991)	• Mosaic • Individualistic • Dynamic • Free-Market • Competitive	

Figure 2. Basic spatial concepts for landscape planning

Spatial concepts

Spatial concepts guide, inspire and communicate the essence of a plan or planning strategy. Spatial concepts are often articulated as metaphors, which are highly imageable and understandable by the public, but which also can support and inspire the planning process (Zonneveld 1991). Examples include: 'green heart', 'ring city' and 'edge city'. Spatial concepts are well accepted in planning, but less so in science since they are by definition subjective and derived from intuitive thinking. They represent an important interface of empirical and intuitive knowledge through which rational knowledge is complemented with creative insights. Spatial concepts are essential tools for proactive or innovative planning, and can structure and inspire the planning process, particularly with respect to public participation – a key factor in transdisciplinary planning.

Figure 2 presents a series of basic spatial concepts for planning. These can be understood as a kind of 'strategic tool box' with which planners can articulate strategies that respond to the given landscape context and configuration and the forces and dynamics of landscape change with the intention of planning a more sustainable spatial pattern.

An example of a more comprehensive spatial concept is Forman's 'Aggregate-with-Outliers Principle", which addresses the provocative question "What is the optimum arrangement of land uses in a landscape?" (Forman 1995, p. 437). Forman's concept states that land uses should be aggregated, yet maintain small corridors and small patches of nature throughout developed areas, as well as outliers of human activity spatially arranged along major boundaries. This strategic model for spatial planning, which addresses multiple landscape-ecological goals: maintains large patches of native vegetation; accommodates human needs / preferences; contains a variance of grain size; supports generalist and specialist species, spreads risks; supports genetic variation; and accommodates outliers located along a boundary zone.

Another important spatial concept in sustainable planning is the 'Framework Concept', which is based principally on abiotic geo-hydrological landscape patterns

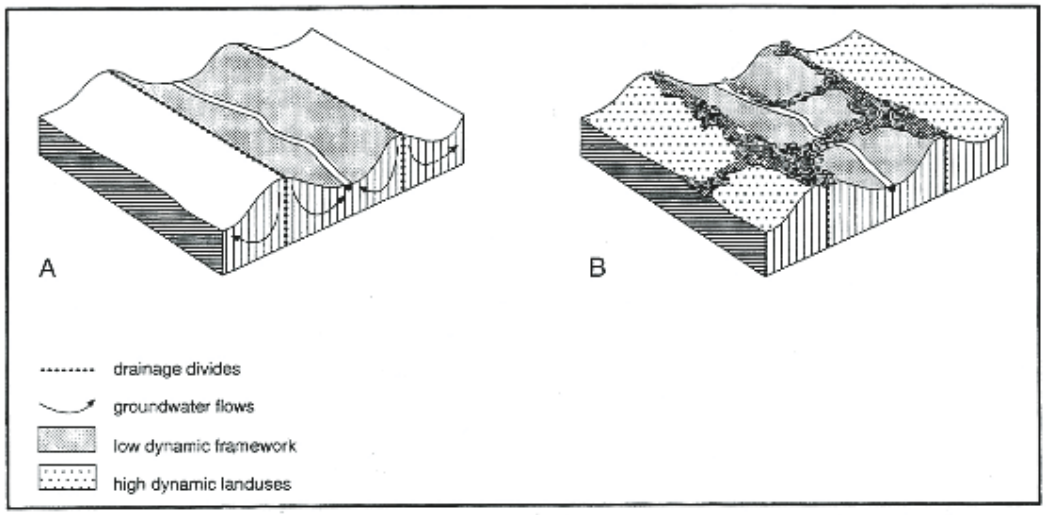


Figure 3. The Framework Concept (Van Buuren and Kerkstra 1993). 3A illustrates the concept of a hydrological unit defined by surficial topography and subsurface hydrology; 3B shows how the hydrological unit defined in 3A can be managed to support 'low-dynamic' nature / habitat redevelopment

that can be isolated and managed to provide for a linked network or framework of 'low-dynamic' functions (i.e. nature development; see Figure 3). Within the 'gaps' of the framework are complementary opportunities for 'high-dynamic' land uses (e.g. 'intensive agriculture' or 'urbanization' (Van Buuren and Kerkstra 1993). A version of the framework concept is represented in the Plan Stork for restoration of floodplain forests in The Netherlands (De Bruin, Hamhuis and Van Nieuwenhuijze 1987).

The typology presented above is intended to frame a more informed and transparent discussion and distinction among the many approaches and methods available for planning. As planning methods embrace the challenge of sustainability, integration and adaptation of existing methods will become necessary to address varying needs and goals. When a planner understands more explicitly how the methods can be distinguished, as by applying this typology, a more informed choice of method(s) may be made. Following are three procedural planning methods that may be relevant, or adaptable, to implement sustainable landscape planning across a range of contexts.

Selected sustainable landscape-planning methods

Three planning methods will be briefly presented and discussed in terms of the typology presented. All three are considered procedural methods, intended to operationalize the planning process.

Ecological Planning Model

Steiner's Ecological Planning Model (1991; 2000) addresses multiple abiotic, biotic and cultural goals, with a focus on land-use allocation. The model is an 11-step procedure for studying the biophysical and socio-cultural systems of a place/landscape to reveal where specific land uses may best be practiced. It is based on Ian McHarg's Ecological Planning Method. The Ecological Planning Model includes an emphasis on goal establishment, implementation, administration and public participation through systematic education and citizen involvement throughout the process (see Figure 4). It can be considered transdisciplinary as it involves professionals, experts and citizens in a highly interactive process. The framework is adaptable to multiple strategic contexts and it employs spatial concepts in the form of design explorations at a finer scale. The Ecological Planning Model has been applied effectively across a range of cultural and environmental contexts.

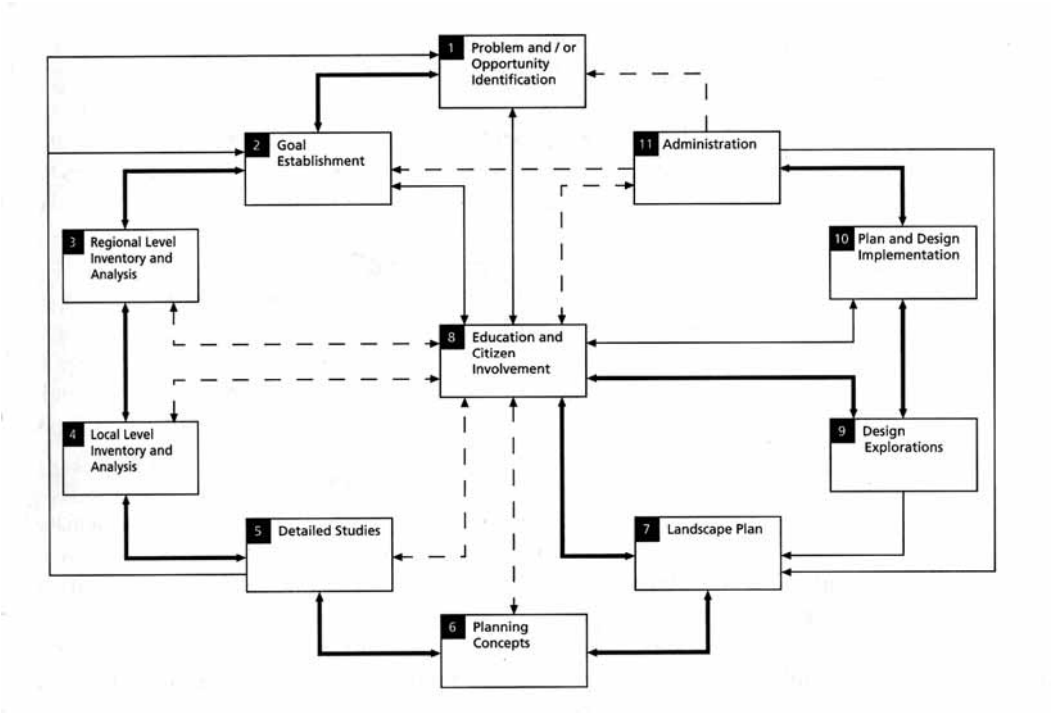


Figure 4. The Ecological Planning Model (Steiner 2000)

Framework Method for Landscape Planning

Steinitz' Framework Method for Landscape Planning (1990; 1995) is presented as a series of six questions that are fundamental to landscape planning:

1. Representation: How should the state of the landscape be described in terms of content, boundaries, space and time?
2. Process: How does the landscape work? What are the functional and structural relationships among its elements?
3. Evaluation: How does one judge whether the current state of the landscape is working well? The metrics of judgment include: beauty, habitat diversity, cost, nutrient flow, public health or user satisfaction.
4. Change/Intervention: By what actions might the current representation of the landscape be altered (whether conserving or changing the landscape)?
5. Impact: What predictable differences might the changes cause (i.e., using process models to simulate change)?
6. Decision: How is the decision to change (or conserve) the landscape to be made? How is a comparative evaluation to be made among the alternative courses of action?

Steinitz' framework provides a robust and flexible process for assessing a landscape and for engaging scientific experts, professionals and stakeholders in an informed, iterative and participatory planning process. The framework is suited to address multiple ABC goals, and is adaptable to any strategic planning context. It can be considered transdisciplinary as it integrates public and expert participation. The framework does not include spatial concepts per se, however in practice it develops alternative future scenarios that represent a form of spatial concept.

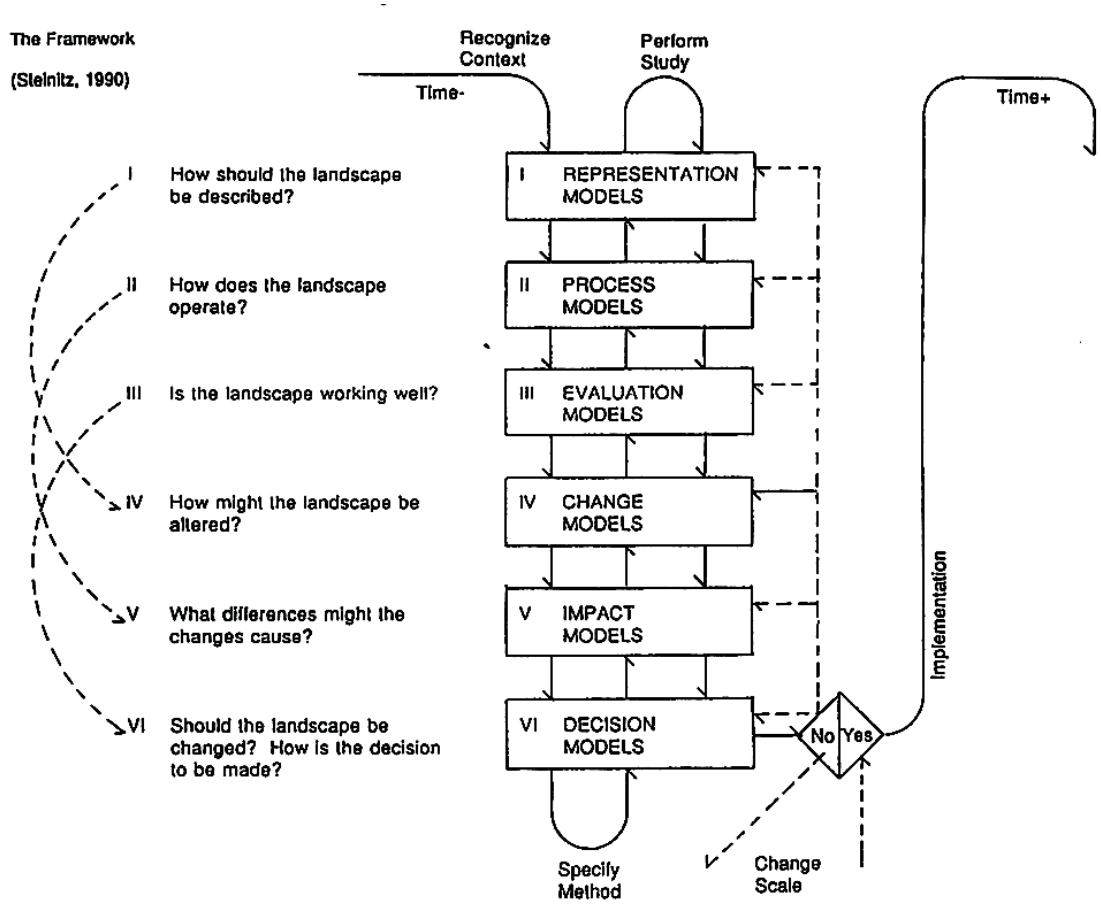


Figure 5. Framework Method for Landscape Planning (Steinitz 1995)

Framework Method for Sustainable Landscape Ecological Planning

The Framework Method for Sustainable Landscape Ecological Planning explicitly addresses multiple abiotic–biotic–cultural goals and resources (Ahern 1995; 1999). The Framework is presented as a linear process, but actually is nonlinear, cyclical and iterative and may be entered at any point in the process (e.g. planning could start with a reevaluation of an existing plan). It was conceived to be transdisciplinary, as it includes knowledge from science, planning and stakeholders and citizens. The method explicitly acknowledges the strategic context, and relies on spatial concepts to resolve patterns of spatial compatibility and conflict. This method is based largely on landscape-ecological theory and concepts, as understood and applied through spatial assessments and spatial concepts. As with Steinitz' method, this framework guides the planning process through a series of alternative future scenarios, to inform, inspire and challenge the decision-making process to link planning actions with potential outcomes. The scenarios describe a current situation, some alternative future(s) and the necessary steps or actions needed to link the present with the future. These scenarios are not intended to be complete plans, but are appropriate for encouraging informed discussion of alternatives. The scenarios are evaluated, with public, expert and stakeholder input. The discussion leads to a landscape plan that is adaptive in terms of implementation, monitoring and education.

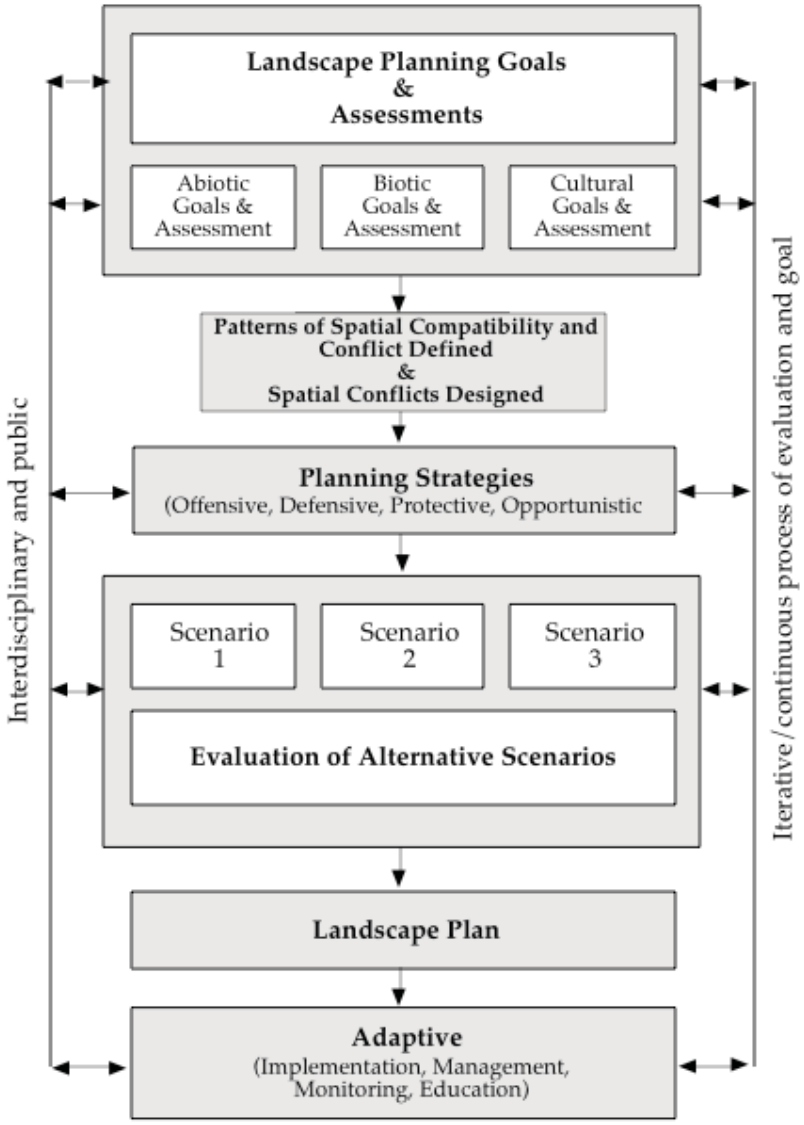


Figure 6. Framework Method for Sustainable Landscape Ecological Planning (Ahern 1999)

Barriers, challenges and strategies to implement sustainable landscape planning

The preceding typology and discussion of selected methods was presented to frame the subject of sustainable landscape planning. Regardless of the method selected or adapted, significant barriers and challenges exist to the implementation of sustainable landscape plans. Chief among these are: uncertainty and adaptability.

Uncertainty is inherent in multipurpose planning. Uncertainty exists in several principal forms relative to planning: geographical/spatial, temporal, process, transferability, and human input unpredictability. Strategies from science are helpful to aid planners in reducing uncertainty, including: replication and pseudoreplication of data, the use of data analogues, developing multiple hypotheses, and monitoring.

Planners operate in the 'real world' where there is an imperative to act. The world doesn't stop or wait while planners work to collect data to reduce uncertainty. Planning operates on a target that is, by definition, moving. The adaptive approach re-

conceives uncertainty as an opportunity to 'learn by doing'. Adaptive management has been practiced in resource management for at least two decades, but has not yet been widely integrated into planning. Adaptive management re-conceives management actions as experiments that have testable hypotheses (Rutledge and Lepczyk 2002). Whereas traditional management hesitated to apply new policy decisions until proof of efficacy was obtained through long- and short-term empirical studies, adaptive management is a proactive method under which projects and policy decisions are used as 'experimental probes', to learn by doing (Holling 1978; Walters 1986). Data made available upon the outcome of each policy decision or model implemented are used to structure alternative and future choices (Walters and Holling 1990), attempting to reduce the amount of uncertainty and improving ecological knowledge and understanding over time. Monitoring is the primary tool used to gauge the efficacy of decisions made, and is itself the subject to a wide range of uncertainty. In the adaptive approach, uncertainty lies in determining appropriate systems or populations of study, spatial-temporal scales and geographic extent. Under a traditional planning/decision-making approach, decisions on each of these areas of uncertainty would be made before a plan was implemented and before a monitoring programme could be designed. Under an adaptive approach, these principle areas of uncertainty (determining appropriate systems or populations of study, spatial-temporal scales and geographic extent) can become part of adaptive hypotheses, which can then inform both planning and monitoring actions and interpretations.

To achieve a true adaptive planning method will require a process that is genuinely transdisciplinary. Adaptive planning requires that the planner accept a certain level of uncertainty and risk, maintain a commitment to monitoring, and perhaps most importantly, be willing to fail.

Thresholds and guidelines represent important alternatives to adaptive planning and can aid sustainable planning. Dale et al. (2000) developed the following generic guidelines for land-use planning and management that serve an important function in framing the key issues and questions, and to inform sustainable planning decisions:

1. Examine the impacts of local decisions in a regional context.
2. Plan for long-term change and unexpected events.
3. Preserve rare landscape elements and associated species.
4. Avoid land uses that deplete natural resources over a broad area.
5. Retain large contiguous or connected areas that contain critical habitats.
6. Minimize the introduction and spread of non-native species.
7. Avoid or compensate for effects of development on ecological processes.
8. Implement land-use and land-management practices that are compatible with the natural potential of the area.

The Environmental Law Institute developed a series of conservation thresholds intended to inform biodiversity planning (2003). The thresholds are based on a systematic literature review to synthesize quantitative scientific findings and to present specific recommendations regarding key conservation-planning parameters including: minimum patch area by species type, proportions of suitable habitat, size of edge effects and riparian buffer width. While this level of generalization may be unacceptable to scientists, under an adaptive planning model, they could be applied and tested, thus potentially yielding new knowledge.

Conclusions

The global focus on sustainability is influencing planning theory to converge in several respects. There is a distinct focus on spatial planning at a broad/landscape scale in recognition of the widespread acceptance of substantive theories from landscape ecology. Under the sustainability paradigm, single purpose, sectoral planning is being replaced with multipurpose planning that explicitly acknowledges the integrated continuum of abiotic, biotic and cultural resources goals. The complexity and scale of broad-scale, multipurpose planning necessitates a transdisciplinary approach to address the complexity of the challenge, while engaging citizens affected by the plan in meaningful ways. If there is a frontier in sustainable planning, I believe it lies in the development of an adaptive approach to planning in which plans are made with the best knowledge available, but with explicit acknowledgment of uncertainty, followed by monitoring and re-evaluation of plans in order to close the loop, and to 'learn by doing'.

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