# Approaches for spatially explicit cost-effectiveness analysis of conservation policy mixes

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The dramatic loss of species since industrial times and particularly in the past 60 years shows that the efforts that have been dedicated until now to protect biodiversity and the provision of ecosystem services have proved to be insufficient. There is therefore a need to design policies that in a more effective way address the problems that derive from the changes forced on nature by human activities. The evaluation of existing policies provides the basis to improving existing policies.

Typical for the nature conservation problem is that multiple protection objectives encompassing different geographical scopes are necessary. These are more likely to be addressed successfully by a variety of complementary and synergetic instruments, a policymix, rather than by single instruments. This complexity needs to be addressed both when formulating and designing conservation policies, and in their evaluation. Cost-effectiveness is one criterion for evaluation that can help adapt policies to achieve more gains in conservation assuming a certain level of costs.

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Conservation gains are often assessed through simple indicators such as number and/or area of protected areas, but attention to more refined ecological criteria can more adequately evaluate impacts. One important consideration is that different ecological processes are threatened at different spatial scales. A tiered approach to assess gains at different nested levels of governance and of ecological scale is therefore needed.

The complexity of the conservation problem sets further limits to policy evaluation; an overall measure of biodiversity is practically not feasible, but appropriate indicators, combined with reference values, permit to assess relative changes in time.

Conservation planning tools (CPTs) have typically been designed for effective conservation planning, thereby, they offer opportunities for conservation policy analysis based on indicators such as the representation of ecological diversity, and the spatial coherence and size of areas under conservation actions. The algorithms compare gains in conservation in terms of these indicators with the costs

associated with the conservation actions thereby, enabling cost-effectiveness analysis. In addition, CPTs enable to address the spatial structure of the conservation problem. Particularly suitable to the conservation problem is that some CPTs, such as Marxan with zones, can support the analysis of a policymix by evaluating conservation gains attributed to the various instruments through a common 'currency of effect', the instrument's contribution to the achievement the conservation targets. Both *ex-post* analysis and prospective, *ex-ante*, analysis for instrument design or improvement can be conducted with CPT methods.

Using examples from the application of CPT methods in the case studies in Norway, São Paolo State (Brazil), Costa Rica and Portugal, we illustrate the potential and limitations of CPT methods for conservation policy mix analysis; and we compare the pros and cons of CPT methods with Program Impact Evaluation methods (BACI) for *ex-post* policy evaluation.